THE UNIVERSITY OF ALABAMA
COMPUTER SCIENCE

A National Math and Science Initiative Program
A+ COLLEGE READY
A Division of the A+ Education Partnership

CS4Alabama: A Model for Statewide Deployment of CS Principles Courses

2014 SIGCSE NSF Showcase

Jeff Gray, *University of Alabama*
Mary Boehm and Carol Crawford, *A+ College Ready*

External Evaluators:
Kathleen Haynie and Sheryl Packman
Haynie Research and Evaluation

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CS4Alabama Year 1

Challenges with Current AP CS A

- One of College Board's lowest participating exams
- Very much a "Programming"-centered course, with focus of content covering syntax and semantics of a specific language (Java)
- Deep and less broad
  - Full range of computing's impact could be missed, as well as exciting contexts to motivate students
  - Many in-service teachers lack content knowledge to teach current AP exam

CS Principles – a new AP Course!

- http://online.wsj.com/article/SB10001424127887324049504578543822451290856.html

Core Characteristics of CS Principles

- 7 Big Ideas
  - Abstraction, Algorithms, Creativity, (Big) Data, Impact, Internet, Programming,
- Three Performance Tasks
  - Investigate, Explore, Create
- AP-level rigor (first exam in May 2016)
- Deep PD available and curriculum being developed
  - NSF CE21, Code.org, PLTW
- More Accessible
  - Easier PD for in-service teachers
  - Attract more diversity from topic focus (not just a programming course)

The CS4Alabama CE21 Project Goals

- State participation in current CS AP has been very low

(with 220k HS students; 5200 US History and 120 Latin AP exams):

2001	2007	2008	2009	2010	2011	2012	2013
22 CS A	27 CS A	41 CS A	24 CS A	51 CS A	99 CS A	97 CS A	126
12 CS AB	7 CS AB	11 CS AB	22 CS AB				

- Project has backing of State Department of Ed
  - CS Principles officially coded course in Alabama that counts as math elective (December 2013)
- The Teacher Leader model enables 9 first-year Teacher Leaders to serve as mentors to 40 other teachers in years 2 and 3

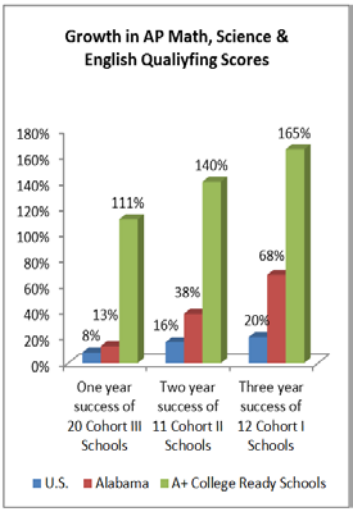

Figure 1: Comparative Growth of Qualifying AP Scores in Alabama

- Following the NMSI model:
  - Over 108 schools in Alabama associated with A+CR with the infrastructure to support sustainability at project end
  - NMSI partners are in 7 states
  - Alabama's **percent increase** in qualifying scores on AP exams over the past three years ranks Alabama #1 among all 50 states in: 1) Qualifying scores (3 or above) on AP SEM exams, and 2) Minority qualifying scores on AP SEM exams

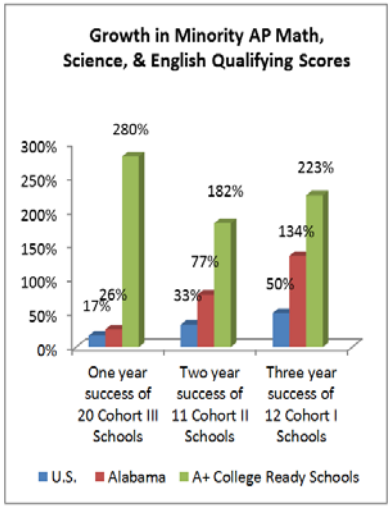

Figure 2: Growth of Minority Qualifying Scores in A+CR Schools

The CS4Alabama CE21 Project Goals

- Key Focus
  - Professional Development to bootstrap 50 new CS Principles Courses across Alabama using the NMSI model
- Goals
  - Train 50 teachers and help over 2500 students learn about computer science in a more rigorous course than is currently offered at most schools
  - Build a network of peer collaborators among our state's teachers, such that they do not feel isolated (e.g., forming a CSTA chapter)
  - Provide teacher-developed curriculum resources that will be shared on the CS10k Community of Practice
  - Deep evaluation to understand what best practices emerged from our experience

Stratified PD following Teacher Leader Model

- Three tiers of cohorts across three years
  - Year 1 - Teacher Leaders: Those currently teaching advanced form of CS
    - 9 Master Teachers who help develop and test curriculum during the first year of the grant
  - Cohorts 1 and 2: Two groups of 20 for 2nd and 3rd year of grant
    - Deep range of experience (some with CS degree, to those with little to no experience), who will be teamed up with a mentor and assisted in year-round PD
    - Initial experience with a Google CS4HS a year prior to engagement

PD Structure – Year 1

(2013-2014)

- Format
  - Summer
    - 3 day Google CS4HS for those who have not attended our past PD efforts (early June)
    - 4-day long PD in late June with all new teachers
    - Assigned homework (lesson plan development and associated activities) and biweekly virtual meetings
  - Fall and Spring
    - Saturday Sessions: one day PD
    - Biweekly training meetings
    - Student recruiting for next Fall offering

PD Structure – Years 2 and 3

(2014-2015 and 2015-2016)

- Format
  - Summer
    - 6 week online PD in MOOC style
      - Focus: Content knowledge tied to CSP Learning Objectives
    - 4-day long PD in late June
      - Focus: Pedagogy and performance tasks
    - Assigned homework (lesson plan development and associated activities) and biweekly virtual meetings
  - Fall and Spring
    - Saturday Sessions: one day PD
    - Biweekly training meetings; Master teach mentoring
    - Student recruiting for next Fall offering

PD Structure

	2013			2014			2015			2016
	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr
Teacher Leaders convene for a weekend planning session	PI, C0									
Curriculum refined (based on UA CS Principles course, and each year's K-12 course; C2 refinement in post-study)	PI, C0				PI, C1					PI, C2
Marketing of CS Principles Course at each school for student recruitment	PI, C0			PI, C0, C1			PI, C0, C1, C2			
Teachers purchase equipment for Summer training and Fall course (tablets/phones)	C0			C1			C2			
Professional Development: Week-long APSI-like sessions (onsite at UA); summer-long reflective learning		PI, C0			PI, C0, C1			PI, C0, C1, C2		
Virtual biweekly training meetings (ACCESS); archived for those with intermittent schedule conflict		PI, C0	PI, C0	PI, C0	PI, C0, C1	PI, C0, C1	PI, C0, C1	PI, C0, C1, C2	PI, C0, C1, C2	PI, C0, C1, C2
Video recording of courses and training sessions		PI	C0	C0	PI, C0	C0, C1	C0, C1	PI, C0, C1, C2	C0, C1, C2	C0, C1, C2
Cohorts offer CS Principles course at their school			C0	C0		C0, C1	C0, C1		C0, C1, C2	C0, C1, C2
PI offers CS 104 course at U. Alabama			PI			PI			PI	
Recruit new cohort from established A+CR connections				PI			PI			
Student summer camps		PI, S			PI, S			PI, S		
Student competition				PI, S			PI, S			PI, S
Saturday student study sessions			PI, S	PI, S		PI, S	PI, S		PI, S	PI, S
Publication of results				PI			PI			PI
Evaluation: Course coverage, student learning, teacher preparation		C0, E	C0, S, E	C0, S, E	C1, E	C0, C1, S, E	C0, C1, S, E	C2, E	C0, C1, C2, S, E	C0, C1, C2, S, E

(Cx represents specific cohort; PI represent PIs/Staff; S indicates student participation; E corresponds to Evaluator assessment)

Measures of Success

Evaluation Questions	Measure	Evidence of Success
Teacher Professional Development and Learning Outcomes		
What is the quality of the professional development? What is the extent to which Teacher Leaders and other cohorts feel prepared to teach CS Principles materials? What is the impact of the in-service effort for participants? Do participants gain adequate content and pedagogical content knowledge? What added value is provided by virtual meetings and other resources? How well is the professional development model working? Is the project scaling to schools as expected? To what extent are the A+CR staff able to master the content to sustain the effort?	Teacher surveys (pre/post professional development); Teacher Leader and cohort interviews; Observations of virtual monthly meetings; Assessment of participant artifacts.	Teacher Leaders indicate adequate preparation for teaching (year 1) and for working with new teachers (years 2 and 3) as co-operative learners; Participants feel the preparation and continued support is adequate; Participant assignments show adequate content knowledge and pedagogical proficiency.
Course Implementation		
How are URMs recruited into the course? How engaged and motivated are students in the class? Do students persist in the class? Are students comfortable with the classroom climate? In what ways are CS Principles materials incorporated into a variety of learning contexts? What content topics and resources are used by instructors and how often? What are instructors' perceptions of the curricular materials (usability, quality, adoptability)? What is the efficacy of the state's ACCESS infrastructure to deliver professional development and shared teaching? To what extent do course implementations meet the ideals? How diverse are the course implementations?	Course syllabi; Instructor pre/post surveys; Instructor biweekly activity logs; Students post-course survey.	Course syllabi indicate alignment with Big Ideas and Learning Objectives; Cumulative activity logs indicate full content exposure with sufficient time per topic/activity; Instructors indicate material/strategies are engaging, esp. under-represented students (URMs); Students indicate enjoying class, activities, language.
Student Outcomes		
Do students' CS attitudes, interests, perceptions of relevance, confidence, self-efficacy, creativity, and content knowledge (e.g., social impacts of computing) change as a result of course participation? Does student learning increase? In what ways do students think computationally (e.g., recursively, abstractly)? Do students perceive CS as relevant? Are students interested in subsequent CS opportunities? Do students successfully pursue subsequent coursework? Do the Alabama undergrads/grad supported on the grant develop an appreciation and interest for helping to promote computer science education in K-12?	Instructor pre/post surveys, Student pre/post interest and attitude surveys; Common assessment (pre, midterm, final); Student enrollment and retention; Student grades; Exit interviews for Alabama supported students.	Survey results indicate gains in students' CS interest and attitudes, especially for URMs; Student retention is high; Student grades and common assessment results indicate successful learning of content, across and by Big Ideas and Learning Objectives; Instructors perceive adequate student learning; Alabama students continue with K-12 computer science activities after project ends.

College Equivalent Course for AP Mapping

- A new course, CS 104, was introduced in Fall 2011 (continued in 2012 and 2013)
  - Part of National Pilot with College Board
- Opportunities for this course
  - Fall 2013 class focused on pre-service teachers (secondary math education); over 60% women
  - Secondary MathEd now counts this course as satisfying their formal Computing requirement
  - Both CS and Ed students supported on grant to help work with HS teachers to develop new curriculum materials
  - Our grant supports a CS PhD student who already has a PhD in Curriculum Design from School of Ed; possible dissertation topic on CS Principles

Summary of CS104 University Course

- Split between Snap! and App Inventor
- Some CS Unplugged Mixed In
- Readings
  - Books: *Blown to Bits*; Wolber et al. App Inventor book
  - Papers: Wing's *Computational Thinking*, Kramer's *Is Abstraction the Key to Computing?*
- Grades:
  - Six individual assignments (two short essays)
  - Two team projects (presentation, implementation)
  - Three exams and 7 very short quizzes

Things that we felt were a success

- Creativity Soared
- Team Projects Highly Collaborative
- Diversity
  - Year Averages:
    - 17 different majors across 29 students (first essay)
    - Broad interest from Freshman to Seniors
    - 13 of 29 students were women or males from underrepresented populations
- Sustainability
  - Strong interest on campus to offer perpetually
  - Several high schools in Alabama offering the course this year from Google CS4HS workshop
  - NSF CE21 initiates the seed that A+ College Ready will continue

Google CS4HS

NSF

Things that did not work so well

- Rushed to cover all CS Principles topics in a 3-hour course
  - App Inventor focus
  - Restructure of deadlines for CS Principles Performance Tasks
- In 2011, several students dropped the course before midterm
  - Transition to more rigorous course vs traditional “literacy” course
- Some team project ideas were unrealistic
  - Perhaps indication of creativity

Backup Slides

- Related past projects

NSF ITEST

ALADDIN

This project was funded by NSF ITEST AWARD (#0737703); with UAB

- The Birmingham Consortium for Computer Education (Aladdin) focuses on training minority high school student cohorts (98% African American) in computer science, through a three years sequence of activities that build on each other, including:
  1. Alice and game programming (summer before 10th grade)
  2. Linear algebra focused on examples from the Alice experience (10th grade in-class)
  3. Computer visualization in the context of Mechanical Engineering and Medicine (summer before 11th grade),
  4. Introduction to robotics and Java (during 11th and 12th grade).

NSF ITEST ALADDIN

This project was funded by NSF ITEST AWARD (#0737703); with UAB

- **Results**

- Pre-/post-tests students show about 40% increase in IT content knowledge concepts, and a college-level understanding of linear algebra.
- Pre-/post-interest in IT careers greatly increased (most had little idea about potential careers before participating).
- Lessons learned inform their other school subjects (especially advances a systematic approach to their education and provides analytic skills).

NSF DRK-12

This project was funded by NSF DRK-12 AWARD (# 0918216); with Clemson/UAB

- The Birmingham City Schools purchased 15k laptops for K-5 grades, but provided no PD for teachers!
- Our objective was to design, implement, and assess a structured intervention aimed at (1) teachers, (2) students, and (3) families that enhanced the students' understanding of STEM fundamentals by incorporating laptops into an inquiry-based educational process.
- **Selected Results**

- The mean Teacher XO Skill Level increased from 1.17 to 2.04 ($p<.001$; scale range: 0-4)
- 90% of the teachers participating in institutes felt confident that they could design their own effective lesson plans and utilize the ICAC developed lesson plans in their classrooms.
- The training significantly increased teachers' perceived comfort in incorporating XO activities

NSF BPC

This project was funded by NSF BPC AWARD (# 0940564); with Clemson/UAB

The multi-tiered mentoring model (M3) was created to foster excellence in grades 5-20 computer science education in the Birmingham area. The goal of the BPC-M3 program is to provide sequential tiers of mentoring, by which the learner in one tier becomes the mentor-teacher to the next tier down. This model focuses on providing a more sustainable and effective pathway for students from underrepresented backgrounds to pursue careers in computing.

- **Approach**

At each tier of this model (college, high school, middle school), students learn to program in Alice, CS Unplugged and robotics. The college and high school student-mentors learn about how to communicate their knowledge to the next tier of students.