Active Learning for Upper-Division Computer Science Majors

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Introduction

Traditional lecture doesn't work. This is evident from two factors:

1. Graduation rates are low (4 yr => 13% & 6 yr => 38.1%)[1]
2. Retention rates are low (43% S & E)[2]

Where does this come from?

- Low academic performance

Literature Survey

Literature supports active learning over a traditional lecture classroom.

Active Learning strategies, based on a social learning atmosphere:

- Flipped Classroom (HW in class)[6]
- Just-in-time Teaching (Online quizzes)[3]
- Peer Instruction (Group Activities)[4]
- Pair Programming (2-to-1)[5]

Expected:

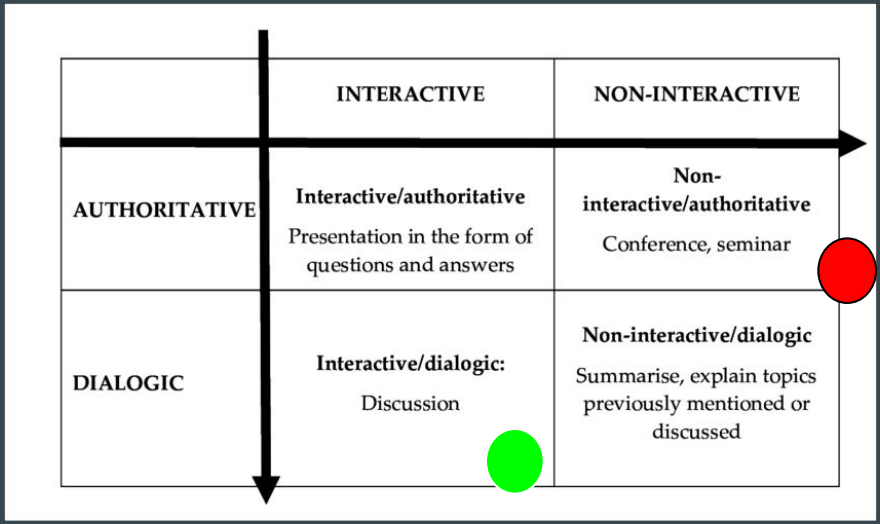
- Increase in quality of social interaction
- Increase in academic performance

Background

Upper Division (UD) CS is incredibly understudied.
Most other studies deal with introductory CS courses if they deal with CS at all.

Experimental Classroom:

Traditional Classroom:



[7]

This is the first study to implement these pedagogical strategies in conjunction with each other for Artificial intelligence and compares to a control group..

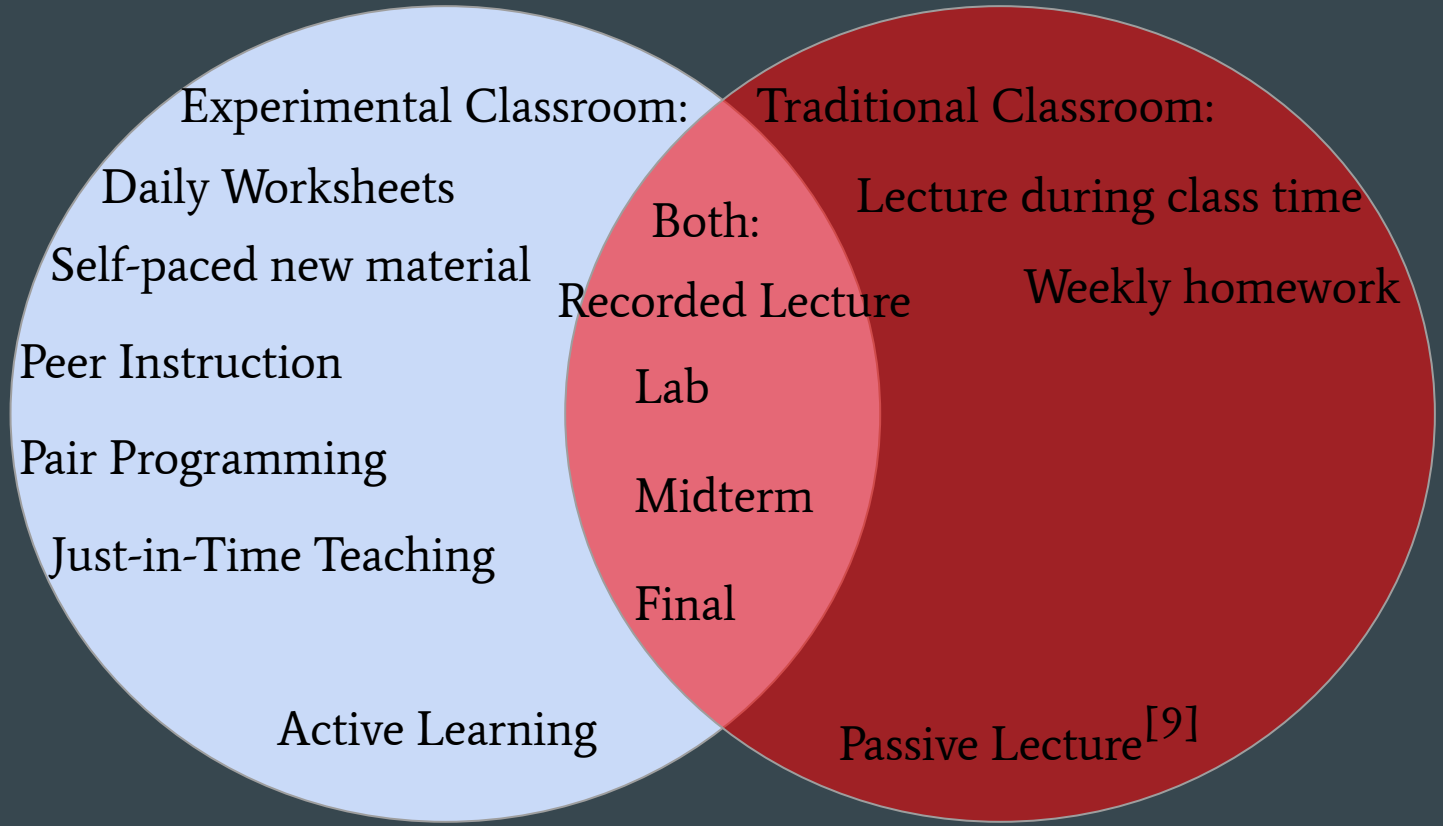
Research questions

1. If an instructor provides prerecorded video lectures and has notes available to students at any time. Will they benefit?
2. How does instructor confidence affect the experience in the classroom?
3. Does the flipped classroom model positively affect student-to-student and student-to-instructor/ISA interaction?
4. Does active learning positively impact academic performance in upper division CS?

Survey methods

- Pre- and post attitudinal likert scale surveys (Ques. 1, 2, 3)
  - Distributed and collected at the beginning and end of the semester
  - Normalize conditions/biases
- Midterm and final scores to measure quantitative performance (Ques. 4)
- Kahoot! Performance (Ques. 3)
  - “Kahoots”, are multiple-choice quizzes that can be accessed via a web browser or the Kahoot app.[8]
  - We use this to measure student-to-student interaction between the control and experimental groups.

Novel Pedagogical strategies



Qualitative Results

- Our study is currently in progress with data collected only from the control group, but here are some responses that affirm a few of our research questions so far
  - “Sometimes the content can be bland and it can become ~~~ simply reading powerpoints.” [sic]
  - “Usually, I find powerpoint material in STEM courses to be ineffective, while handwritten or typed lecture notes are specifically tailored to a class and usually more useful.”
  - “Most professors should do video recordings because it helps. Having a detailed syllabus of what the class will be discussing in lecture daily helps.”
  - “*Lectures are recorded and edited * Notes always available [checked box] this class is quite good.”

Conclusions

- Traditional lecture is not effective, students underperform
- Active learning forces active participation and engagement with the learning material
  - It encourages social engagement with peers, the instructor and instructional student assistant.
- Study still underway, though we expect active learning, peer instruction, pair programing and just in time teaching fixes the issues with traditional lecture

Citations

1. Graduation: https://www.collegefactual.com/colleges/california-state-university-bakersfield/academic-life/graduation-and-retention/chart-graduation-rate-first-full.html
2. Retention: https://www.nsf.gov/nsb/sei/edTool/data/college-10.html
3. Jjit: https://onlinelibrary.wiley.com/doi/abs/10.1002/tl.469
4. Peer-instruction: https://dl.acm.org/doi/abs/10.1145/2499947.2499949
5. Pair programming: https://dl.acm.org/doi/abs/10.1145/1145287.1145293
6. Flipped classroom: https://www.msuedtechsandbox.com/MAETELy2-2015/wp-content/uploads/2015/07/the_flipped_classroom_article_2.pdf
7. Authoritative & dialogic: https://www.researchgate.net/figure/Different-Communicative-Approaches-Mortimer-Scott-2003-p-35_fig1_303900031
8. Kahoot: https://kahoot.com/what-is-kahoot/
9. Active v passive: https://onlinelibrary.wiley.com/doi/abs/10.1002/hrdq.20025

Questions

- Is flipped classroom or any of these methods effective?
- How were worksheets implemented?
- What are the differences between graduation & retention rates?
- What are the differences between pair programming and peer instruction?

Appendix A: Is flipped classroom or any of these methods effective?

All methods implemented have shown promise in lower division and non cs related courses.

In one case, peer instruction was implemented with upper division cs courses and it improved academic performance among that group.

Appendix B: How were worksheets implemented?

Worksheets were created well before students attended class. The ISA would review the worksheet before attending class.

1. Students are broken into pairs
2. One is assigned the navigator role the other the driver
3. Navigator vets questions and responses
4. Driver clarifies questions if needed. Discusses the question with navigator and answers questions
5. After a few questions, roles are swapped.
6. During this entire process, the instructor and ISA walk around the class to answer any questions that may need more clarification
7. Students are graded on participation

Appendix C: What are the differences between graduation and retention rates?

Graduation Rates are the rates at which students finish university or college.

Retention rates are the rate at which first time freshmen return to university or college.

Appendix D: What are the differences between peer instruction and pair programming?

Peer instruction is questions asked generally to the class and students answer these questions in groups.

Pair programming is two programmers on one terminal to solve one problem.