ALADDIN

(*The UAB Alice, Linear Algebra, Dynamic Dimensional Information Network*)

Drawing the GENIEous out of the kid
emPowering the next generation for information technology

UAB CORD emPowering rising stars
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THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
Schools of Education, Engineering, and Natural Science & Mathematics

The Birmingham City Schools

The Bessemer City Schools

The Black Data Processing Associates BDPA

National Science Foundation
WHERE DISCOVERIES BEGIN

DELL

McWane Science Center

SOUTHERN RESEARCH
Legendary Discoveries. Leading Innovation.

The purpose of the program is to greatly increase the computer and linear algebra skills of area students. Students successfully completing the two-year program will be highly competitive for admittance into top computer science and math programs in the USA.

There are four target audiences. The experience will be led by faculty and students from the UAB computer science, mathematics, mathematics education, and engineering departments in collaboration with area high school teachers, parent facilitators, and community volunteers. The four target audiences are as follows:

1. Each year of the program recruits 50 9th grade students from the Birmingham City Schools and Bessemer City Schools. 98% of the students in these districts are minority and about 30% are from families living below the poverty line. The Aladdin project seeks both outstanding math students and students that appear to have great potential but need further engagement. This population is greatly underrepresented in the IT, computer science and mathematics professions.

2. The parents of these students will learn about the promise of these careers and how to facilitate their child's progress.

3. 12 teachers train each year as facilitators in one or more of the aspects of the program. These teachers transition to their classrooms the discovery-based teaching lessons they learn, and they thus are the foundation for sustainability of the program and for excellence in science and technology education at their schools.

4. UAB graduate/undergraduate students facilitate the various programs each year, thus greatly assisting the students, but more importantly, they become aggressive advocates for, and participants in, excellent K-12 science and technology education throughout their careers.

The program has 5 parts:

1. The "Alice Film Festival" is a week-long summer camp that introduces over 60 students (four weeks with 15 students per week) to the world of computer visualization. Students will use Alice (*www.alice.org*) to design and implement simple movies and video games. From the very beginning, students will be asked to consider the notion of storytelling to construct their programs. In storytelling, the students describe the steps needed to bring about the animation within their program much like an animator or screenwriter constructs the scene of a cartoon or movie. This storytelling approach helps the students to reflect on desired behavior in an algorithmic manner that fosters analytic and logic skills development. Following the instructional sessions, each student will be given free time to explore a motivating case study that applies the knowledge learned in the module. For example, during the first day of interaction, students will build a simple movie involving an athlete kicking a ball that moves across the screen, or moving an ice-skater through a series of spins and jumps. This first movie will introduce much of the Alice environment and several programming constructs.

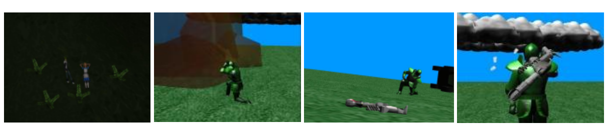

Figure 1: Screen shots from two 60 second Alice films made by high school students visiting UAB. The first shot in the lower panel illustrates the full screen image that the student employs to create the animation and manipulate the environment.

2. "Mathematizing Alice's World" After completing the initial summer program, the students will be able to use Alice to create videos in which objects move about and interact in 3-dimensional space. Thus, they will have learned some of the structure of programming without the distraction of syntax. In "Mathematizing Alice's World" they will engage in an after-school discovery-based experience that will be taught at area high schools, thus providing easy access for the students. Four separate sections (15-18 students per section) will meet once a week for three hours for 36 weeks.

In a typical three-hour experience the whole group will watch a fragment from an Alice video, preferably one made by the students in the previous summer. This particular video fragment will not involve rotations, but only translations in the picture plane (though this will not be stated). Breaking up into groups of four, the students will identify a specific simple motion in the Alice video and examine the mathematics behind it, so that they can duplicate it. The students will already understand from their Alice experience that the motion has duration and occurs in frames (steps). They will be encouraged to represent the steps visually from the beginning to the end of the motion, and evaluate if the motion is one motion, repeated, or a compound motion (e.g., Does the transformation occur in a plane or in three dimensions?). The groups will reconvene to report on the simple planar motion their group has selected. Discussion will center on whether the selected motion is simple and planar, and in what plane it occurs.

Figure 2. Students working on their Alice creations. During the school year, the students learn about the linear transformations that allow them to create three-dimensional action in a two-dimensional space.

3. "Robot Challenge" will be offered during the summer of the participants' rising junior year. This camp will be an intense week-long 40-hour experience in advanced computing and research design. The four weekly sessions (up to 15-18 students in each session) will initiate a working knowledge of computer programming (e.g., in Java or C) that will offer further appreciation of 3-D object manipulation learned in both previous experiences. The inquiry-based experience focus will be mathematics-informed robotics projects that will build on previous knowledge of planar motion. Students will write robotics control software to perform some task in a spatio-temporal context, rather than just on-screen. For instance, they will manipulate position vectors to control the movement of a robot that pushes objects into a proper configuration within a specific time-frame. Students will be taught the computer science principles of embedded software control while providing additional experience in writing computer programs, a skillset they will need to exploit in their junior year mentored experience.

Figure 3: Left: Students building their robots; Right: students demonstrating to their parents their ability to control their robot from a program they wrote. Such demonstrations show the parents the excitement of computer science. This helps the parents to understand the promise of technology education and careers and engages the parents in being facilitators of their child's education.

4. "Computer Graphics and Visualization" offered in the junior year will allow students to conduct, assess and prepare for presentation an advanced project in computer visualization. This will provide students with higher skills in programming and logical concepts, such as decisions, looping and computer graphics. These projects will be collaborative projects of 2-3 students. Each group will meet once a week for 3.5 hours after school at the UAB ETLab. The program will continue for 36 weeks. Students will be guided to create geometry in the 3-D space for use in their projects. They will then be guided into learning the basic programming skills of computer visualization. This training will meet the challenges and amplify the opportunities by using an open-source tool called "Paraview" (*www.paraview.org*) first to introduce students on how to represent the information in a dataset properly, and then guide them with the programming skills to develop simple visualization algorithms with the provided blackbox codes.

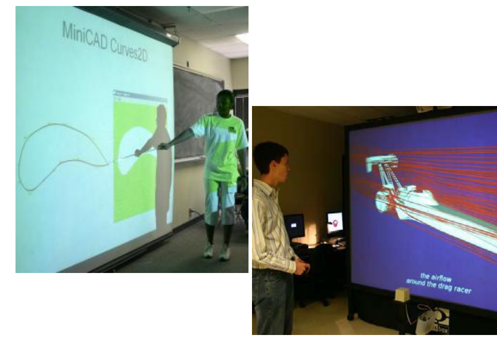

Figure 4: A student demonstrating his ability to manipulate in three dimensional space using miniCAD and another summer student finalizing his 3-D model to demonstrate the airflow around the drag racer that he designed. This modeling in 3-D space allows the student to calculate total air drag on the racer and to redesign the racer to minimize such drag.

5. Rewards are important engagement tools, but the best reward is one that will be lasting. In ALADDIN, we propose to offer every graduate a week-long training session in computer hardware during the summer before his or her senior year of high school. During this week, students will build a desktop computer that they may keep. Further, the training will provide each student completing the course with A+ computer certification. This will prepare students for well-paying summer positions and part-time positions during the school year in the computer/IT industry. Further, for students who decide to delay college entrance, they will be able to secure a reasonably attractive position in the computer/IT industry. Throughout the pipeline of engagement, activities and incentives will be offered to the students and their families to improve the success rate of students progressing to competitive college programs and pursuing a STEM career after graduation.

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