O que é Educação em Computação? Resultados e aprendizados da parceria Insper-UIUC

Igor Montagner

Insper

Sobre mim

Igor Montagner

- BsC (2010) e PhD (2017) Ciência da Computação na USP
- *W-operator learning using linear models for both gray-level and binary inputs*
- Pesquisador em *Computing Education*
  - avaliação formativa
  - aprendizado por maestria
  - algoritmos e linguagens de programação

Insper

Foco em Ensino

- Robótica (auxiliar), Cloud, Megadados, **Sistemas Hardware-Software**, SuperComputação

Primeiras experiências em "Pesquisa" (2018)

- PAEE/ALE: "*Customizing rubrics to enable open-themed projects in Robotics and AI*"
- COBENGE: "*Usando avaliação por pares para encorajar a auto-avaliação*"

Frontiers in Education' 19

Fig. 1: Microcontroller and LCD used in Day One activity. Students coded several simple image filters and tested their execution in embedded hardware.
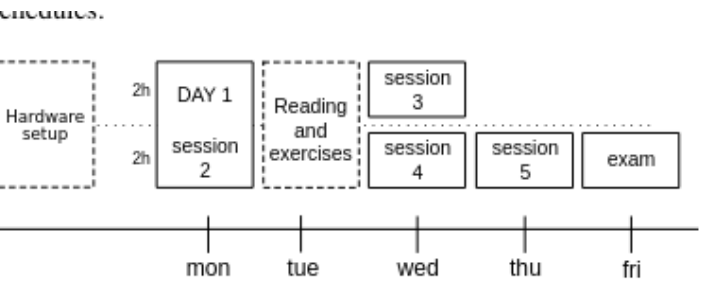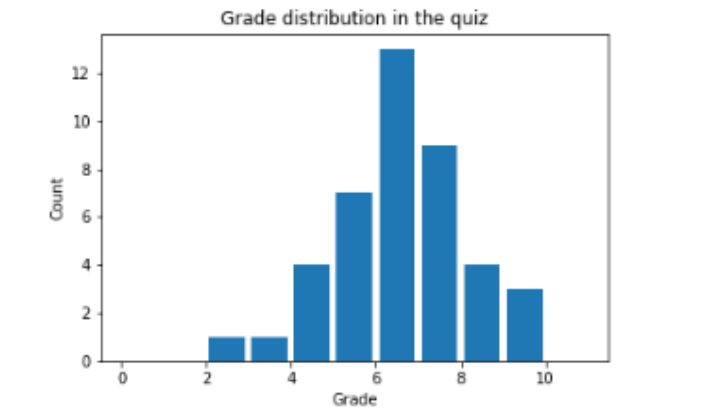

Fig. 2: Session distribution on the week

Fig. 3: Histogram of grades in the quiz, which was composed

Teaching C programming in context: a joint effort between the Computer Systems, Embedded Computing and Programming Challenges courses.

MONTAGNER, I. S.; FERRAO, R. C. ; MAROSSI, E. ; AYRES, F. J

- mais rigor estatístico e pedagógico

- trabalhos com "cara Insper"

- mais trabalhos/autores com quem podemos aprender

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	ID	Total	Misconception %
Function Parameter Use and Scope	A.4	27	**0.95**
	A.5	17	
	A.1	2	
	A.3	1	
	A.2	1	
	A.6	1	
Variables, Identifiers, and Scope	B.2	80	**21.9**
	B.4	55	**19.05**
	B.1	14	
	B.3		
Recursion	C.2	16	**5.71**
	C.3	5	**0.95**
	C.1	5	
Iteration	D.2	12	**0.95**
	D.3	10	
	D.4	10	
	D.6	8	
	D.5	6	
	D.1	1	
Structures	E.3	7	**1.9**
	E.5	6	**0.95**
Pointers	F.2	35	**1.9**
	F.4	34	**7.72**
	F.5	14	**3.81**
	F.3	14	**1.9**
	F.1	7	**1.9**
Boolean Expressions	G.2	47	**10.48**
	G.1	31	**1.9**
	G.3	20	**1.9**
	G.4	5	

TABLE II

CI RESULTS OVERVIEW (N=105), **ID** IS THE MISCONCEPTION OF EACH GROUP OF QUESTION; **TOTAL** THE NUMBER OF TIMES THAT IT APPEARS ON ALL DATA AND **MISCONCEPTION** IS THE PERCENT OF STUDENTS IN WHICH THAT MISCONCEPTION APPEARED MORE THAN ONCE, EMPTY CELLS ARE MISCONCEPTION THAT DO NOT APPEARED MORE THAN TWO TIMES.

Frontiers in Education' 22

How much C can students learn in one week? Experiences teaching C in advanced CS courses.

FERRAO, R. C. ; MONTAGNER, I. S. ; CACEFFO, R. ; AZEVEDO, R .

- **RQ1**: can students learn the basics of C in one week?
- **RQ2**: which are the most frequent/important misconceptions detected?
- **RQ3**: can students complete practical projects after the crash-course?

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Fig. 1. Technologies students would like to learn

Fig. 2. Histogram of accepted PRs per student.

Frontiers in Education' 22

Learning professional software development skills by contributing to Open Source projects

MONTAGNER, I. S.; KURAUCHI, A. T. N.

- Design de currículo

- Learning Objectives, Assessment, Student outcomes

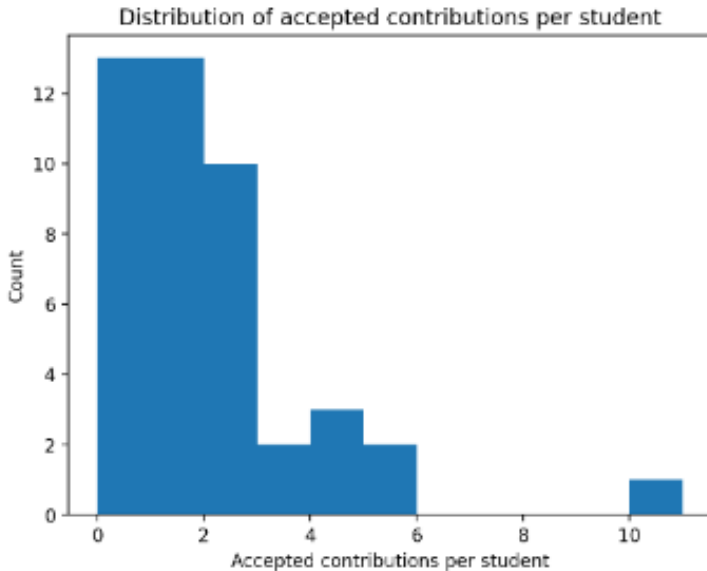- Validação dos resultados usando dados

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| 11 | | Better code | Addressed linting problems in a poorly written project | 5 | 25/09 |
| 12 | | Release created | Created a release and published a binary package for users | 5 | 25/09 |

Code

Any activity that results in a code contribution to open-source software projects is accepted in the course.

id		Name	Description	XP	Date
21		Code Contribution	Submitted a pull request fixing a bug.	7	04/12
22		Contribution Accepted!	A non-trivial pull request was accepted by an external project.	13	04/12
23		Simple Contribution Accepted!	A simple pull request (with trivial changes or small code refactorings) was accepted by an external project.	3	04/12
24		Bug Report	Reported a bug in a repository, and another user was able to reproduce it.	5	04/12
25		Feature Request	Made a request for a new feature in a software.	2	04/12
26		INSPER Project	Made additional contributions to an INSPER educational project.	5	04/12

Community

A software project is also defined by the interactions of all the people around it: users, developers, and translators. This category includes non-technical contributions that benefit these individuals.

id		Name	Description	XP	Date

Frontiers in Education' 19 e 22

- Novos Colaboradores (UNICAMP)

- Metodologia melhora significativamente
    - mais conectada com literatura
    - medições mais rigorosas

- Discussões interessantes nas sessões técnicas

Tem algo diferente de COBENGE/PAEE-ALE nesses eventos

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Parceria Illinois-Insper

Adapting immediate feedback and frequent testing to project-based courses

(Insper) Igor Montagner, Rafael Corsi --- (UIUC) Mariana Silva, Craig Zilles

- Mastery learning, second chance testing, formative assessment, flexible deadlines

Sabático 2022 - UIUC

4 meses como aluno de doutorado

- Journal Club (TUE 4PM)

- Reunião do Grupo de Pesquisa (FRI 11AM)

- Disciplina de pós sobre pesquisa em educação (TUE, THU - 9AM)

Além das reuniões de pesquisa com a equipe

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Pesquisa em Educação em Computação

- Parte ciência exata

  - Assuntos como Programação, Matemática discreta, Compiladores, Engenharia de Software....

  - Conceitos de computação no nível mais fundamental

  - Viés teórico/conceitual ou prático

- Parte ciência social

  - métodos e ideias da psicologia aplicada

  - teorias da educação e modelos de cognição

  - muitos fatores de confusão

" Students are a lot like people! "

Postlethwait, Sam N., American Biology Teacher, 37, 4, 205, Apr 75

Author suggests various methods to improve teacher-student relationships such as open houses, learning students names and being available for informal talk sessions.

Onde publicar?

Índice h5 em parênteses

- **Prioridade 1**
  - Eventos ICER (32), SIGCSE(47) / ITiCSE(35)
    - **acceptance ratio 20-30%**
  - Journals IEEE ToE (33), ACM ToCE (34)
- **Prioridade 2**
  - Eventos Frontier in Education (26) / EDUCON (32)

E o Brasil?

- educomp (<10), SBIE (12), WEI (11)

COBENGE e PAEE-ALE?

Comunidade de Prática

- relatos de experiência

- troca de ideias e inspiração

- encontrar pessoas com mesma vontade de ensinar bem

Conferência de Pesquisa

- gerar conhecimento generalizável

- metodologia científica importa

- relatório de experiência com reflexão profunda

Metodologia de Pesquisa

Research Questions

Logistics (intervention, grading, semester-based)

Qualitative vs Quantitative? Ethics Committee?

Experience report vs Tools vs Research paper

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Evaluating Mastery-oriented Grading in an Intensive CS1 Course

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

Insper

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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

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

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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

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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

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

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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

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Second chances on Quizzes

Improvements in all topics

Final scores include both first and second attempts

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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

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

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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%)

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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!

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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. "

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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

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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

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embedded-check: a Code Quality Tool for Automatic Firmware Verification

ITiCSE' 2024

- não sou primeiro autor (Rafael Corsi)

- discussões, ideias, brainstorms, escrita

- papel diferente, mais maturidade

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Muita coisa acontecendo ainda

- *submetido SIGCSE 2025* **Exploring Different Specifications Grading Policies**

- *piloto / análise de dados pendente* **Correção automática de qualidade de código em CS1**

- *Experimento em andamento* **Comparing paper and digital exams: does sketching/drawing help students?**

- IC em ensino de programação em C
  - Isabela Vieira 3o sem BCC

Minhas reflexões para o futuro

1. Colaborações importam e **tem que ter aspecto presencial**

2. Estar presente na comunidade

    i. Eventos Científicos na fronteira são essenciais

    ii. Participar de comunidades que encoragem crescimento

3. Cultura de Pesquisa

    ○ Matérias de pesquisa são valiosas

    ○ Undergrad research

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