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When is Automated Feedback a Barrier to Timely Feedback?

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Introduction

- Computing courses continuing to grow
  - 1000+ students in introductory classes
- Struggle to provide students with timely access to help in office hours
- Common solutions
  - More instructors via peer teachers
  - Automated feedback, like an autograder

Related Work

- Peer teacher feedback in office hours organized by a web-based office hours queue [Smith ‘17]
  - Students face long wait times
- Automated feedback systems are used to provide timely feedback to students [Gao ‘16, Sharrock ‘19, Perretta ‘18, Keuning ‘18, Singh ‘13]
  - Near zero wait time
  - Limited feedback styles

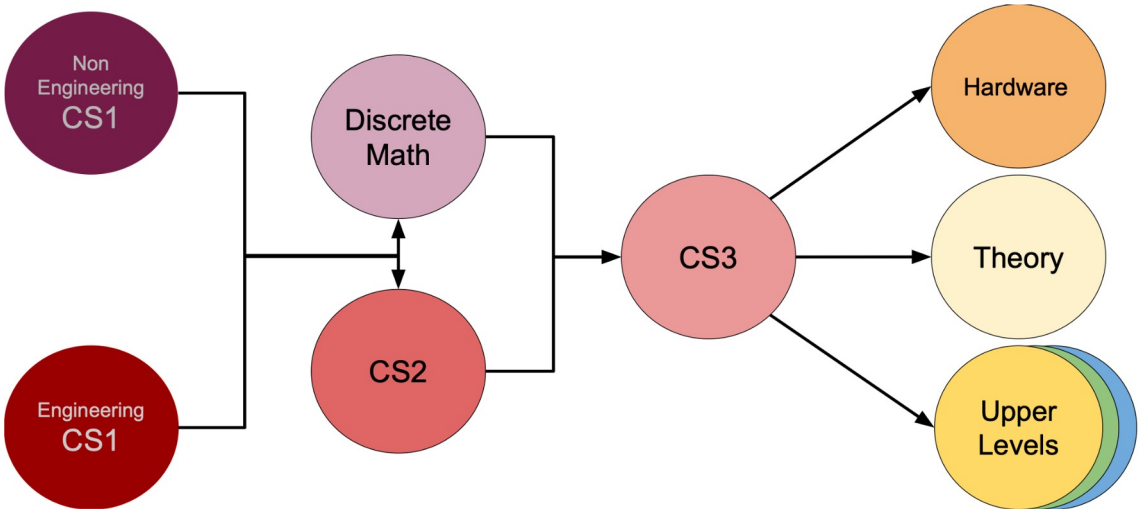
We examine the relationship between automated feedback and demand for peer teacher help in office hours

Research Question

Is there an association between autograder feedback style and demand for office hours?

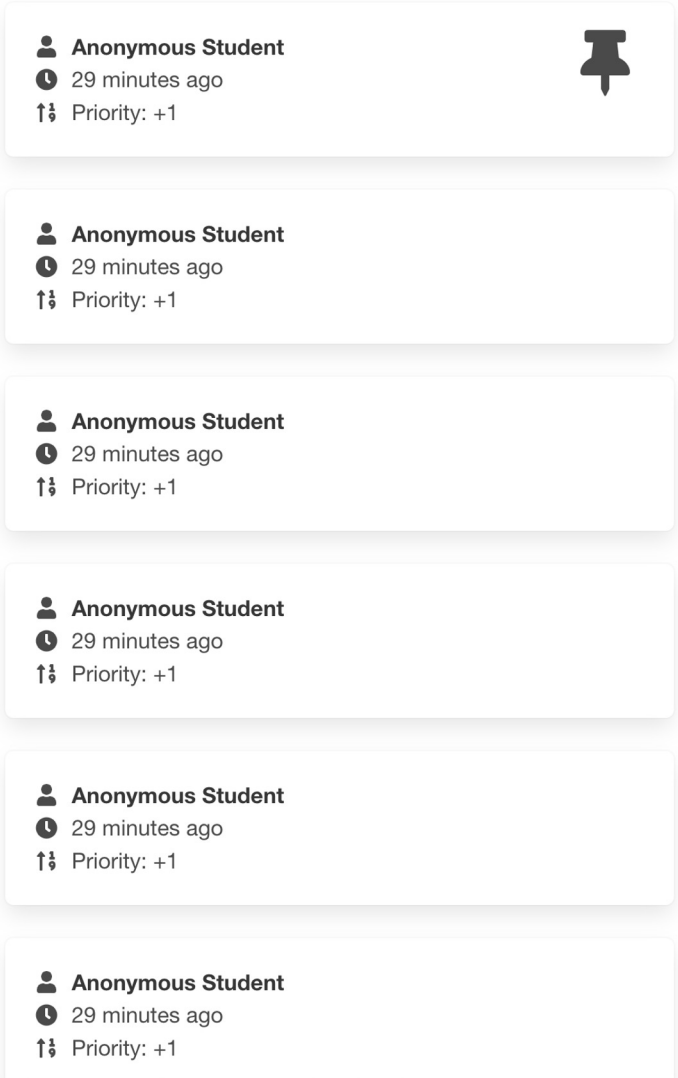
Curriculum Overview

- Data collected from computer science courses at a large public research institution
- Web-based queue to facilitate office hours
- Automated feedback with an autograder



Office Hours Queue

- Students join a digital queue
- Instructors remove students when helping them
- Record wait time
- Record encounter length (time spent with student)



Autograder

- Student submits code to web interface
- Autograder provides feedback

- Four different categories of feedback
  - **Hidden code**, no feedback
  - **Hidden code**, opaque feedback
  - **Hidden code**, detailed feedback
  - **Visible code**, detailed feedback

Hidden Code

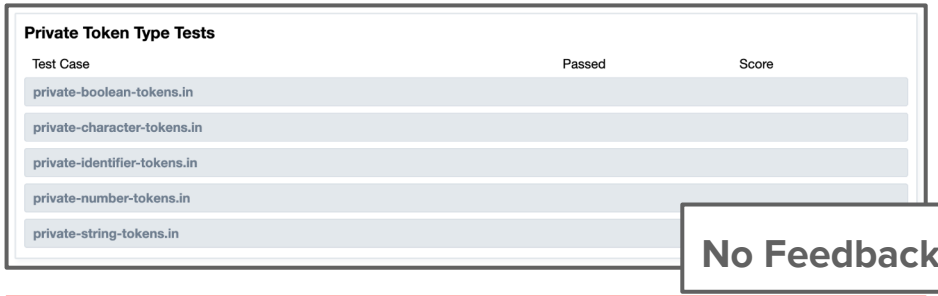
Test case source code is *not* published.

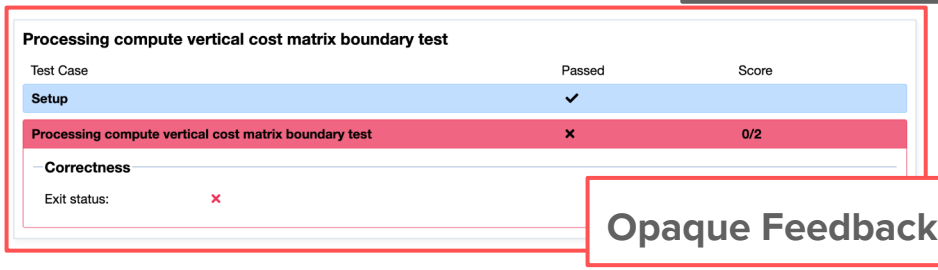
Visible Code

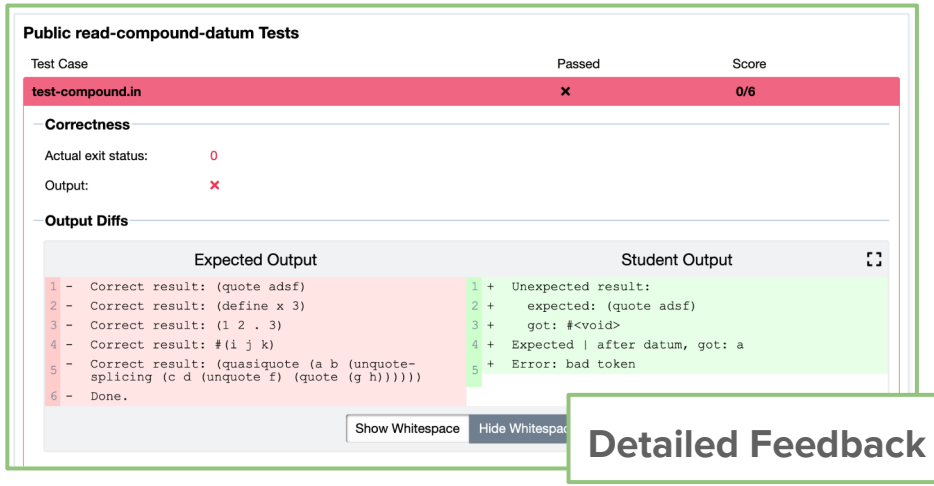
Test case source code is published.

Autograder

- Hidden code, **no feedback**
  - Most tests run after deadline
- Hidden code, **opaque feedback**
- Hidden code, **detailed feedback**
- Visible code, **detailed feedback**







Dataset

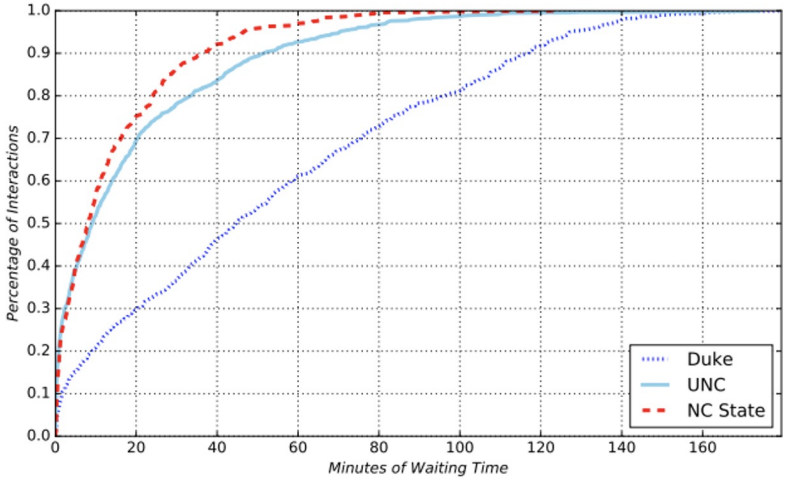
- 105941 records
- 17 unique courses
  - 2 100-level
  - 4 200-level
  - 2 300-level
  - 9 400-level
- 3 years of data collected between September 2016 and December 2019
  - Pre-COVID

Data Validation and Confounding Variables

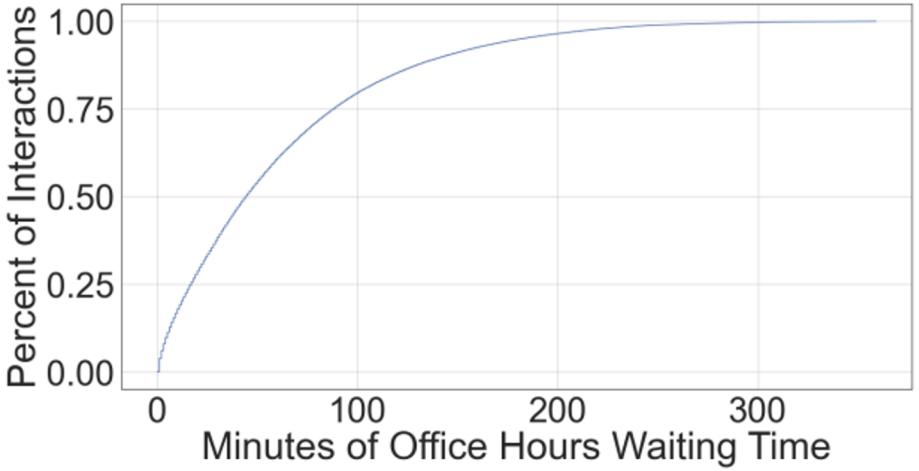
Does our data match previous work?

Key Takeaway

Many students, across institutions, are waiting for at least 1 hour to receive help in office hours

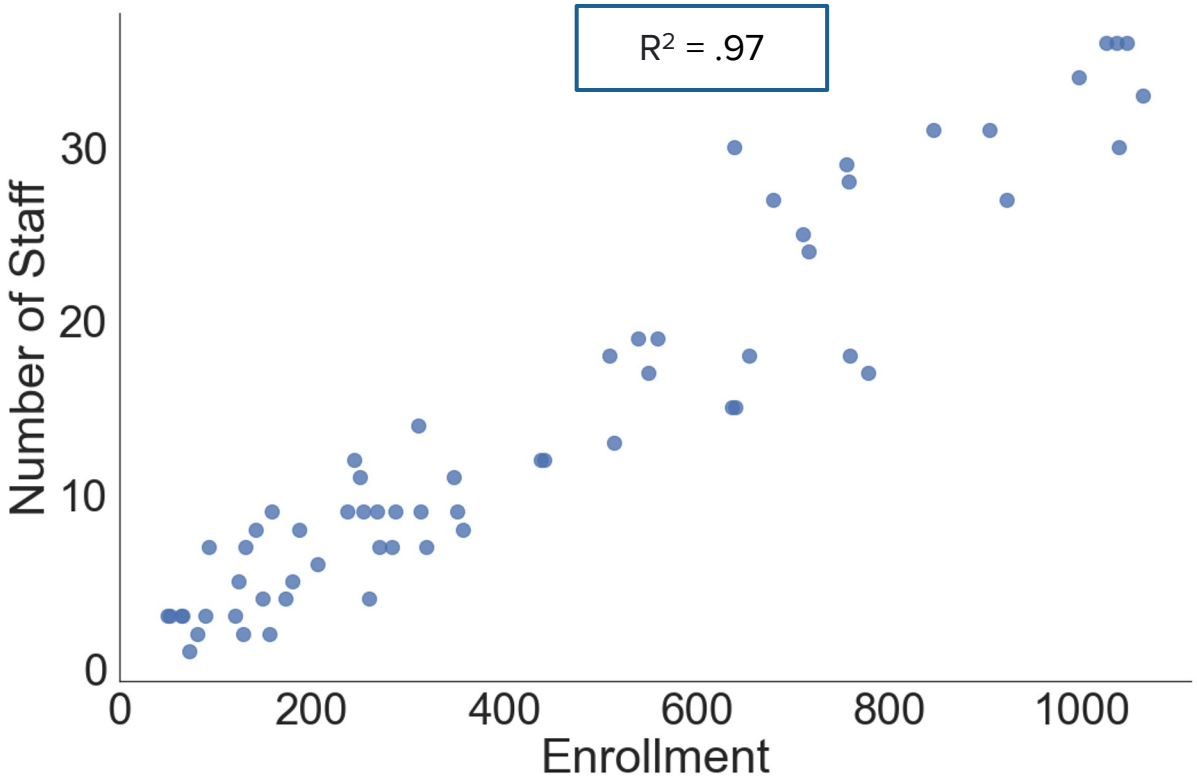


Smith Et. Al.



Keefer and DeOrio

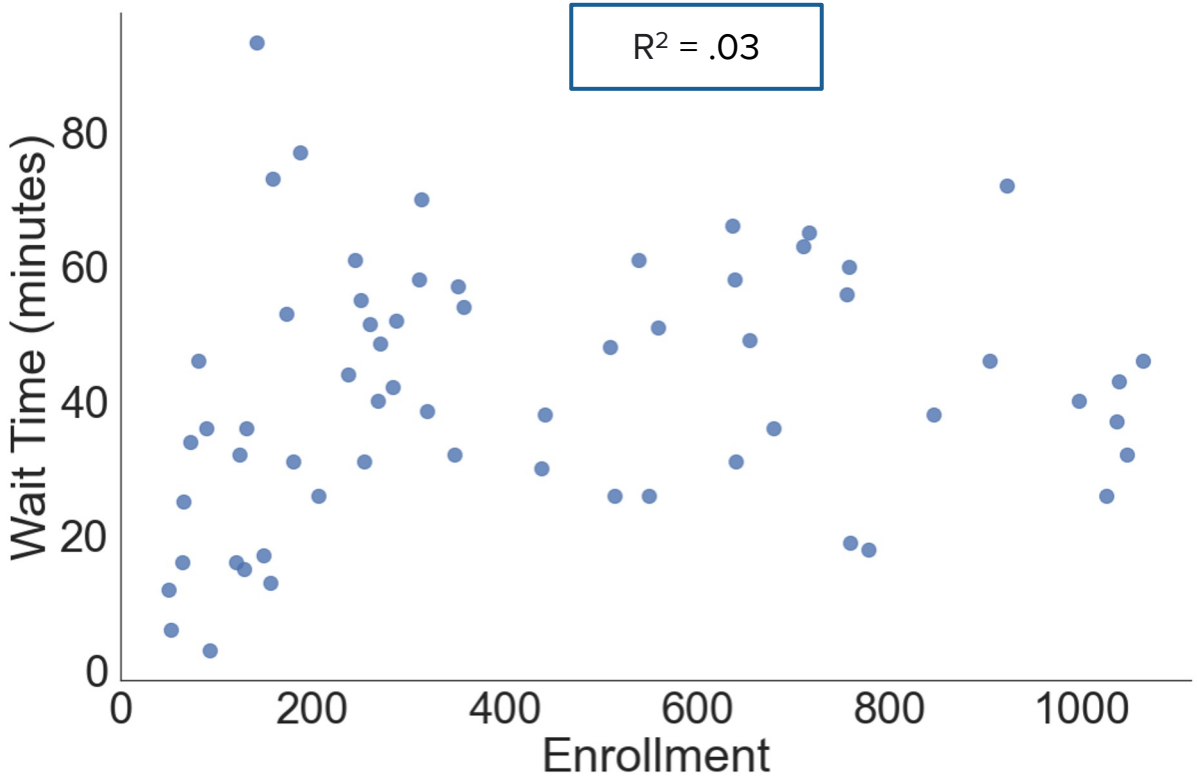
Do some classes have more staff?



Key Takeaway

All classes in our study have similar capacity to help students

Do larger classes have longer waits?

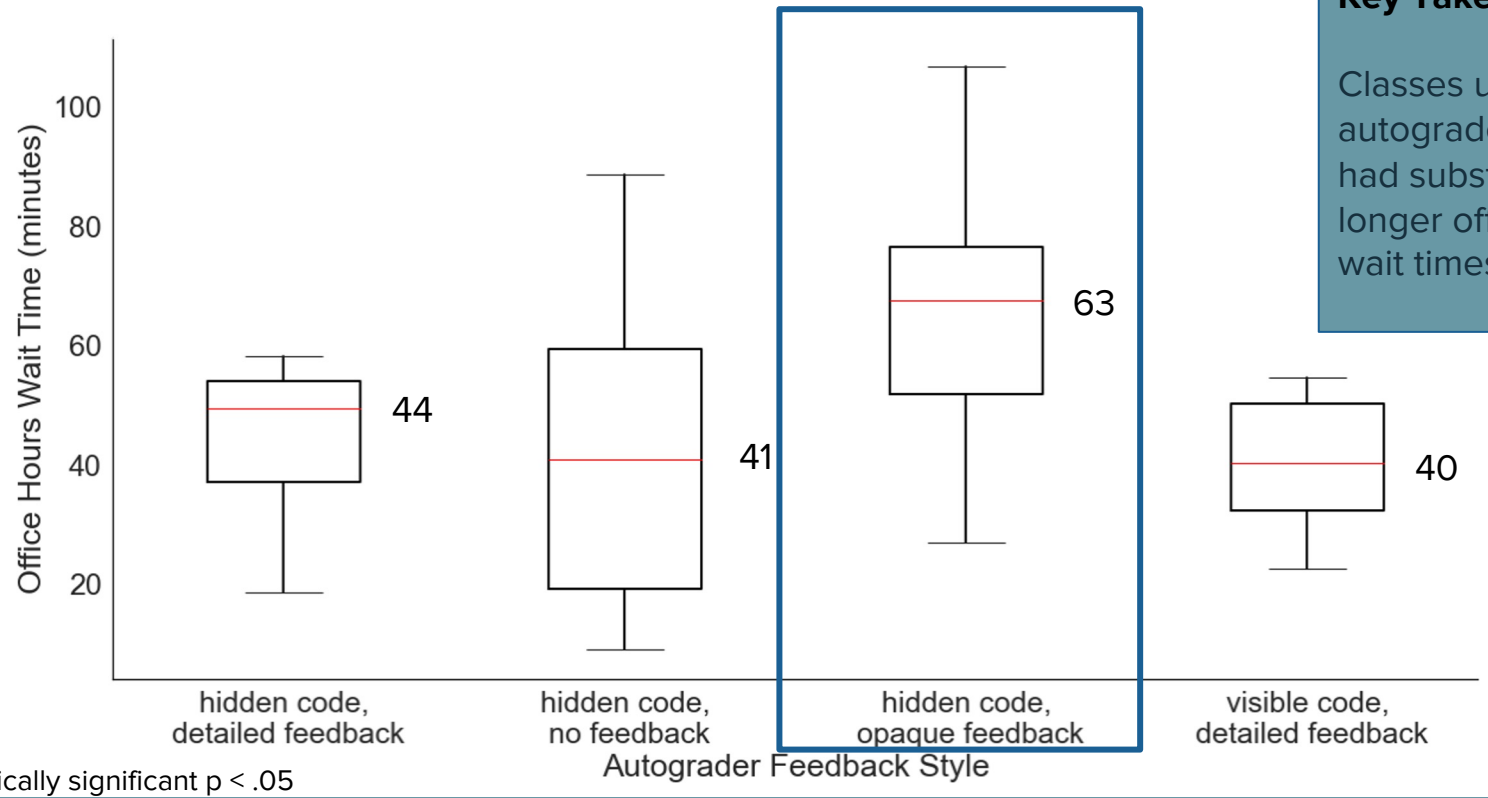


Key Takeaway

Classes of any size can have long waits

Is All Automated Feedback Equally Helpful?

Do wait times vary by automated feedback style?

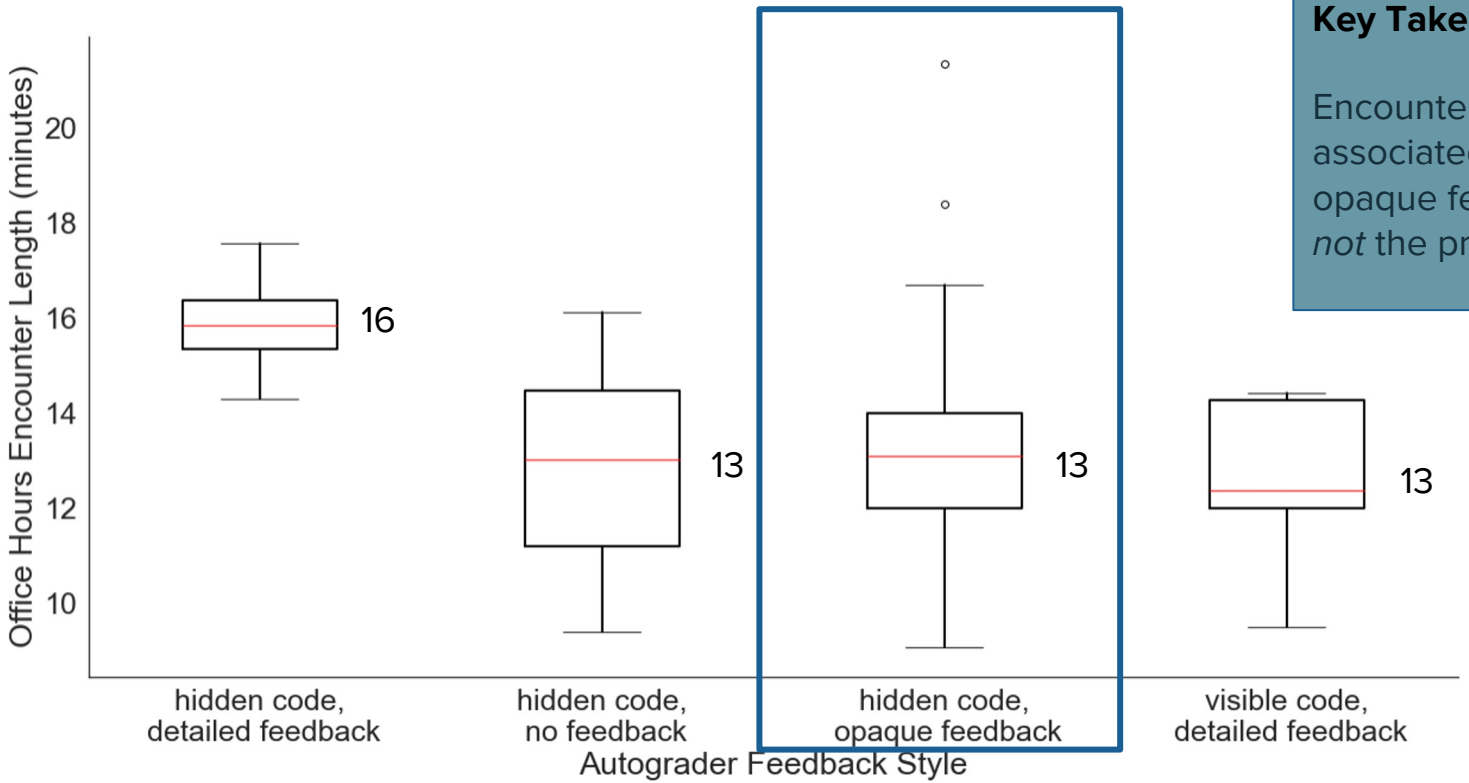


Key Takeaway

Classes using opaque autograder feedback had substantially* longer office hours wait times

*Statistically significant $p < .05$

Do encounter lengths vary by feedback style?



Key Takeaway

Encounter length associated with opaque feedback is *not* the problem.

Discussion

- Classes using opaque feedback had substantially longer wait times compared to classes using other feedback styles
- Classes using opaque feedback did not have substantially longer encounter lengths compared to classes using other feedback styles

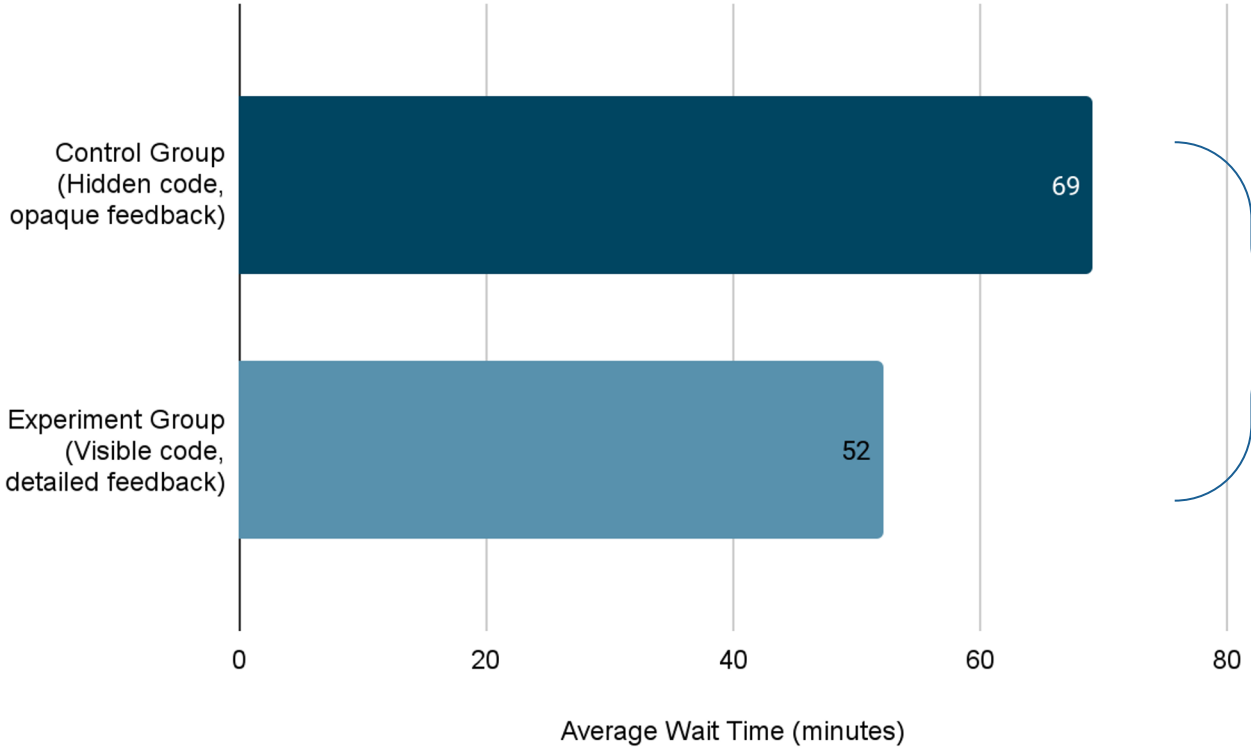
Hypothesis: There is a greater demand for office hours in classes with opaque automated feedback

Case Study

What happens to wait time when feedback style changes?

- Web Systems course during two consecutive offerings
- Control group used an autograder with the “Hidden code, opaque feedback” style
- Experiment group used an autograder with the “Visible code, detailed feedback” style

Case Study Results



24% decrease in mean wait

Key Takeaway

There was a statistically significant* drop in wait time

*Statistically significant $p < .05$

Conclusions

- Statistically significant association between feedback style and wait times for peer teaching office hours
- “Hidden code, opaque feedback” style associated with 43-57% longer wait times
- Changing feedback style to provide more detailed feedback resulted in a 24% decrease in mean wait time in case study

Conclusions

- Opaque feedback may incentivize students to come to office hours with questions about why a test is failing.
- Some automated feedback may counter-intuitively increase the amount of time it takes for students to get useful feedback.
- Courses using opaque feedback for pedagogical reasons may need to plan for extra office hours resources