

## **Research Statement**

### **Barbara Ericson**

Barbara Ericson envisions a future in which electronic books (ebooks) dynamically adapt to the student and help that student efficiently construct his or her own knowledge while drawing on the student's interests and prior knowledge as part of a community of learners. Ericson will draw from her extensive experience in 3d graphics, artificial intelligence, user experience, and computer science education to make her vision a reality. Her current research team at the Georgia Institute of Technology has already created several free interactive ebooks (see <http://runestoneinteractive.org>) for introductory programming courses that are currently being used by tens of thousands of students at hundreds of institutions. These ebooks were designed based on research from educational psychology and include runnable and editable Python and Java code, code visualizers, worked out solutions to problems interleaved with practice activities with immediate feedback, and audio tours of code. One ebook was created to help prepare secondary teachers to teach an introductory computing course. This teacher ebook includes pedagogical content knowledge, including common misconceptions. Teachers who have worked through more of the interactive activities have reported more confidence in their ability to teach the material and shown increased performance on end of chapter tests. We are using a design based research approach to iteratively develop and test the ebooks. In addition, we conduct experiments to test some of our hypotheses.

Interactive ebooks could be created for many subjects, not just introductory programming. They could include models that students can execute and modify to gain a better understanding of scientific and mathematical concepts. Interactive and adaptive ebooks should increase student engagement and provide support to help all learners reach their potential.

For her dissertation, Ericson is exploring one type of practice problem in the ebooks, called a Parsons problem. In a Parsons problem the correct code for a program is provided, but is mixed up, and must be placed into the correct order. Her between subjects experiment with 135 undergraduate students indicated that solving Parsons problems with distractors is a more efficient way to learn than requiring students to fix code with the same errors as the distractors, or than having them write the equivalent code. She is currently studying adaptive Parsons problems, where the difficulty of the problem changes depending on the student's performance. She will conduct an observational study of teachers solving both adaptive and non-adaptive Parsons problems this summer. In the fall she will conduct another study to compare the efficiency and effectiveness of learning by solving adaptive Parsons problems vs non-adaptive Parsons problems.

Ericson is also interested in increasing the diversity of computing students. She has been working on this issue since 2004 as a research scientist. She created Rise Up 4 CS in the spring of 2013, originally to help African American high school students

succeed in their Advanced Placement (AP) Computer Science courses in order to encourage more of them to major in computing. In the fall of 2014 she added a similar project for women called Sisters Rise Up 4 CS. The projects provide both remote and in-person help sessions and undergraduate near-peer role models. The projects use one of the interactive ebooks that Ericson has been creating. Participants show significant growth in confidence and interest in computing from pre to post. Several participants reported that they wouldn't have passed the AP exam without the project. A survey of the over 200 alumni of the project showed that over 25% credit the project with changing their intended college major, with the vast majority of those changing to a computer major. Females reported that they especially enjoyed meeting other women in computing since they are usually in classes that are mostly male. Every year since we started offering Rise Up 4 CS, a new record number of African American students pass the AP CSA exam in Georgia. The number of African American students who pass the exam has increased from 22 in 2012 to 60 in 2016. Every year since we started offering Sisters Rise Up 4 CS, a new record number of women have passed the AP CSA exam in Georgia. The number of women passing the exam actually doubled from 119 in 2014 to 238 in 2016. This year we opened Rise Up 4 CS to all underrepresented students. We have trialed Rise Up 4 CS at several other colleges and universities with similar results. Ericson would like to scale up Rise Up 4 CS nationally.