

SPARC Think outside the semester

Teaching a creativity-based skill: Intentional learning of introductory programming through self-pacing

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Outline

1. Motivation and introduction to the SPARC teaching model
2. Example SPARC class
3. How can you adapt this model to your classes ?

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Teaching Intro Programming

- **Enrollment** has been skyrocketing worldwide
 - CS 112 growth: 2016—598, 2015—500+, 2014—484, 2011—215
- Lots of **failure** : Average 37%-45%
 - A significant proportion of the class cheats
- Students are very **diverse**
 - Background knowledge, learning speed, cultural backgrounds
- Lots of **dropouts** and **change** of majors
 - Much less **diversity** in senior CS courses
- Lots of research indicates that **lecturing doesn't work** for problem-solving courses

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Not Just Programming

- Students study many **creativity-based problem-solving** skills and subjects:
 - Mathematics
 - Science
 - Engineering
 - Painting
 - Writing
- These skills are hard to teach through **traditional** lectures

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Approaches

- Flipped and hybrid classrooms
 - Uses all or some class time for practice
 - Assumes students come prepared
 - Assumes all students fit in the same box
- Online asynchronous classes
 - Allows students to self-pace
 - Less feedback, especially face-to-face and individual
 - Low completion rates

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The SPARC Model

- Self-paced demonstration of skills and knowledge
- Students practice, using any resources
- Students take assessments when ready

Content delivered online, outside of classrooms

Class meetings used for collaborative and assisted practice

Collaborative practice problems (*peer learning*)

Instructors work with students individually

Individual assessments in separate labs

Multiple attempts are allowed

Automated grading of assessments

No competition

Self-paced learning

Teachers **TEACH** instead of talk

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SPARC Benefits and Strengths

- Classes focus on **group work**
 - Instructors and TAs often give **mini-lectures**
 - Ratio of TAs to students is about **1:10**
- Students learn at their own **pace**
 - Some finish **early**, others continue **after** the semester
- Students have **multiple chances**
 - ~10 stages of assessments, five chances to pass each
- Separating practice from assessment increases learning and essentially **eliminates cheating**
- Students and instructor **enjoy** the class more

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SPARC Case Study: CS 112

- Pass rates
 - Avg pass rates, traditional lecture-based sections : **55-63%**
 - SPARC pass rate last fall : **84%**
- Caught cheating
 - Typical honor code cases are a significant proportion, if not the majority of students that fail the course

Based on preliminary data, students in our SPARC section seemed to have done as well, or better, than students in traditional sections on the same final exam problems

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Mini-Demo of the SPARC Model

We are going to run a mini-example SPARC class

- Audience plays the part of students
- TAs are our TAs & project members
- Learning Objective : How to solve KenKen puzzles
 - Assessment 1 : 3x3 puzzle
 - Assessment 2 : 4x4 puzzle
- Process :
 1. Watch a short learning video
 2. Work in groups to practice solving puzzles
 3. Ask for help when needed
 4. When ready, report to "lab" for an assessment (5 retakes)
- We will discuss how **you** can use this after the demo

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Class Time

- KenKen rules :
 1. Fill in blank squares with digits 1, 2, and 3 so that each row and each column has all the digits without repeat
 2. Dark-lined areas have a value, and the digits you place inside the area must compute that value with the arithmetic operation given

Video

<https://www.youtube.com/watch?v=vbmohVTtDgs&list=TLq79gKLqk88>

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SPARC Model Elements

- Self paced learning
 - handout and video
 - encourage peer interaction through ice breakers
- Practice problems during class
 - in groups
 - immediate feedback
 - yellow sashes available to answer questions
 - mini lectures by yellow sashes
- Take assessments when ready
 - immediate feedback
 - retake up to 5 times until passed
 - finish early, or take longer than the semester

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Demo Debriefing

- Did you achieve the learning objective ?
- Did you experience the effects of collaboration ?
- Did you participate in a mini-lecture ?
- Did you take an assessment more than once ?
- Did you get promoted to yellow-sash ?

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What We Have Learned

- UTAs are essential
- Mini-lectures really help
- Class atmosphere and student-teacher relations are much better
- Cheating virtually disappears
 - Saves instructor time (teachers, not cops)
 - More students pass
 - Fewer students have to retake the course
- There is a fine line between learning slower than average and procrastination

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SPARCing Intro Programming

- Assignments automatically graded
 - extremely important for practice assignments, as students get immediate feedback
- If students do not pass an assessment within two attempts, we meet individually to review and discuss learning strategies
- Automatically keep track of students' practice and assessment progress
 - both instructors and students can immediately see their progress

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Applying SPARC to Your Class

Open discussion time

Separable Elements

1. Self-pacing
2. Separate practice and assessment problems
3. Collaboration
4. Peer-learning—UTAs
5. Flipping the classroom
6. Mini-lectures during class work
7. Automated evaluation of problems

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