CS Oklahoma Initiative:

Improving CS Education Offerings for New and Preservice Educators

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# Abstract

As technology becomes more and more complex, it is becoming critical that children grow up with a working knowledge of how computers work, both from a theory standpoint and an application stand point. Unfortunately, this knowledge is currently only feasibly obtained through college level coursework, as a majority of high schools in the U.S. do not offer computer science curriculum outside of optional AP credit classes. Oklahoma is no different in this regard, as according to the non-profit computer science education advocate program Code.org, there are only 23 out of 453 high schools in Oklahoma offer the computer science AP curriculum. This award will be used to implement alternative computer science course teachings for those who are attending the University of Oklahoma’s College of Education program. Additionally, free course offerings for preservice teachers (teachers already in the Oklahoma public school system) will be created to allow these teachers the opportunity to gain certification to teach computer science coursework in Oklahoma high schools. All of this will be done through collaboration with the University of Oklahoma’s Department of Computer Science and College of Education, with teaching spaces provided by the University of Oklahoma’s Innovation Hub. These two goals combined aim to increase the total number of high school teachers (both preservice and newly graduated) who are certified to teach computer science curriculum by at least 15%, and thus vicariously increase the number of Oklahoma high school students with access to computer science education before college. This initiative is estimated to cost roughly $300,000, and will take roughly 3 years to set up.

# **Project Description**

## Statement of Need

Obtaining an education in computer science is becoming more of a necessity as modern society pushes forward with advances in computers and technology. These advances come with a notable cost of complexity, something that is illustrated expertly by the “Million Lines of Code” diagram compiled by NASA, Quora, Ohloh, and Wired. This diagram shows just how complex modern programs have become by comparing the number of lines of code in various source codes throughout time. The current job market reflects this rise in complexity. The Bureau of Labor Statistics estimated that the Computer and Information Technology industry will “grow 12 percent from 2014 to 2024, faster than the average for all occupations.”(However, achieving training in computer science is nearly exclusively obtained through attending college, something that is not necessarily financially possible for a portion of Oklahoma’s population.

This is especially true in Oklahoma, where according to the Oklahoma State Regents for Higher Education’s 2015 study on high-school to college going rates, only 47.3% of Oklahoma high-school graduates in 2015 attended college the next academic semester. While there are certain Advanced Placement computer science courses offered at various high-schools across Oklahoma, according to the non-profit education platform Code.org only 23 of the 453 high-schools in Oklahoma offer this course. As the above statistical evidence shows, even though computer science is becoming more prevalent in society, society’s education on the subject is not keeping up with its exponential growth.

One big reason as to why high schools in Oklahoma do not offer computer science curriculum for their students is due to a lack of educators who are certified to teach computer science at a high school level. This is largely because there are hardly any programs established to certify preservice and / or new educators in teaching computer science. Adding to this pre-existing detriment, the Oklahoma public school system has had repeated budget cuts for the past several years, with a total drop of 23.6% per-student funding over the last 6 years according to the Oklahoma Policy Institution. This cut in funding limits the training that high schools in Oklahoma can offer for non-core programs, and thus training for computer science is not a possibility for most educators at these high schools.

To alleviate this problem, the CS Oklahoma Initiative will setup programs to certify Oklahoma high school teachers in computer science curriculum by offering free summer-long workshops for preservice teachers at the University of Oklahoma’s Innovation Hub in collaboration with OU Gallogly College’s Department of Computer Science as well as OU’s College of Education. The Initiative will also work to implement changes in the current degree plans for the College of Education to introduce coursework over teaching computer science.

## Goals

* Increase the total number of preservice high school teachers who are certified to teach computer science in Oklahoma high schools
* Increase the total number of new high school teachers who are certified to teach computer science in Oklahoma high schools
* Improve currently certified computer science high school teacher’s knowledge through free computer science workshops
* Increase the number of Oklahoma high schools who have computer science certified staff
* Increase the number of Oklahoma high schools that offer computer science courses

## Objectives

* Train at least 100 preservice teachers in computer science curriculum teaching by the end of 1st year of implementing this program
* Increase the number of OU graduates qualified to teach computer science by at least 20 by the end of the 2nd year of implementing this program, an increase from 1 in 2016
* Increase in total number of OU high schools that offer CS courses by at least 10% by the end of the 2nd year of implementing this program
* Establish a new degree plan within OU’s College of Education focused on computing / mathematics

## Plan of Work/Methodology

The CS Oklahoma Initiative is centralized around the idea of increasing the total number of high school educators who are qualified to teach computer science curriculum in Oklahoma. This will be done through the implementation of two key programs at the University of Oklahoma: the CS Educator’s Degree Plan and the CS Preservice Plan. These two plans will focus on the two target audiences of this proposal: those attending the University of Oklahoma’s College of Education and any preserve (preexisting) Oklahoma high school teacher interested in becoming qualified to teach computer science curriculum, respectively.

**CS Educator’s Degree Plan:**

The first of these plans, the CS Educator’s Degree Plan, will utilize preexisting resources available at the University of Oklahoma to implement a new degree plan centralized on teaching computer science concepts in tandem with mathematics concepts. The mathematic concepts to be taught will be pulled from the currently offered mathematics degree plan, while the computer science concepts to be taught will include the following, with descriptions of the curriculum and reasoning listed next to each course:

* ***Introduction to Computing*** 
  + **Course Description:** Basic overview of topics that will be covered pursuing the CS Educator’s Degree Plan, including programming, networking, security, computer architecture, discrete mathematics, and computing ethics.
* ***Introduction to Programming (Java)*** 
  + **Course Description:** Introduction to the design and implementation of computer software with an emphasis on abstraction and program organization for students with no prior programming experience. Topics include: variables and constants, arithmetic and Boolean expressions, conditional statements, repetition, methods, arrays, linear and binary search, basic sorting algorithms, object-oriented programming, documentation, and testing.
* ***Programming Structures & Abstractions*** 
  + **Course Description:** The design and implementation of computer programs using disciplined methodologies. Use of several abstract data types. Software reuse through encapsulation, composition, aggregation, inheritance, polymorphism, and generics. Topics include recursion, GUI development, file processing, and unit testing. A program design tool will be used. Introduction to ethics in computer science, including philosophical ethics theories. Discussion of intellectual property rights and privacy.
* ***Computer Organization*** 
  + **Course Description:** An introduction to the architecture, organization and design of uniprocessor-based computer systems. Topics include processor, control and memory design and organization, pipelining and vector processing, computer arithmetic, I/O organization, and computer systems security.
* ***Discrete Structures***
  + **Course Description:** Introduction to the theory of discrete structures useful in computer science. Topics include combinatorics, relations, functions, computational complexity, recurrences, and graph theory.
* ***Human Computer Interaction*** 
  + **Course Description:** An introduction to human-computer interaction and graphical user interfaces. Topics include principles of human-computer interaction, human perceptual and cognitive abilities, user interface analysis and design, window systems, and social implications of computing. Current user interface programming tools will be described and used.

All the courses listed above have been selected to allow a wholistic approach to important topics in computer science to allow educators to have the ability to teach on not only programming, but also theoretical ideas present in the field. Except for *Introduction to Computing*, all the above courses are currently offered by Gallogly College of Engineering’s Department of Computer Science at OU, and would have to be opened for non-engineering majors to take. *Introduction to Computing* will be a new course specifically designed as a broad overview of computing that will need to be created specifically for this degree plan. This will be done through collaboration with the Department of Computer Science at OU, and will serve to introduce basic computing concepts to non-engineering majors. This course will be taught by a staff of the Department of Computer Science, and will be a 1-hour credit course.

This plan seeks to increase the total number of college graduates from the University of Oklahoma with the skills and certifications necessary to teach computer science related curriculum in Oklahoma high schools. Currently, there are very few universities in the U.S. who offer education degrees with a focus on computer science, as most high schools in the nation only require a general science or mathematics degree with an interest in the CS field to be able to teach computer science related coursework. However, as technologies improve, this is projected to change. Thus, by creating a specific degree plan for computer science educators, the University of Oklahoma would set itself apart from other universities and making the university itself more appealing to prospective students.

**CS Preservice Plan:**

The second of these plans, the CS Preservice Plan, will be a crash course in essential computer science topics for preservice high school teachers in Oklahoma. This crash course will implement a revised version of the Exploring Computer Science (ECS) curriculum that has been tested and proven effective by Code.org for 9-12th grade students wishing to gain experience in computer science who do not have access to it at their high schools. This curriculum is composed of 5 main units, each focusing on a separate area of the field. These units, along with their descriptions, are shown below:

* ***The Internet***
  + **Unit Description:** “This unit explores the technical challenges and questions that arise from the need to represent digital information in computers and transfer it between people and computational devices. Topics include: the digital representation of information - numbers, text, images, and communication protocols.”
* ***Digital Information***
  + **Unit Description:** “This unit further explores the ways that digital information is encoded, represented and manipulated. In this unit students will look at and generate data, clean it, manipulate it, and create and use visualizations to identify patterns and trends.
* ***Algorithms and Programming***
  + **Unit Description:** “This unit introduces the foundational concepts of computer programming, which unlocks the ability to make rich, interactive apps. This course uses JavaScript as the programming language, and App Lab as the programming environment to build apps, but the concepts learned in these lessons span all programming languages and tools.”
* ***Big Data and Privacy***
  + **Unit Description:** “The major goals of the unit are 1) for students to develop a well-rounded and balanced view about data in the world around them and both the positive and negative effects of it and 2) to understand the basics of how and why modern encryption works.”
* ***Building Apps***
  + **Unit Description:**“This unit continues to develop students’ ability to program in the JavaScript language, using Code.org’s App Lab environment to create a series of small applications (apps) that live on the web, each highlighting a core concept of programming. In this unit students transition to creating event-driven apps.”

The above curriculum will be compiled into a 1-month long teaching workshop that will aim at educating participating preservice teachers in teaching said curriculum. This workshop will take place at the University of Oklahoma’s Innovation Hub Active Learning Classroom (ALC), a resource offered up by OU for free to anyone, thus reducing the cost of finding a space to teach this workshop.

Compiling this curriculum will be done by Dr. Sridhar Radhakrishnan, the Dean of the Department of Computer Science, with close collaboration with the curriculum team at Code.org. In addition to using the curriculum outlined above, Dr. Radhakrishnan will recommend any supplemental material that might further the teachings offered.

To teach this workshop, staff in the Gallogly College of Engineering’s Department of Computer Science will be asked to teach on a singular unit, thus requiring 5 total staff members. An incentive bonus check will be offered for teaching a unit, and a staff member can sign up to teach multiple units if they please. All staff members will be vetted by Dr. Radhakrishnan to determine whether they have a heavy grasp of the subject matter.

This workshop will be offered free of charge every summer beginning at the start of June and running until the beginning of July, from 9 A.M to 5 P.M, Monday through Friday. Lunch will be provided on Fridays from local restaurants.

Overall, this plan seeks to increase the total number of preservice Oklahoma high school teachers by at least 10%, with plans to continue increasing that number in the future. In doing so, the likelihood that an Oklahoma high school offers computer science courses will increase, and the overall number of students who will gain some level of experience in the field will rise.

## Project Evaluation

Initial results for this initiative will be available 1 year after the initiative is started. Results can be broken down into two sections, one for the CS Educator’s Degree Plan and one for the CS Preservice Plan.

The metrics for success for the CS Educator’s Degree Plan will be in the form of the total number of OU graduates from the College of Education who have chosen this degree path, the total retention number for the degree path, and the number of graduates who go on to teach computer science related coursework in high schools across the nation. At the time of this proposal being written, “universities in Oklahoma only graduated 1 new teacher prepared to teach computer science since 2016” (Oklahoma Fact-Sheet). This program aims to increase this number by at least 5 by the end of the first year, and by at least 15 by the end of the second year. This will not only set the University of Oklahoma as the leading university in teaching this degree plan in the state, but will also likely increase the overall number of CS certified teachers in Oklahoma (assuming a portion of the graduates remain in the state). This program also aims establish a retention rate for this program of at least 50% after the first year, as there is likely going to be a portion of incoming students who change degree paths after their freshman year.

The metrics for success for the CS Preservice Plan will be in the form of the total number of preservice teachers who participate in the summer workshop, the total number of preservice teachers who complete the workshop, and the total increase in Oklahoma teachers certified to teach CS. At the time of this proposal being written, Oklahoma has no official service for training preservice teachers in computer science topics. This program aims to remedy that by creating such a program. This program intends to have at least 50 teachers sign up for the first summer workshop. Additionally, it intends to retain at least 40 of these teachers, as it is expected that a portion will not be able to complete the full workshop due to external influences. Finally, it intends to increase the total number of teachers certified to teach CS courses by at least 40.

Overall, this proposal plans on delivering two main objectives: creating a degree plan at the University of Oklahoma’s College of Education for becoming a computer science certified teacher. Additionally, it aims at creating a computer science certification workshop that will run over the summer based on curriculum from Code.org’s Exploring Computer Science curriculum. These two paths should be established before the end of the first year implementing this proposal, as these are imperative for the success of the rest of this proposal.

Ideally, this program aims to have every high school teacher in Oklahoma attend the summer workshop and gain experience to CS, however it is understood that not every teacher will want to commit the time and effort into learning a new subject. However, as the statistics for the total number of CS certified high school teachers are currently so low, any noticeable improvement in these numbers will be deemed a success for this program.

Finally, at the end of each summer workshop in the CS Preservice Plan, participants will be asked to participate in a short survey asking for any noticeable areas of improvement for the workshop. This feedback will then be used in future workshops to better improve the overall quality of the program, and hopefully attract more teachers in future years. Dissemination of this program will rely heavily on promotional flyers and e-letters to willing high schools in Oklahoma, as well as word of mouth as teachers participate in and complete the summer workshop.

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# Budget and Justification

# Timeline