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## **AC 2012-3656: ART2STEM: DISCOVERY THROUGH DESIGN LINKS MIDDLE SCHOOL GIRLS TO STEM SKILLS AND CAREER PATHS**

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Executive Director of Alignment Nashville (AN) since 2005. AN is a non-profit that supports K-12 education. She was formerly vice-president and dean of technologies at Nashville State Community College for 30 years. Rogers has led several NSF funded grants aimed at reforming teaching and learning. She is currently assisting the Ford Next Generation Learning Initiative as part of the national team.

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Sandra Harris is the Program Manager for Art2STEM, a three-year grant that the National Science Foundation awarded to Alignment Nashville. The project seeks to impact the number of middle school girls enrolling in STEM-focused Career Academies in high school. Sandra was formerly the Technical Director and Community Access Coordinator for The Renaissance Center.

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David McNeel is Co-PI on Alignment Nashville's program From Art to STEM, Co-PI on University of Massachusetts Boston's Synergy Collaboratory for Research Practice and Transformation, and a consultant with Metro Nashville Public Schools' Smaller Learning Communities initiative. He served as PI and Co-PI for the Synergy conference series and Director of the Center for IT Education (CITE).

## **Art2STEM: *Discovery through Design* Links Middle School Girls to STEM Skills and Career Paths**

### **Abstract**

Art2STEM (A2S) is an informal education program of Metropolitan Nashville Public Schools (MNPS), Alignment Nashville, PENCIL Foundation, Adventure Science Center, and Tennessee Tech University (TTU) and was initially funded by a three-year grant from the National Science Foundation (NSF). The project is a part of NSF's Innovative Technology Experiences for Students and Teachers (ITEST) Strategies track. A2S is designed specifically for girls in grades seven through nine who attend MNPS. The project seeks to engage the girls' interests, skills and abilities in science, technology, engineering, and math (STEM). The project goal is to build upon the current interest areas of girls, particularly creative interests such as art, so that more choose to pursue STEM education in high school through career academies and in post-secondary education. Small teams of teachers and mentors provide hands-on, problem-based, and active-learning activities for girls in after school at the targeted middle schools. This paper reports the current deliverables of the A2S project.

### **Introduction**

A2S is focused on 7th – 9th grade MNPS girls who are discovering that creativity is an essential part of the world of STEM. The goal of A2S is for middle school girls to develop a vision and confidence for their future education and career in any STEM field. A2S links and strongly supports many of the current priorities and initiatives of MNPS in the following areas:

- High School redesign and restructuring which has resulted in the establishment of a number of academies with STEM-related pathways
- Renewed emphasis on rigor, relevance and relationships by
  - Focusing on developing a deeper understanding of a subject versus just learning facts,
  - Connecting with local business and industry to make education more relevant, and
  - Developing caring and supporting connections with faculty
- Emphasis on graduates being college and career ready and beginning that emphasis early on, not just in high school
- Increased emphasis on project- and problem-based and other forms of experiential learning as an instructional method
- Development of educational and career plans for the future

The strategies and activities successfully developed and implemented by the project collaborators are after-school sessions, business site visits, university visits, family night, summer camp, professional development activities and focus groups. The external evaluation team continuously collects data from the project deliverables and reports them to project implementation team. Project implementation team meets weekly to discuss efficacy and, as needed, determines new tactics and methodologies to constantly advance the project deliverables.

This paper describes the successful practices developed and implemented in A2S.

## **Background**

STEM workforce is crucial to America's innovative capacity and global competitiveness. Yet women are vastly underrepresented in STEM careers and among STEM degree holders despite making up nearly half of the U.S. workforce and half of the college-educated workforce. That leaves an untapped opportunity to expand STEM employment in the United States, even as there is wide agreement that the nation must do more to improve its competitiveness.

- Although women fill close to half of all jobs in the U.S. economy, they hold less than 25 percent of STEM jobs. This has been the case throughout the past decade, even as college-educated women have increased their share of the overall workforce.
- Women with STEM jobs earned 33 percent more than comparable women in non-STEM jobs – considerably higher than the STEM premium for men. As a result, the gender wage gap is smaller in STEM jobs than in non-STEM jobs.
- Women hold a disproportionately low share of STEM undergraduate degrees, particularly in engineering.
- Women with a STEM degree are less likely than their male counterparts to work in a STEM occupation; they are more likely to work in education or healthcare.

There are many possible factors contributing to the discrepancy of women and men in STEM jobs, including: a lack of female role models, gender stereotyping, and less family-friendly flexibility in the STEM fields. Regardless of the causes, the findings of this report provide evidence of a need to encourage and support women in STEM.

In filling up such a gap, it is important to start educating our future generation at early ages. The A2S project (<http://art2stem.org>) uses advanced design and manufacturing technologies to facilitate the MNPS students' interest in art and to structure a journey of exploration for the engaged girls so that they will discover how their interest in art can be complemented and enhanced by STEM. To be successful, the project leadership team has recognized that teachers who influence the students daily must also participate and understand the connection of art and design to STEM career fields. In 2011-2012 academic year nine middle schools were established as A2S project sites. Activities at each site were facilitated by teams of "coaches," consisting of teachers and volunteer mentors. A2S provides the coaches with a variety of professional development opportunities that focus on project orientation, pedagogical frameworks, and technical tools.

The following sections will explain the project activities:

## **Project Activities**

A2S is currently in its third year and offers a number of hands-on learning activities to its teachers and students. This section will describe these activities extensively.

### Professional Development

It is important to train the coaches (leadership teams) in terms of pedagogical subjects, Google documentation sites, assessment instruments, scheduling, expectations, and technology tools. Before the start of Fall and Spring semesters one full day of professional development is provided for the project coaches. The latest professional development activity is given below:



January 7, 2012: 21 A2S coaches (representing nine MNPS middle schools, four local businesses, and one local university) participated in a Professional Development and Planning day for the spring semester. The event was facilitated by the A2S Implementation Team; and segments of the agenda were led by A2S coaches who shared successful practices and encouraged an interactive exchange of ideas among teams. Representatives from TTU provided training on two A2S software programs: GoAnimate and Google SketchUp. Club leaders walked away with session topics for their spring club meetings; and each club posted their schedules to the master A2S calendar.

### Afterschool Club Activities

Each A2S coaching team plans and creates their club meeting schedules by semester. Club schedules are then posted on the master A2S Google calendar. Each STEM-focused activity is specifically prepared to increase students' interest in STEM careers. Concepts are executed in three-part modules; allowing three club meetings to a particular concept. To help students make real-world connections to their club experiences, some modules are complemented by a field trip (site visit) to a local business related to a particular A2S module (see example below).

#### **Design & Manufacturing**

- **CLUB MEETING 1: Symmetry/ Golden Triangle**
- **CLUB MEETING 2: Science of Sculpture (Play-doh models)**
- **CLUB MEETING 3: SPORE Creature Creator & Rapid Prototyping**

**Trip/Business Engagement: Tennessee Technological University – Rapid Prototyping Lab**

### STEM Business Engagement

Each A2S club is obligated to hold a minimum of two STEM-focused business site visits per semester. Business engagement is facilitated through A2S partner, PENCIL Foundation, a non-profit agency that links community resources with Nashville public schools. Business site visits complement current club activities. These visits help students solidify their club activities and increase their interest in STEM fields.

As an example: on December 6, 2011, the A2S club from Thurgood Marshall Middle School (TMMS) had 31 participants (including 29 seventh and eighth grade girls and two MNPS teachers) attend a field trip to Advent, a Nashville business specializing in creating dynamic display spaces for businesses and colleges. This business visit complemented TMMS' club three-session module on computer aided design (CAD) and allowed students and coaches to link their afterschool club meetings to the authentic, real-world manufacturing processes involved in designing and creating display spaces.

#### STEM Higher Education Institutional Visits

Each year A2S students and coaches attend a full day STEM event organized by a higher education institution. Since 2009, A2S participants have participated in this STEM activity organized by TTU. The focus of the visit is to engage the girls in TTU's cutting edge rapid prototyping (RP) laboratory. Students and coaches use the RP laboratory to create three-dimensional objects and design them using their artistic skills. Students and coaches are able to keep their creations. In addition to experiencing the RP laboratory, students have a chance to visit the Biology Laboratory, compete in Lego Robotics Design and a Paper Airplane Contest.



A2S participants (including 112 students, 15 MNPS teachers, and 3 volunteer mentors) made the third annual A2S trip to TTU on October 29, 2011. This day trip was an opportunity to tour the TTU campus and spend time going in-depth with RP. The schedule was designed to allow students and coaches to experience an RP lab and link their afterschool club meetings on CAD to the authentic, real-world manufacturing process of RP.

#### Summer Camps

Week-long summer camps are organized to let students engage team-based, intensive STEM activities in a residential camp environment. Coaches serve as the facilitators of camp activities. The camp schedule is planned collaboratively by teams of coaches working alongside A2S community agency, Adventure Science Center. Outcomes of the camp projects are demonstrated on the last day of camp. The 2011 A2S camp schedule is below:



## A2S Resident Camp Schedule July 10-15, 2011 Lipscomb University

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
7:00- 8:00		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast
8:00- 9:00		Clean Room	Clean Room	Clean Room	Clean Room	Clean Room
9:15- 10:15		<b>Off Site Field Trip: Lighthouse Chrstn</b> (Kindt, Mosow, Smith, Wright, Norwood, Vaughan, Marshall)	<b>Water Treatment &amp; Flood Study</b> (McDonald, Wright, Little, Rakus, Smith, Marshall)	<b>Sculpture &amp; Science Lesson</b> (Graham, Jimenez, Little, Kindt, Norwood, McDonald, Marshall)	<b>Interior Design Lesson</b> (Medlock, Norwood, Rakus, Little, Smith, Kindt, Marshall)	Clean Room
10:30- 11:30			<b>Water Test Lesson</b> (McDonald, Wright, Little, Rakus, Smith, Marshall)	<b>Museum Art &amp; Exhibit Design</b> (Graham, Jimenez, Little, Kindt, Norwood, McDonald, Marshall)	<b>Interior Design Lesson</b> (Medlock, Norwood, Rakus, Little, Smith, Kindt, Marshall)	<b>Finish Projects</b> (McDonald, Smith, Jimenez, Marshall)
11:45- 12:30		Lunch (Off Site)	Lunch	Lunch	Lunch	Lunch
12:45- 1:45		<b>Off Site Field Trip: Opryland Hotel</b> (Kindt, Mosow, Smith, Wright, Norwood, Vaughan, Marshall)	<b>Levee Build Activity</b> (McDonald, Wright, Little, Rakus, Smith, Marshall)	<b>Museum Art &amp; Exhibit Design</b> (Graham, Jimenez, Little, Kindt, Norwood, McDonald, Marshall)	Focus Groups (Edvantia)	<b>Finish Projects</b> (McDonald, Smith, Jimenez, Marshall)
2:00- 2:30	Check- In		Break	Break	Break	Closing Campfire
2:45- 3:45	Check- In	<b>Progressive Project</b> (Kindt, Mosow, Smith, Wright, Norwood, Vaughan, Marshall)	<b>Progressive Project</b> (McDonald, Wright, Little, Rakus, Smith, Marshall)	<b>Progressive Project</b> (Graham, Jimenez, Little, Kindt, Norwood, McDonald, Marshall)	<b>Progressive Project</b> (Medlock, Norwood, Rakus, Little, Smith, Kindt, Marshall)	<b>Check Out</b> (McDonald, Smith, Jimenez, Marshall)
4:00- 5:00	Evening Program (Little, Rakus, Vaughan)	<b>Progressive Project</b> (Kindt, Mosow, Smith, Wright, Norwood, Vaughan, Marshall)	<b>Progressive Project</b> (McDonald, Wright, Little, Rakus, Smith, Marshall)	<b>Progressive Project</b> (Graham, Jimenez, Little, Kindt, Norwood, McDonald, Marshall)	<b>Progressive Project</b> (Medlock, Norwood, Rakus, Little, Smith, Kindt, Marshall)	
5:15- 6:15	Evening Program (Little, Rakus, Vaughan)	Dinner	Dinner	Pizza Dinner	Dinner	
6:30- 8:00	Evening Program	Evening Program	Evening Program	Evening Program	Evening Program	
10:00	Lights Out	Lights Out	Lights Out	Lights Out	Lights Out	

### Family Nights

It is important to celebrate the accomplishments of the A2S clubs. At the end of the Fall semester, students prepare posters, video clips, and virtual displays to showcase their clubs for family, friends, and representatives from businesses and colleges who have hosted A2S field trips. This Family Night event is scheduled after business hours so that the greatest number of parents and business/college representatives can attend and see the students' accomplishments.



A2S held their third annual Family Night event at Adventure Science Center on December 5, 2011. Sponsored by Deloitte, a company that supports A2S with seven volunteer mentors who serve on the leadership teams of four A2S clubs, the celebration gave participants an opportunity to share their A2S club experiences with family and friends. A crowd of approximately 103 consisted of teachers and students from eight MNPS middle schools (Apollo, Croft, DuPont Tyler, Joelton, Litton, Oliver, Thurgood Marshall, and West End) attended the program. Special guests included business engagement partners who hosted field trips (LP Building Products, Deloitte, and TTU) and consulted on summer camp (Metro Water Services).

### **Conclusions**

A2S is a successful ITEST project focused on the state-of-the-art strategies and activities that help the middle school girls understand the link between art and design and STEM careers. Although ultimate goal is to increase the enrollment in STEM-focused Academies in high school the impact of a program like A2S is ultimately determined not by quantitative measures like the number of club meetings and attendees, participants in professional development workshops, etc. but rather by its ability to change lives. The following statement from an actively engaged A2S parent is representative of the kind of impact such experiences can have on a student's life: "Through A2S, she [my daughter] can see possibilities. There is a spark in her, in her eagerness to learn more in her science classes. I see the grades pulling up – not just in science, but in every one of her subjects. I directly credit A2S for her making the honor roll for the first time in eight years. So, thank you. This is one life that A2S has changed."

### **Acknowledgements**

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### **Bibliography**

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