Evaluating Mastery-oriented Grading in an Intensive CS1 Course

Igor Montagner, Rafael Corsi, Andrew Kurauchi, Mariana Silva, Craig Zilles

Insper | The Grainger College of Engineering Computer Science

Igor Montagner (igorsm1@insper.edu.br)

Our context - Insper

- Brazilian private non-profit institution
- Scholarships + stipends for 10-15% of students
- CS major started in 2022
- Cohort-based (*no courses outside of major*)
- Enrollment: 50 students per semester

Igor Montagner (igorsm1@insper.edu.br)

Developer Life - Intensive CS1 course

- 24 hours per week
- 6 two-hour in person meetings
- 5 office hours
- Active learning with occasional mini-lectures and live coding
- Shared between 3-5 professors

Igor Montagner (igorsm1@insper.edu.br)

DeveloperLife - Intensive CS1 course

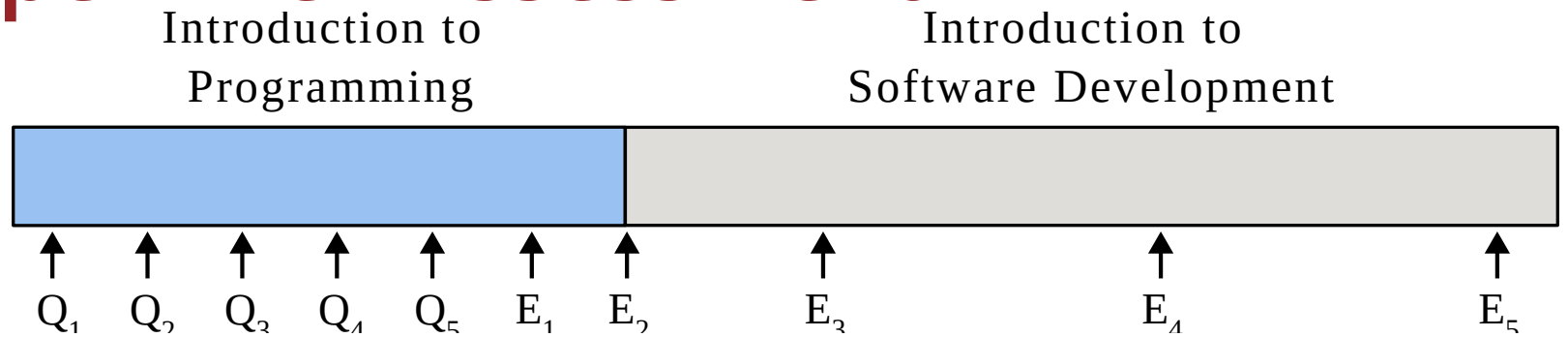
Broad view into many aspects of computing

Students are able to deliver a working software

Every course from the 2nd semester on can involve coding

Igor Montagner (igorsm1@insper.edu.br)

Developer Life - Assessment



- 5 low stakes formative quizzes Q_i worth 10% of final grade
- 5 high(er) stakes Exams E_i worth 55% of final grade
- Each week a new topic is included

Exams are spread over the semester to allow student to catch-up if necessary

Final exam grade is the average of the 3 largest scores

Igor Montagner (igorsm1@insper.edu.br)

First experience (challenges)

- **Tendency to increase the gap between the faster and the slower learners**
- For students, catching-up was hard even with 5 exams
  - Double the workload
  - Even higher stakes on the last exam
- Coding-only exams gave us (instructors) little feedback on students weaknesses

Mastery Learning and Second-chance testing

Incorporate a way to help students catch-up into the "regular" course path

Second-chance testing: Every assessment includes a retake a few days later and some time dedicated to reviewing mistakes.

- Reduce failure rates
- Study for the second-chance remediating material missed on the first one
- Reduces self-reported test anxiety

Igor Montagner (igorsm1@insper.edu.br)

Research Questions

- **RQ1**: Do second chances help students to increase their performance over time in intensive courses?
- **RQ2**: Are second chances effective in reducing stress/mental load/weight of assessments in intensive courses?

Intervention

Cohort of Fall 2023 had the following changes

1. Add second chances for Quizzes
2. Two types of questions:
    - Short answer - parsons, multiple choice, fill the blank
    - Coding - autograded, involve problem solving, manual code quality evaluation
3. Extra week for reviewing material between Exams 1 and 2

Igor Montagner (igorsm1@insper.edu.br)

Week 1: variables, operations and functions

Week 2: conditionals
Week 3: loops (while)
Week 4: lists + for
Week 5: dictionaries

Week 6: problem solving

Week 7: coding competitions (optional)

Legend

Content Quiz Retake Exam

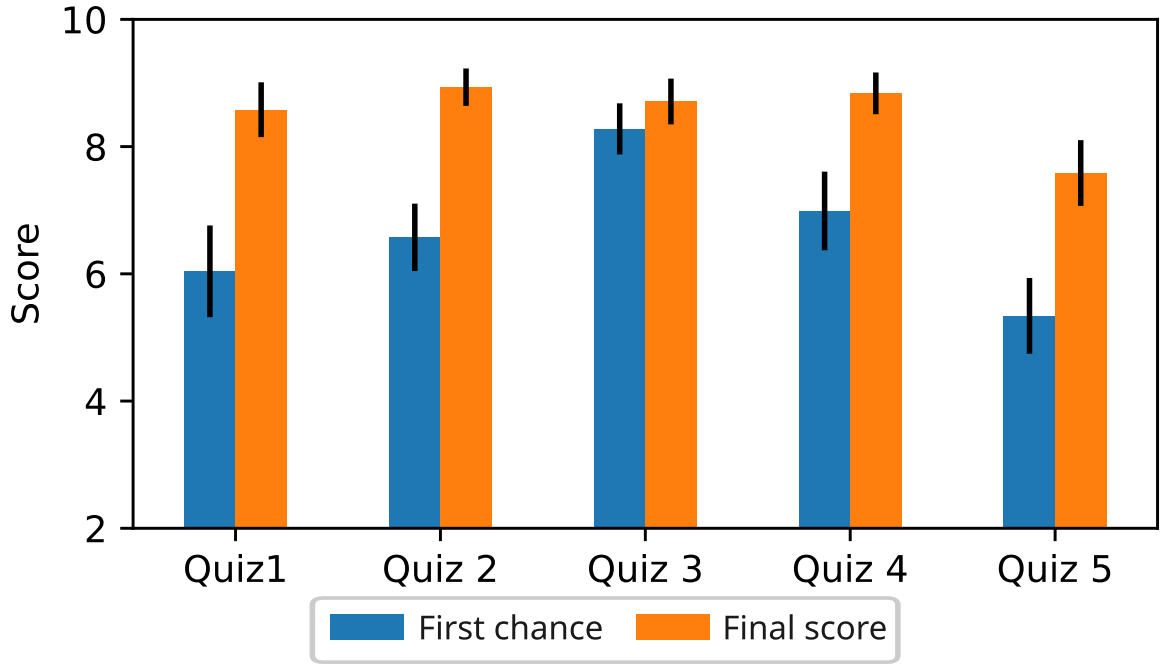
Igor Montagner (igorsm1@insper.edu.br)

Methodology

Mixed-methods study, $N = 39$ students.

1. Quantitative analysis
    - Quiz and exam grades
    - Coding and short answer
2. Qualitative study
    - Interviewed 10 students
    - Grounded Theory
    - Prompts about mental state, study habits and test-taking strategies

Second chances on Quizzes



Improvements in all topics

Final scores include both first and second attempts

Igor Montagner (igorsm1@insper.edu.br)

Second chances on Quizzes

Students have different test-taking behaviors and gains

- **ALL** ($N = 12$):
  - From failling to passing grades
- **FIRST** ($N = 6$):
  - Improved from already good grades (>70%)
- **SKIP** ($N = 21$):
  - Almost all skipped $Q5$ (dictionaries)
  - Might be procrastinating/gaming the system

Second chances on Exams

	E1	E2	E3	E4	E5
Short Answer	8.19 (1.11, N=39)	8.49 (1.21, N=36)	8.35 (1.28, N=38)	8.68 (1.11, N=32)	8.70 (1.27, N=27)
Problem Solving	6.82 (2.02, N=39)	7.29 (2.04, N=36)	8.53 (1.92, N=38)	7.73 (1.43, N=32)	8.80 (1.37, N=27)

Table 1: Mean, standard deviation and N for all 5 exams (E1 through E5)

- Short answers are satisfactory from the start
- Coding questions start lower and trend upwards with decreasing standard deviation

Igor Montagner (igorsm1@insper.edu.br)

Second chances on Exams

- 5 exams, average of the largest 3 scores
  - Exams $E4$ and $E5$ are optional for some
- Taking $E4$ and/or $E5$ benefits students differently
  - $N = 5$ went from failling to passing grade
  - $N = 16$ improved a passing grade (<75%)
  - $N = 14$ improved an excellent grade (>75%)

Igor Montagner (igorsm1@insper.edu.br)

Students are getting better over time

Encouraging results for the slower learners

Many students are taking all quizzes/exams even when they don't needed it

 More statistical details in the paper!

Igor Montagner (igorsm1@insper.edu.br)

Interviews analysis

- $N = 10$ volunteers with different final grades
- Grounded theory analysis, 2 coding steps
- Three main themes
    i. retake decision making
    ii. mental state
    iii. study habits

Retake decision making

Students find grading system confusing and are not sure if they can skip

> (...) I didn't know how to make the calculation to see if it was worth it for me to retake the exam

Exam is challeging in a good way

> They were coding exercises that involved something quite challenging, you know? And we could do something interesting.

Igor Montagner (igorsm1@insper.edu.br)

Mental state

First chance matters, but retakes help reduce anxiety after exams

> It was good to have this second chance, because it was not discouraging. I think I even knew some cases of friends who didn't do so well at the beginning, but they're doing well now, and they didn't give up.

Being rewarded for persistence

Igor Montagner (igorsm1@insper.edu.br)

Study habits

Study habits did not change over time. Student display good attitude towards learning

> “You must always be studying, always up-to-date with the subject matter because, otherwise, it will accumulate, and the faculty won't always be pushing you to study”

Lessons Learned I

1. Adding second-chance testing had a positive effect on grades
2. Students reported decreased test-related stress
    - but not for the first-chance
3. Good attitude towards learning was observed

Lessons Learned II - improvements

Feedback delay is very relevant when multiple chances exist

Grading systems for extensive, content packed courses

Igor Montagner (igorsm1@insper.edu.br)

Evaluating Mastery-oriented Grading in an Intensive CS1 Course

Igor Montagner, Rafael Corsi, Andrew Kurauchi, Mariana Silva, Craig Zilles

Insper | The Grainger College of Engineering Computer Science

Igor Montagner (igorsm1@insper.edu.br)