



Pre-College Student STEM Activity in Ghana

*Sponsored By IEEE Control Systems Society Outreach Fund
2013*



By: Dr Ashitey Trebi-Ollenu



Introduction

The IEEE Control Systems Society Outreach Fund 2013 provided funds to the Ghana Robotics Academy Foundation (GRAF) to expand GRAF's 2013 Robotics Inspire Science Education (RiSE) program and promote Control Ideas and Techniques to pre-college students in Ghana.

CSS Outreach funds were used to purchase 12 Lego NXT kits and 10 Windows 7 laptops that were used to form new science clubs in high schools and training instructors/mentors for the science clubs.

The Ghana Robotics Academy Foundation was founded by Dr Ashitey Trebi-Ollennu (member CSS, SMIEEE) in 2011 as a nonprofit volunteer organization dedicated to motivating and inspiring the next generation of Ghanaians interest and participation in science and technology. The mission of Ghana Robotics Academy Foundation (GRAF) is to design accessible and innovative programs that will excite and motivate young Ghanaians to pursue careers in science, technology and engineering, build self-confidence, knowledge and life skills. In three words "*To Demystify Science*". GRAF's Robotic Inspired Science Education (RiSE) program introduces students to the excitement and experience of solving real world problems by applying, science, technology, engineering and math skills. Using LEGO MINDSTORMS technology, students work alongside professional engineers to design, build and program robots to solve real world problems. RiSE is about transforming both the perception and reality of the science, technology, engineering and math education for young Ghanaians. The key to RiSE's success is connecting science theory with practice and hands-on learning experience and exposing students to professional engineers who mentor teams.

The practical course complements traditional theoretical lectures by enabling:

- A practical application of classroom curriculum
- Inspires students by showing them that they have talents
- Requires teamwork, leadership and problem solving skills
- Fosters creativity, critical thinking, and innovation
- Career-molding experience, students learn skills that aid in future job placement.

RiSE 2013 Report

The Ghana Robotics Academy Foundation (GRAF), Robotics Inspired Science Education (RiSE) 2013 events were held in Tamale (zone 1): Friday 27th September to Saturday 28th September, Kumasi (zone 4): Monday 30th September to Tuesday 1st October 2013, Accra (zone 2): Wednesday 2nd October to Thursday 3rd Oct 2013, and Cape Coast (zone 3): Friday 4th October to Saturday 5th October 2013.

A. Control Ideas and Techniques for Rise 2013:

- a. Proportional Control applied to line following robot;

- i. RiSE 2013 Autonomous Rescue Challenge entails students designing a robot to follow a black line on a white surface. For the past RiSE events 2011 and 2012. Students have used Bang Bang control to solve this problem, as a result their robots move in a zig zag fashion. Interestingly, most of the students have been asking how they can make their robot follow the line smoothly.
- ii. In addition, CSS Outreach Fund 2013 enabled GRAF to teach students to calibrate their light sensor using the equation of a line. Although the Lego NXT has a calibration program for the NXT light sensor it only works with a single light sensor. The RiSE 2013 Autonomous Rescue Challenge course required teams to use multiple light sensors. So we taught students how to use the equation of a line calibration approach which provided flexibility to the teams. In addition, it was a very straight forward application of classroom curriculum in practical and hands-on learning. This proved to be a hit with the students 100% of all the teams that participate in RiSE 2013 calibrated their light sensor using the equation of a line.
- iii. CSS Outreach Fund 2013 enabled GRAF to introduce the students to proportional (P), PD and PID to over 200 students across the country.
- iv. For the high school category of the RiSE 2013 Autonomous Rescue Challenge over 75% of the teams used at least proportional control and out that 35% used PD. The winning team an all-girls team used PD controller.



Figure 1 Female high school student watching her robot follow the Autonomous Rescue Course

b. Servo Control

- i. RiSE 2013 Multi-Grain Sorter Challenge entails students sorting a cup of mixed four colored grains into four cups using the Lego NXT-color sensor.
- ii. CSS Outreach Fund 2013 enabled GRAF to introduce the students to servo control using a lookup table where each color grain will be mapped to a servo position. In addition, we introduced the students to the concept of initializing the position of their servos using a touch sensor to ensure accurate positioning.
- iii. RiSE 2013 Multi-Grain Sorter Challenge was a stretch challenge for the teams since the grains were real grains of varying sizes and shapes.

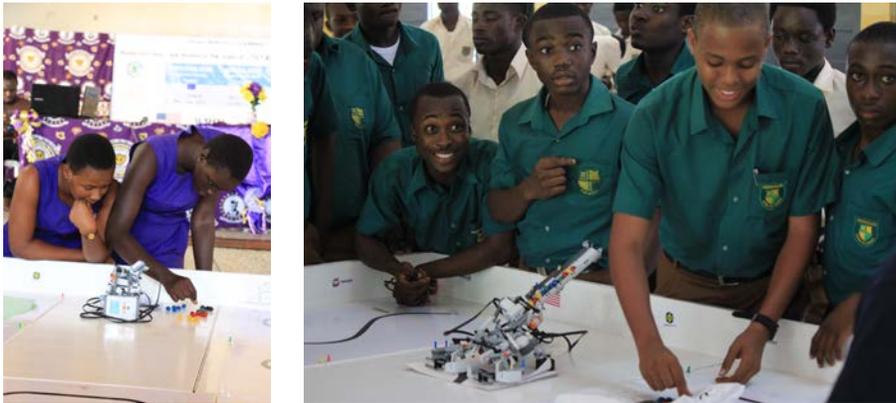


Figure 2 High school students setting up their multi-grain sorter robots

Summary

CSS Outreach Fund 2013 enabled GRAF to introduce pre-college students to the excitement and experience of solving real world problems by applying Control Ideas and Techniques.

The lasting impact of CSS Outreach Fund 2013 for supporting STEM for pre-college students in Ghana is best expressed in the words of the participating students, see the following pages.

The Ghana robotics Academy Foundation (GRAF) will like to express their sincere appreciate to the IEEE CSS Outreach Fund 2013 for their sponsorship for RiSE 2013.



RiSE 2013 Infographic

Robotics Inspired Science
Education (RiSE).

RiSE 2013

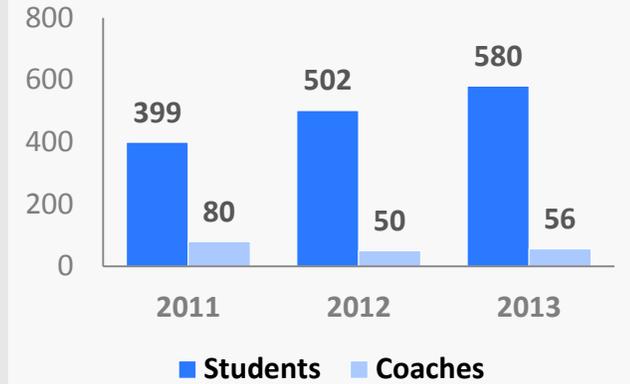
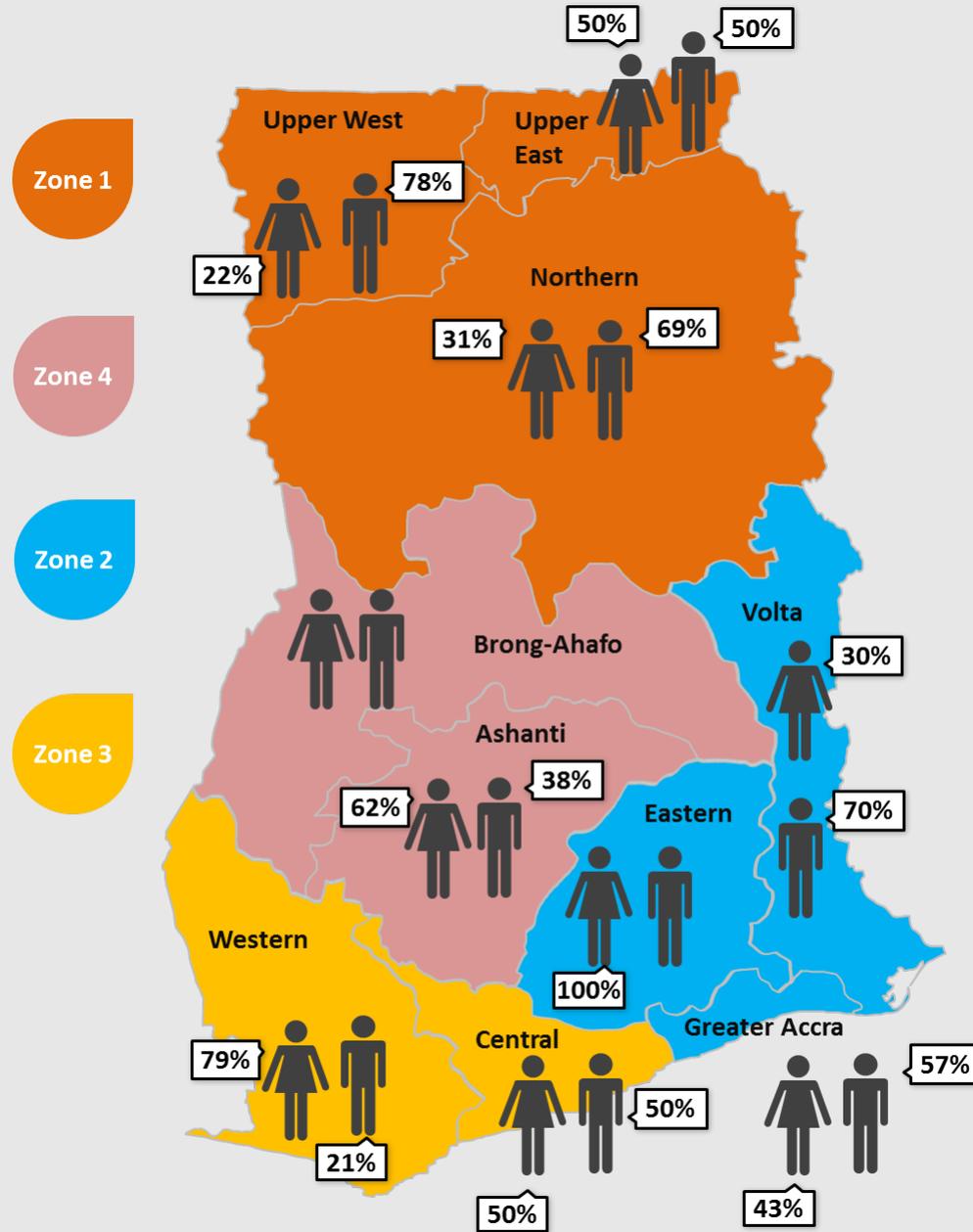
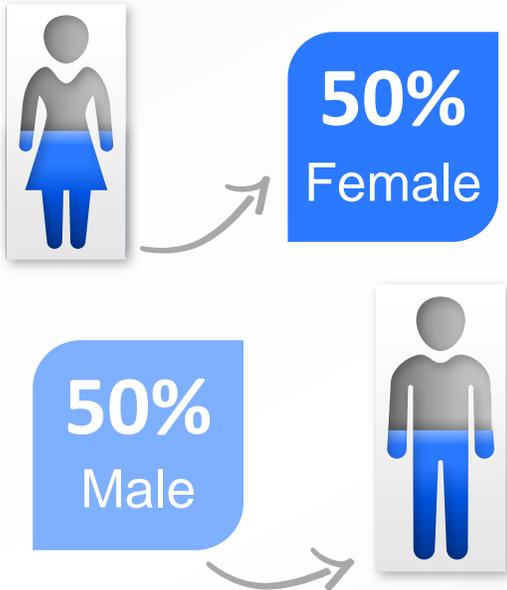
GHANA



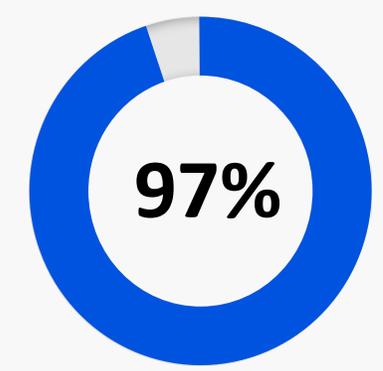
ENGINEERING YOUNG FUTURES

RiSE 2013 Participants Demographics

The Ghana Robotics Academy Foundation (GRAF), Robotics Inspired Science Education (RiSE) 2013 events were held in Tamale (zone 1): Friday 27th September to Saturday 28th September, Kumasi (zone 4): Monday 30th September to Tuesday 1st October 2013, Accra (zone 2): Wednesday 2nd October to Thursday 3rd Oct 2013, and Cape Coast (zone 3): Friday 4th October to Saturday 5th October 2013.

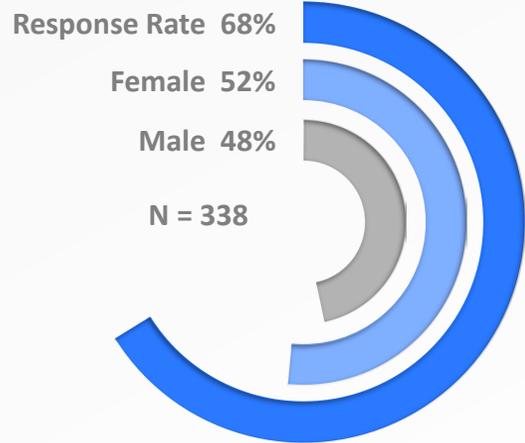


**16%
Growth**



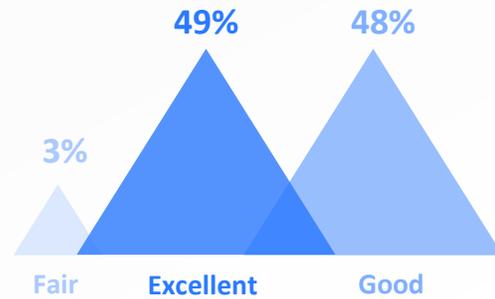
Of Participants Rated RiSE 2013 "Excellent" or "Good"

RiSE 2013 Survey Summary

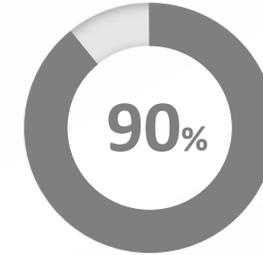
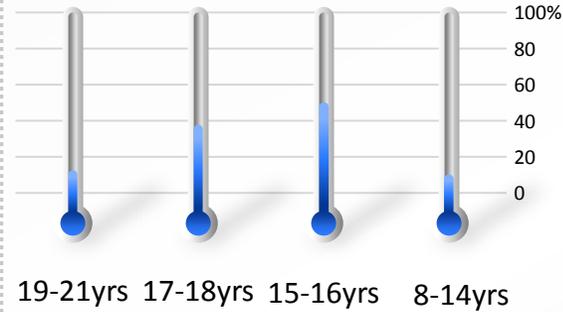


Satisfaction with RiSE

97% of participants rated their RiSE 2013 experience as “excellent” or “good”.



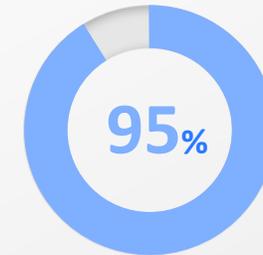
Participants Demographics



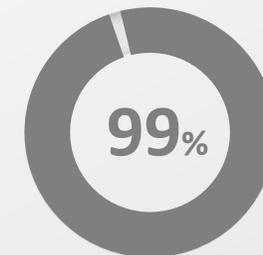
Participants rated their overall level of involvement as a 4 or 5 on a scale of 1 to 5, with 5 indicating “very involved”.



Participants reported an increased understanding of the critical role of science and technology play in everyday life.

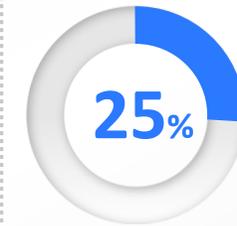


Participants reported that RiSE had provided them with challenging real life experiences that complements their academic curriculum by connecting theory to practice.

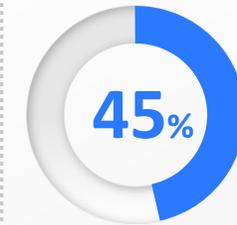


Participants reported having fun.

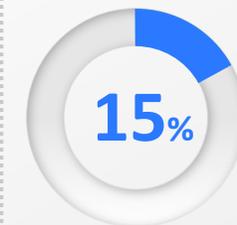
- | | | | |
|----------|---|--|-----|
| A | My interest in science and technology greatly increased as a result of being in RiSE. | | 80% |
| B | I gained a better understanding of how STEM is used to solve problems in the real world. | | 90% |
| C | I became more interested in a career that involved math, science or technology as a result of RiSE. | | 70% |
| D | I gained a better idea of what I wanted to study in college as a result of RiSE. | | 80% |
| E | RiSE helped me gain practical application of classroom curriculum in real-world settings. | | 90% |



Came from families where both parents highest level of education is graduated high school or less than high school.



Came from families where neither parent had attended 4-year or 2-year college.



Came from families where both parents graduated from a four or two-year college

RiSE 2013 IMPACT : In Their Own Words



"... realising that programming and designing is more fun and understanding than I imagined; now when my teachers teach I can easily create a visual picture in my head and I can pay closer attention to details."

Richmond Selasie Klinogo (M), Ghana Christian International High School, Forth Year



"RiSE has really help me in my ideology about science and technology because of the fact that I could invent new stuffs on my own. The most important part of RiSE is about your creativity."

Aaron Barkoh Mensah, Opoku-Ware (M), First Year



"RiSE helped me build things I never imagined I could do and I also learned a lot in terms of physics..."

Esther Alebeye Adongo (F), Navrongo Senior High, Second Year



"I have been in high school for two years and RiSE is the only program which has allowed me to use the physics and elective mathematics that I learn into practice and I will never forget this experience."

Stephanie Boakye Anokye, Mfantsiman Girls, Second Year



"I had always wanted to pursue a career in medicine (pediatric -neuro surgery) but now I have a change of mind.I know that I have a calling for programming."

Emelia Doreen Boadi-Misa (F) , St Mary's, Accra, First Year



"RiSE had the greatest impact on me, when it came to the aspect of using our theoretical knowledge in science and math in a practical way to have a feel of solving human problems."

Asantewa Sisi Yaa Bosompem (F), Ghana Christian International High School, Second Year



"Talk of getting to solve Ghanaian problems like the grain sorter in sorting most Ghanaian grains which made me really think we can really solve our problems as the youth of Ghana and it has cultivated in me a culture of excellence and I know I can one day do something for Ghana."

Albertina Awurama Owotey Mankoe, St Louis Girls', Kumasi, First Year



"RiSE has taught me the principle of analyzing problems critically to find a solution to it. I like the fact that we use some concepts from what we study in school to solve such challenges."

Marian Asamoah , Archbishop Porter Girls, Takoradi, Second Year



"Through RiSE I have been convinced to choose a career in science and to discard the negative idea about science I had over the previous years."

Samuel Ayine Atule (M), Bawku Senior High, Second Year



"The programming of robots gave me a very enormous experience about science and technology. More so, it has increased my interest in science and technology."

Francis Adu Sarfo (M), Prempeh College, Kumasi, Second Year



"Team work: This really help me a lot because I got to learn how to listen to their view point and how to communicate well."

Christiana Abazing Iirase, Bolga Girls Senior High, Second Year



"I think both the programming and building had a great impact on me because I want to be an aerospace engineer and I am going to build up machines and program it. RiSE made me know how it's going to be like in the nearest future."

Stephanie Boakye Anokye, Mfantsiman Girls, Accra, Second Year