

The problems addressed in this project proposal are the high attrition rate of CS-majors during their first year of study and a critical need for innovative materials and strategies for teaching introductory computer science (CS1). These two problems are actually facets of the same issue – how to more successfully reach a wide range of students in introductory programming courses. The problems are made more urgent by a rising need for Information Technology professionals and the increasing reliance on computer-skilled people in a technology-driven workplace. Unfortunately, the enrollment of women in computer science has been declining, and there are few minorities in computer science.

This proposal is to integrate a high-impact, high-interest program visualization environment, Alice, into CS1. Results of our previous NSF projects concerning the usage of Alice provide evidence that this approach can significantly improve achievement and retention of high-risk CS-majors during their first year. We propose to develop instructional materials for teaching CS1 using our integrated approach. The approach used in this project will take advantage of a high-level of interest in graphics, animation and storytelling (commonly found among students who have grown up in a multi-media world). Nonetheless, the major emphasis is the use of visualization to teach and learn a strong core of fundamental programming concepts and problem-solving techniques in an object-oriented, interactive environment.

A major stimulus for this project is the high attrition rate of computer science majors in undergraduate programs. It is expected that the combination of programming requirements for 3D animations along with instruction in the fundamentals of programming concepts and problem solving techniques will strengthen and enhance student skills as well as providing sufficient programming experience to improve student performance in CS 1 and beyond. This project will be implemented by developing a complete draft of a textbook, creating curricular materials, including laboratory exercises, and applying and integrating the text and curricular materials in CS1 at two institutions. Progress will be assessed by student surveys and interviews of students and instructors. In addition, attrition in the students' first year of study will be tracked.

Two major outcomes from this project will be realized. First, is the development of instructional materials: textbook, laboratory exercises, and lecture/demonstration slides. Second, resultant data will be examined to determine whether the proposal supports learning enhancement using Alice in CS1 with an ultimate goal of reducing the first-year attrition rate in computer science. All materials will be freely available and disseminated online. If the results of this project meet expectations, future work will include applying for a grant to fully develop, test, and disseminate the materials in a broader study.

Intellectual Merit. Evaluating the effectiveness of visualization as a teaching and learning tool, e.g. in algorithm visualization, is an ongoing effort by leading researchers in the field, as evidenced by two visualization groups actively pursuing this topic [40, 41]. Additionally, we believe that we can successfully integrate Alice into CS1, leading to an increased number of computing students, helping to meet the predicted national shortage of computer professionals.

Broader Impacts. Integrating Alice into an introductory computer science class is probably the largest single wish of our 750+ member Alice community. We are confident that a successful integration will help our community (consisting of faculty from four-year and two-year schools, research and liberal arts schools, HBCUs, HSIs, and high schools), and may well lead to a significant expansion of the Alice community of educators, in the US and abroad. Dissemination of information about the developed materials and test results will be provided more broadly through papers and presentations at SIGCSE and ITiCSE conferences. The textbook developed as part of this grant will likely be published by Prentice Hall.