

## Project Summary

The problems addressed in this project proposal are (1) the high attrition rate of CS-majors during their first year of study and (2) a critical need for innovative materials and strategies for teaching programming components in computer literacy courses and in programming courses for non-CS majors. 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, non-CS majors often have poor attitudes toward programming courses and the enrollment of women in computer science has been declining.

This proposal is to use a high-impact, high-interest program visualization environment, Alice, to introduce a strong core of fundamental programming concepts (e.g., objects, classes, methods, functions, decisions, variables, parameters, and loops) and problem-solving design techniques to beginning programmers. Results of our previous NSF proof-of-concept project provide evidence that this approach can significantly improve achievement and retention of high-risk CS-majors during their first year. Also, we have anecdotal evidence that this approach captures student interest and motivates positive attitudes for women and minorities.

Our proof-of-concept grant yielded a prototype of instructional materials and a textbook that work synergistically with a high interest software environment. The prototype materials have been pilot-tested and peer reviewed. An objective of this full project is to revise and expand the prototype material based on what we learned in the pilot. Other faculty members have successfully used our materials, but no formal testing beyond our pilot project has been done. Thus, a second objective is to use and formally test the revised and expanded materials at four regional test sites the first year and at least six additional sites in the second year of the project. The regional test sites are at different types of institutions (two major universities, an HBCU, and a liberal arts college) serving students with diverse backgrounds and career goals.

**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]. One of our Co-PIs has been a visualization researcher for ten years and two of the PIs are active in one of the visualization groups. As part of our research, we are developing quantitative and qualitative measures of effectiveness of visualization in teaching and learning fundamental concepts of programming, under the direction of a professional evaluator.

**Broader Impacts.** In this project, we will provide professional development for a small core of regional leaders at four test sites during the first year and then expand the scope to additional faculty at schools in the nearby areas. It is anticipated that this will create a community of faculty who will present their experiences and findings at regional/national conferences. 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 the proof-of-concept grant is under contract for publication by Prentice Hall. The publisher's web site will be linked to our own web sites for continued contact and support. The Alice website will provide an online community forum for interaction between software developers, authors, and faculty. In summary, we expect this full grant project to lay the groundwork for a national dissemination network.