

# ISEC 2014

IEEE Integrated STEM Education  
Conference

Friend Center  
Princeton University  
Saturday, March 8, 2014

## Program Book



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## **Thank you to our sponsors!**

IEEE Princeton / Central Jersey Section  
IEEE Region 1  
IEEE Education Society

8:15 – 3 pm

REGISTRATION IN THE FOYER  
SPEAKER PREPARATION ROOM – DEAN'S CONFERENCE  
ROOM

8:15 – 11 am

BREAKFAST IN THE CONVOCATION ROOM

9 am – 3 pm

DEMONSTRATIONS AND EXHIBITS IN THE CONVOCATION  
ROOM AND FOYER

IEEE Future Directions

*Bichlien Hoang, Senior Program Director - Life Sciences, IEEE  
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IEEE RepRap 3D Printer Exhibit - 3D for Everyone!

*Rebecca Mercuri, Immediate Past Chair, IEEE Princeton / Central  
Jersey Section and Notable Software, and Kevin Meredith, Drexel  
University*

EDS-ETC: SNAP Circuits and the Vassar English Language  
Learner Outreach Program (VELLOP)

*Joyce Lombardini, IEEE EDS; Tracey Holland and Hannah  
Wallace, VELLOP*

9 – 10 am

KEYNOTE 1 IN FC 101

Inspiring Innovation

**Karen Panetta, Ph.D., Associate Dean of Graduate Education,  
Tufts University and IEEE WIE International Director**

10 – 10:20 am

**FC 004: \*Combining World Class Research and Development  
Philosophy with Elementary and Secondary School Teaching  
Practices**

**E. Petersen, R. Tillinghast, S. Dabiri, and M.C. Gonzalez,  
ARDEC, US Army, Picatinny (NJ) Arsenal**

The need for Science, Technology, Engineering, and Mathematics (STEM) education programs in elementary and secondary schools is a goal most professional educators and scientists support. What form these programs take can lead to considerable debate. In the search for some common ground the authors of this paper envisioned a school where children want to attend, where professional scientists and engineers work together with creative dedicated experienced teachers, and where the curriculum contains activities relevant to today's technologies and nurtures the creativity necessary to develop the technologies of the future. This school would be in a location where the students would have access to actual working laboratories in which engineers use state of the art equipment to solve real problems. The school environment would foster the creation of Integrated Product Teams (IPT) where girls are as excited and deeply involved as boys and students gain experience making presentations of their work to research and development professionals with comfort and confidence. Students develop the understanding that there is no shame in being wrong as long as they utilize what was learned to redesign and try again. Students willingly share knowledge with other students, desire to continue working instead of taking snack and lunch breaks, and at the end of the day when parents arrive to take their children home, these students beg for permission to stay and continue their assignments. If the above vision seems like pure

fantasy, one need only visit the Picatinny STEM Academy Summer Enrichment Program.

**FC 006: \*The Necessity of Including the Arts in STEM  
C. DeSimone, Edgar MS, Metuchen (NJ) School District**

A great change in education is taking place at this moment. Studies have shown our U.S. students to be behind, threatening our place in the global community. Our businesses decry the skills (or lack of skills) for their incoming employees. Everyone agrees that we need to change the tide. STEM is the current model holding everyone's attention, and the addition of the arts is gathering STEAM. Stakeholders weighing in to the debate seem to cause more confusion about what these terms mean, and how we can best implement them in the schools. This paper explores the role of the arts in the K-12 setting, and Middle School General Music in particular, and the impact it has as an integrating force in the STEM debate.

**FC 008: Motion Picture Science: A Fully Integrated Fine  
Arts/STEM Degree Program**

**+V. Scholl, M. Iafrazi, S. Kratzer, D. Long, and J. Pow,  
Rochester Institute of Technology**

Technology has advanced in such a way that there is now a need within the motion picture industry, as well as in society in general, for professionals trained with a comprehensive knowledge of Science, Technology, Engineering, and Mathematics (STEM) as well as the traditional arts. In the School of Film and Animation (SOFA) at Rochester Institute of Technology (RIT) a novel undergraduate program has been developed to cultivate students into professionals with the skill sets necessary to fill this niche. This undergraduate program is Motion Picture Science (MPS), a degree developed to give students relevant tools to take into synergistic STEM and Arts careers in the modern motion picture industry. Pioneered in 2007, Motion Picture Science has consistently boasted increasing enrollment and successful graduates who earn meaningful employment in the fields of their choosing. The program has also provided some valuable insight into the social dynamics of an undergraduate regimen where students representing a comprehensive mix of artistic and scientific personalities work together; a multi-disciplinary reality fully consistent with contemporary filmmaking.

**FC 101: \*Robot Music Camp 2013: An Experiment to  
Promote STEM and Computer Science**

**C.J. Chung and C. Cartwright, Lawrence Technological  
University and C. Chung, University of Michigan**

In order to get students interested in STEM (Science, Technology, Engineering, and Math) areas and to increase preparedness in STEM subjects for successful college education, we developed a STEM curriculum connecting music based on Lego® NXT robots and Java MIDI programming. Through this, we are able to teach the STEM subjects in-depth and create interactive musical robots by emphasizing the computer science behind it. According to surveys from the first summer camp in summer 2013 with eleven high school students, the camp achieved the aforementioned goals and we believe it is a STEAM learning environment that could be effective in student recruitment and retention in STEM.

**FC 109: Why So Few Women in STEM: The Role of Social  
Coping**

**F. Wuhib and S. Dotger, Syracuse University**

Even though there is gradual increase in their participation, women are still underrepresented in science, technology, engineering, and mathematics (STEM) fields. In the 21<sup>st</sup>

\*nominated for Best Paper Award; +travel award winner

century where global economy and national security needs STEM expertise more than ever, the field is not benefiting from the talent of half of the population in the world; women. While many factors are suggested to be potential barriers for women's participation in STEM fields, this paper considers the chilly climate of STEM fields and presents the role of social coping for the success of undergraduate women in STEM educational environment. The findings show that undergraduate women reported greater use of social coping than did men. It is also found that social coping is a better predictor of commitment for women than it is for men. This has implication for the male-dominated, highly impersonal and individualistic culture of STEM fields. Therefore, STEM fields should consider this in creating more collaborative and comfortable environment for women to better participate, retain and succeed in these fields.

10:20 – 10:40 am

**FC 004: How to Teach Basic University-Level Programming Concepts to First Graders?**

**A. Sović, T. Jagušć, and D. Seršić, University of Zagreb**

In this paper, we present five different approaches of teaching 8-years-old children basic concepts of programming and fundamentals of computing. Using mechanical calculators, children learn some of the basic computer architecture and functionality concepts like the accumulator, counter and register shifting. The marble adding machine teaches binary number adding. Basics of procedural programming (chaining instructions, conditional statements, loops, variables) are taught using Lego WeDo or Mindstorms EV3 robots. The same concepts could be introduced by playing games developed for The Hour of Code event. Event based programming can be learned by making the Kodu 3D game. Although those subjects can be quite abstract to grown-ups, through games and practical examples, children adopted the concepts very easily and quickly. We hope that our STEM activities will “awaken an engineer” in at least some of the attendants, and encourage them to enroll one of the STEM faculties at the University of Zagreb.

**FC 006: Preparing to Teach STEM in Middle School Using Understanding by Design Framework: Focus on Using CAD in Creative Arts**

**M.T. Earle and J. Wyatt, Mississippi State University**

This paper will discuss the development of a university course designed to provide the objectives, materials, and methods appropriate for teaching STEM in a middle school in Mississippi. The STEM course consists of ten thematic units. One of the units, Exploring CAD, discusses how to integrate creative arts in the STEM course using CAD and 3-D modeling. Lessons for each unit are designed using the Understanding by Design framework. This is the first time this course is being taught by the author. The next step is to gather student feedback formatively and summatively. Such feedback will be used to inform on future course enhancements for integrating arts in STEM courses. The ultimate goal is to build a repertoire of CAD\_ART projects that will be shared with the greater STEM community.

**FC 008: \*Creating Pathways to Higher Education: A Cross-Disciplinary MOOC with Graduate Credit**

**B.J. Zirger, E. Rutz, D. Boyd, J. Tappel, and V. Subbian, University of Cincinnati**

This paper presents the development and deployment of an education model based on massive open online courses

(MOOC). In this model, a MOOC is offered with “free” academic credit to those participants who successfully complete the course and subsequently matriculate into a degree-seeking program. As a part of this initiative, a pilot MOOC on Innovation and Design Thinking was developed and offered in fall 2013. This MOOC is a cross-disciplinary course that delivers integrated content from two different fields, namely, engineering and business. In this paper, we discuss the goals of our “MOOC to degree” program, attributes of the first MOOC, development and implementation of the program, and preliminary assessment of the course's reach and impact on the learners and educators from around the world.

**FC 101: Teaching K-12 Students Robotic Programming In Collaboration with the Robotics Club**

**S. He, J. Maldonado, A. Uquillas, and T. Cetoute, Vaughn College of Aeronautics and Technology**

We present the result of a study in which a summer K-12 robotics course has been taught by a college professor and three student members from Vaughn College's Robotics Club. Our aim was to provide an enjoyable teaching and learning environment similar to a “Big Brothers” program so that high school students can learn robotics programming more efficiently. We present details on the approach we have taken as well as K-12 student feedback made through the comments on the course survey. Finally, we discuss future work that may be able to improve the teaching approach.

**FC 109: \*Perceptions of University Recruitment Strategies by Female Students in STEM**

**+J. Fetzer, +K. Czerniejewski, and +D. Voll, University of Buffalo**

As Caucasian, middle class women growing up in suburban areas, we never looked at ourselves as outside the majority. But the moment we decided to enter the field of engineering, we became part of a minority: women who pursue degrees in STEM. In this paper we discuss our experiences of the common societal misconceptions about women in STEM disciplines that girls and young women must face as they make decisions about their future career paths, such as “engineering does not benefit humanity,” “you must be a genius,” and that “there are no women in engineering.” We describe our experiences of college recruitment activities for STEM programs, and as incoming students in engineering. We review activities by colleges that positively influenced our degree path decisions, or served as deterrents, and our experiences are compared with the recommendations of other authors.

10:40 – 11 am

**FC 004: EDS-ETC: STEM, SNAP Circuits, and VELLOP**  
**J. Lombardini, IEEE EDS, and T. Holland and H. Webster, VELLOP**

In order to excite young minds, the IEEE Electronic Device Society has created the Engineers Demonstrating Science: an Engineer Teacher Connection or EDS-ETC program. The goal of the program is to enable EDS chapter members to visit local schools or host events designed to engage young students in the field of electrical engineering. By utilizing the easy-to-use Elenco Snap Circuit® kits, students learn about electronic circuits using a “hands-on” approach to experience the exciting and creative field of electronics. We hope to encourage them to consider electrical and electronic engineering as a career. VELLOP is using these kits to help K-12 students who are

\*nominated for Best Paper Award; +travel award winner

English language learners better understand key STEM concepts.

**FC 006: Fostering Innovation in STEM through the Application of Science and Technology History**

**C. Leslie, New York University Polytechnic School of Engineering**

The history of science and technology has an important place in the education of STEM professionals, particularly when it comes to helping to support their desire to successfully invent, innovate, and disseminate new ideas. History, considered as one of the liberal arts, should be thought of as describing the different possibilities that had to be negotiated before arriving at the present. When presented as one of the liberal arts, constructivist insights can serve as a springboard for a student's future research as well as a means for becoming more successful in meeting the challenges of dissemination. The STS approach known as social constructivism can be effectively demonstrated through historical analysis. Two methods of incorporating history into STEM education are discussed: a mini-lesson (or module) approach as part of a hands-on research program and an approach using general education courses for undergraduates.

**FC 008: Training K-12 Teachers in STEM Education: A Multi-Disciplinary Approach**

**N. Anid and S. McPherson, New York Institute of Technology**

The Schools of Education and Engineering and Computing Sciences at New York Institute of Technology collaborated to create a graduate certificate for K-12 STEM education described on NYIT's website <http://www.nyit.edu/academics/stem/>. The basic tenets of the 18-credit certificate program were Common Core State Standards for science, mathematics and technology, technology integration into instruction according to Technological, Pedagogical and Content Knowledge (TPACK) framework, and Science, Technology, Engineering and Mathematics (STEM) content knowledge. The pedagogy focused on hands-on, inquiry-based, and project-based learning to meet the goal of preparing K-12 students for pursuing STEM-related college majors and careers. This presentation will provide an overview of the NYIT STEM curriculum, the results based on the program evaluation, and future plans to revise and implement the program with new cohorts of graduate students.

**FC 101: Integrated STEAM Education through Global Robotics Art Festival (GRAF)**

**C.J. Chung, Lawrence Technological University**

Robotics is all about STEM and art is tightly coupled with all the S. T. E. M. components. A robotics art festival integrating robotics and arts was launched in Michigan in November 2013 to foster interest and engage students in STEM success. Pre-college students entered computer programmed interactive robotics projects in categories: visual arts and performing arts. 13 teams participated in the inaugural event from 2 U. S. States, Canada, and Mexico. Projects demonstrated creative applications of STEM subjects into art projects. Student survey results show that integrating arts with robotics was an effective hands-on paradigm that even brings beauty, joy, fun, and creativity while learning STEM subjects and computing.

**FC 109: Living-Learning Programs for the Success of Undergraduate Women in STEM**

**F. Wuhib, Syracuse University**

The underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields has been an issue of education reform efforts as well as educational researchers.

Researchers have come up with different suggestions for the reasons of the underrepresentation and strategies for the better representation of women in these fields. This paper synthesizes research findings on the role of living-learning programs (LLPs) for the success of undergraduate women in STEM fields. Most of the researchers agreed that women's participation in STEM LLPs has significant effect on their academic performance, social adjustment, retention or persistence, and intellectual ability. In all cases, students in any type of LLPs have better learning outcomes than those who do not participate in any kind of LLPs. However, there is inconsistency in their findings on whether women only LLPs for women in STEM or coeducational, mixed gender LLPs are more effective for stronger student outcomes.

**11 am – 12 noon**

**KEYNOTE 2 IN FC 101**

**Pathways to Success: Inspiration to Close the Gender Gap**  
**Nita Patel, Systems and Software Engineering Manager, L-3**  
**Warrior Systems and IEEE WIE International Chair**

**Noon – 1 pm**

**LUNCH AND NETWORKING IN THE CONVOCATION ROOM**

**1 – 2 pm**

**KEYNOTE 3 IN FC 101**

**STEM Education: Vital for the Future of America**  
**Alicia Abella, Ph.D., AVP Cloud Services Research**  
**Organization, AT&T**

**2 – 2:20 pm**

**FC 004: Multidimensional Comparison of Project-Based Learning Programs**

**E. Bondi, B. Neuberger, M. Iafrazi, and J. Pow, Rochester Institute of Technology**

In response to the nation-wide call for reform in STEM education, a number of universities are introducing non-traditional experiences in their engineering curricula as early as the freshman year. Although many of these experiences can be characterized as "project-based," they vary widely in their implementation. These variations hamper meaningful research on the relative impact these pedagogies have on student learning outcomes. In this paper, we will describe a tool that allows a multidimensional comparison of disparate non-traditional pedagogies. The tool will be used to first characterize and then quantitatively compare and contrast five different freshman-level engineering classes. This tool could provide a common basis for discourse regarding the relative effectiveness of other non-traditional STEM pedagogies regardless of the "labels" that might be affixed to them.

**FC 006: \*Using Wiki-Based Discussion Forums in Calculus: E-Pathway Toward Improving Students' Retention and Learning in STEM Gateway Courses**

**N. Mosina, LaGuardia Community College of the City University of New York**

In order to address a problem of high attrition rates during the beginning of students' undergraduate STEM career and the issue of engaging and retaining students from underrepresented minorities and disadvantaged economic groups, this paper revisits the notion of social learning via Web 2.0 resources and

\*nominated for Best Paper Award; +travel award winner

explores effects of integration of a specific wiki-based online discussion platform, Piazza, into traditional calculus course offered in a two-year minority serving institution. Rooted in the existing research on correlation of students' retention and success in Calculus and their future attainment of an undergraduate STEM degree, the Calculus-with-Piazza e-pathway toward retention and learning improvement, with high emphasis on the culture and art of active social e-learning, is being established and studied in a community college setting. It is shown that Piazza peer-based interaction reduces student isolation and creates effective learning climate in Calculus classrooms. Expectations, experiences, strategies, and outcomes are shared. Broader impacts and future developments are discussed.

**FC 008: Raising Awareness and Challenging Students in A Human Computer Interaction Course**

**N. Ackovska and M. Kostoska, Ss. Cyril and Methodius University**

This paper describes an experience in teaching undergraduate students the subject of Human Computer Interaction and the results achieved over the past six years. A discussion about the methods used to engage the students to actively participate in the course and how they are encouraged to work in teams is also presented. One of the special aspects of this course is that it introduces knowledge about different kinds of target groups, especially people with disabilities or some kind of cognitive, mental or physical limitations. It is shown how the interest of the students for creating applications intended for specific target groups rises. This course is project-based and encourages inquiry-based learning. Some of the projects that are results of this course are also presented.

**FC 101: Integrating 3-D Visualization and Additive Manufacturing into K-12 Classrooms**

**R. Tillinghast, M. Wright, R. Arnold, J. Zunino, T. Pannullo, S. Dabiri, E. Petersen, and M.C. Gonzalez, ARDEC, US Army, Picatinny (NJ) Arsenal**

With the increased availability and affordability of three dimensional visualization and additive manufacturing tools, the opportunity to bring these technologies into the classroom has never been greater. Utilizing 3D scanners, 3D modeling software and 3D printers in the classroom opens the door for hands-on STEM and STEaM education. This paper outlines methods and approaches to introduce these technologies into K-12 classrooms. Including technologies available to educators, methods and approaches to bring these technologies into the classroom and results and lessons learned from in-school pilot programs related to these technologies. Overall this paper is intended to aid educators in bringing these technologies into the classroom to broaden STEM and STEaM education.

**FC 109: Using Virtual Machines in a K-12 Outreach Program to Increase Interest in Information Security Fields**

**M. Nasereddin, T. Clark, and A. Konak, The Pennsylvania State University - Berks**

With projected high growth in STEM occupations and the desire to keep the U.S. competitive in the global economy, there are many initiatives in STEM education to develop highly skilled workers. In addition to preparing for careers in the STEM fields, it is being more and more recognized that STEM training is a valuable part of an education in any field. The study of STEM fields can lead to the development of valuable problem-solving skills, as well as critical and analytical thinking. Students learn to solve new problems and draw conclusions

based upon previously learned principles in STEM studies. Additionally, there are many jobs that are STEM-related, that is not directly in a STEM field but requiring some form of STEM skills. The Information Sciences and Technology (IST) and Security and Risk Analysis (SRA) programs at Penn State Berks recognize the importance of STEM curriculum to education, employment, and the filling of industry demands. In addition to supporting this education through our own programs, we realize that the development of these skills, as well as the nurturing of interest in these fields, must start well before a student enters college. In order to support this, we have implemented an annual Summer Camp that focuses on the development of interest and skills in STEM fields in the K-12 environment across a diversity of backgrounds.

2:20 – 2:40 pm

**FC 004: CincySTEM Urban Initiative: Designing Pathways to Science and Engineering Disciplines through Project-Based Learning**

**K. Wright, M. Sherman, R. Cargile, Hughes STEM High School and V. Subbian, University of Cincinnati**

The CincySTEM Urban Initiative is a program that integrates Project-based Learning (PBL) into 9th and 10th grade classes using educational technology that is provided to teachers and students for use both in classroom and offsite. Five CincySTEM projects were developed and incorporated into an urban and minority-serving high school. This paper presents an overview of the five projects, a case study on one of the CincySTEM projects, and preliminary evaluation results pertaining to impact of the initiative on students' attitude towards STEM majors. The paper also proposes a longitudinal assessment strategy to study academic pathways that students pursue post high school graduation.

**FC 006: Instruction and Assessment of Information Literacy among STEM Majors**

**D. Scharf, New Jersey Institute of Technology**

The ability to find, use, and communicate information effectively is a critical competency for 21st century engineers. Thus it is an important element in retention, graduation, and placement of professional engineers. This study found scaffolded, engaging instruction resulted in impressive gains in higher-order skills associated with writing and information literacy among upper division engineering undergraduates. Students were evaluated using a brief diagnostic essay as an assignment and as a pre- and posttest to measure these skills in engineering majors taking a required technical writing course. The instruction included using Wikipedia as both a teaching tool and a writing assignment. The instrument was scored by multiple readers using a rubric. Interrater reliability was high and validation showed that the instrument could reliably measure and discriminate among five unique information literacy variables. Use of this constructed-response diagnostic enables the evaluation of higher order research and writing skills that have been difficult to assess using limited-response tests, so that learning experiences may be better designed to reach students at the appropriate skill level.

**FC 008: An Integrated Approach to Using Statistic Concept Inventories in Instruction**

**G. Grabarnik, St. John's University, M. Guysinsky, The Pennsylvania State University, and S. Yaskolko, South University**

In this paper, we investigate various possibilities of applying an integrated approach to Concept Inventory (CI) in statistics classes. The paper defines Concept Inventory, states the basic principles and goals of the CIs and respective tests, and outlines current state of related research. The paper sketches possible uses of CIs in various Statistics classes and discusses introduction of the concept based approach in the learning process itself. Such introduction is suggested in a form of concepts based projects and respective CI quizzes. The projects are suggested to be created based on specific students' majors to make them more attractive to the students and motivate them to learn underlying concepts.

#### **FC 101: An Educational Venture Into 3D Printing**

**R. Mercuri, Notable Software and K. Meredith, Drexel University**

The results of the authors' ambitious IEEE project involving the educational use of 3D printers are described. The intention was to involve college/university students in the construction of RepRap Prusa Mendel printers, with the goal of coordinating and accomplishing this in a single semester. Difficulties related to the availability and reliability of the printer used to create the plastic parts, and underestimates pertaining to the time, cost and complexity of the kit construction are detailed. Successful aspects of the project, including its use as a part of a Senior Engineering Capstone and as a live demonstration display for educational conferences, along with suggestions for implementation of similar initiatives, are provided.

#### **FC 109: Cyber Security Education and Training and its Reliance on STEAM**

**J.A. LeClair, K. Hollis, and D. Pheils, National Cybersecurity Institute, Excelsior College**

Cyber security is a highly technical field requiring skilled professionals to develop and protect our digital systems. But what constitutes a well-trained and educated cybersecurity professional? Obviously, they should have a strong IT background – experienced in cutting edge new technologies. They need to understand computer monitoring, processing, system security, data loss prevention, intrusion detection, and compliance requirements. They must have certifications to verify they not only understand the threats, but also the symptoms and how to identify and mitigate them. But in today's environment and within the rapidly expanding, technically vulnerable society, some are concerned whether that is enough.

2:40 – 3 pm

#### **FC 004: \*An Integrated STEM Learning Model for High School in Engineering Education**

**S. Merchant, E.T.A. Morimoto and R. Khanbilvardi, NOAA-CREST Center, The City University of the City College of New York**

The primary driving force of the US economy depends on the advancement of Science, Technology, Engineering and Mathematics (STEM). Historically, the “E” of STEM has been virtually silent in U.S. elementary and secondary schools. In recent years, K-12 engineering education started to gain attention from educators and policy makers. However, there is a strong need for more standardized engineering curriculum and assessment in K-12 classrooms across the country. It is imperative that more efforts are introduced at the local, district, and federal level which help create strategies, education reforms

and opportunities to boost the current meagre national STEM talent pool for a sustained U.S. economy and meet the STEM workforce demands by the year 2020. It is imperative that more efforts are introduced at local, districts, and federal level that helps create strategies, education reforms and opportunities to boost the current meagre national STEM talent pool for a sustained US economy and meet the STEM workforce demands by the year 2020. a team of experts was convened by the NRC at the request of Representative Frank Wolf (VA) to identify highly STEM focused K-12 schools and programs across the country, however this was focused on the science and mathematics of STEM. The National Oceanic and Atmospheric Administration-Cooperative Remote Sensing Science and Technology Center at the City College of the City University of New York funded by NOAA's Educational Partnership Program created a unique project-based integrated STEM learning model that introduces an holistic learning approach to instill college-readiness and STEM motivation among HS students especially students of color and underserved communities.

#### **FC 006: \*Re-engineering Early Engineering and Quantitative Education in the US**

**F. Razo, Pacific Nautilus Academy**

This paper presents a description of basic issues affecting the promotion of quantitative and engineering education from the earlier school grades in the United States. The main focus is on sharing some helpful information and observations regarding the complex pedagogical, socio-economic, technological, organizational and political issues involved. This is important, as the impact of the problems is deep and strategic to the future of the nation. The complexities involved however, warrant the application of the most powerful and successful systems engineering analysis and project management concepts and techniques available. The concept is that it is engineers who naturally are educated and develop strong concepts and skill to analyze, understand and solve real-life issues and problems, and these are the skills in high demand by elementary and high school students currently having worrisome difficulties. A more significant and meaningful inclusion of experienced engineering professionals is therefore recommended to participate in corresponding curriculum and instruction definition and implementation organizations at the district, state, and national levels.

#### **FC 008: Developing Hands-On Experiments to Improve Students Learning via Activities outside the Classroom in Engineering Technology Programs**

**M. Radu, Farmingdale State College**

STEM education must keep pace with the industry leading technologies in order to produce graduates with 21st century knowledge and skills. Teaching methods and approaches are continuously challenged and they evolve as innovative instructional technology becomes available on the market. This paper focuses on the development of a set of laboratory experiments for the students enrolled in the Electrical and Computer Engineering Technology Program at Farmingdale State College. The experiments are developed around the Analog Discovery Board, PC-based test equipment manufactured by Digilent Inc., allowing students to improve their hands-on experience and practical skills outside the traditional laboratory settings.

**FC 101: Pay it Forward: Getting 3D Printers into Schools**

D. Dumond, Aptima, Inc.; S. Glassner, A. Holmes, and D. Petty, Winchester High School; and T. Awiszus, Will Bicks, R. Monagle, McCall Middle School

Students and teachers in the Winchester (MA) public schools have been working to create a 'pay it forward' model that will help other educators and technical enthusiasts obtain and use their own 3D printers. Anyone who receives help from Winchester in building a 3D printer must agree to help two other school groups to build their own 3D printer, therefore fulfilling their role to 'pay it forward' to schools across the country. This exponentially expanding model not only assists in the widespread distribution of 3D printers for educational purposes, but also helps students to understand how technological ideas are discussed, developed, and distributed.

**FC 109: A Cyber Security Discovery Program: Hands-on Cryptography**

A. Konak, The Pennsylvania State University - Berks

As our society increasingly depends on information systems, it is critical for government and private organizations to have access to a talented pool of individuals who are skilled in confronting threats to information security, responding to emergencies, protecting vital information technology assets, and helping to create policies that ensure the privacy of individuals. However, the educational pipeline of the information security workforce is not promising. Particularly, minorities and women constitute a very small percent of the information security workforce. In this paper, we present Cyber Security Discovery Day, a day-long cryptography workshop for middle school students. The overall objective of the workshop program is to introduce students to information security career pathways through informal learning experiences. The workshop program includes many educational as well as fun hands-on activities.

3 – 3:20 pm

**FC 004: Math Projects Integrate Engineering Design & Artistic Creativity**

A. Kukreti, H. Jackson, and J. Steimle, University of Cincinnati; G. Ogden, Goshen Middle School

The Cincinnati Engineering Enhanced Math and Science (CEEMS) Program, funded by the National Science Foundation, DUE #1102990, empowers secondary math and science teachers to integrate the engineering design process and challenge-based learning into the courses they teach. Some of the curricular materials developed by CEEMS participating teachers also incorporate the fine arts into the design process, thus increasing student engagement and demonstrating the importance of a multi-disciplinary approach to learning. This paper describes seven challenge-based learning endeavors developed for middle school and high school math classrooms that demonstrate the connection with math and fine arts. One curricular unit is described in detail to highlight the incorporation of engineering design and challenge-based learning, while the other six are summarized to provide other examples. Traditionally, math instruction features the teacher as the "sage on the stage" and students working individually to apply formulas in order to find the "right" answers. In contrast, CEEMS' pedagogical approaches result in student-directed instruction, which includes cooperative learning groups using creativity and critical thinking to develop unique solutions to design challenges.

**FC 006: Assessing Teamwork Skills and Knowledge**

K. Vance, S. Kulturel-Konak and A. Konak, The Pennsylvania State University - Berks

This paper discusses the importance of assessing teamwork professional skills, in the science, technology, engineering, and mathematics (STEM) disciplines. There is a difficulty in assessing teamwork skills in an educational setting. The main objective of this research is to propose an assessment framework and rubric for facilitating the assessment of teamwork skills. In this paper, learning outcome areas for teamwork skills and knowledge are first defined and then assessment tools for the identified learning outcome areas are introduced. In addition, an assessment rubric is proposed based on the framework of the Model of Domain Learning (MDL) and to apply aspects of the literature found in accordance with the learning outcome areas of teamwork. The assessment rubric will be tested in different course levels in the STEM disciplines at different colleges.

**FC 008: Understanding Best Practices in Control Engineering Education Using the Concept of TPACK**

A. Jwaid, S. Clark, and G. Ireson, Nottingham Trent University

This study aimed to design an integrated pedagogical approach to advance introductory Process Control Engineering Education through the application of the Technological Pedagogical Content Knowledge (TPACK) framework, and evaluating its impact on student learning. The research is initially being undertaken at Nottingham Trent University, UK but we will next adapt it to a case study in Libya. This paper aims to strengthen the teaching of introductory Process Control by using appropriate approaches in universities to improve the learning outcomes for students. From this work a new schematic for teaching Process Control has been developed and, moreover, a thoughtful best practice in introducing Process Control in engineering education can be developed.

**FC 101: \*The Positive Effects of Verbal Encouragement in Mathematics Education Using a Social Robot**

+L. Brown and A. Howard, Georgia Institute of Technology

Studies have shown that the use of verbal encouragement strategies in education is able to maximize learning. This idea is derived from traditional classroom settings where teachers use a multitude of behavioral strategies to maintain the students' level of engagement. Motivated by these educational practices, we discuss the use of a Socially Interactive Robotic Tutor (SIRT) that incorporates a variety of verbal cues into multiple math learning scenarios. In this paper, we present the robotic tutor, the methods used to engage students in the learning scenario, and results from integrating the robotic tutor in the classroom environment. Results derived from 44 students engaging with SIRT during a tablet-based math test show that, when compared to non-interactive methods, verbal cues are able to increase and/or maintain student engagement regardless of student age and math content level.

**FC 109: A Pre-College Recruitment Strategy for Electrical and Computer Engineering Study**

M. Bugallo and A. Kelly, Stony Brook University

Numerous reports have called for improvements in U.S. STEM education, particularly in providing engineering experiences for pre-college students. Such experiences have the promise of producing more participants in the STEM workforce, and improving the overall scientific literacy of the American population. The authors have developed a summer high school camp for prospective engineering students that provides rigorous



instruction and hands-on engineering tasks designed to solve everyday problems. The qualitative data collection involved 8 female participants' wiki pages, which provided nuanced insights related to social cognitive variables such as self-efficacy, science self-concept, and career goals. Students were able to improve their confidence, relate engineering principles to their everyday lives, learn about careers from working engineers, and increase interest in engineering careers. This preliminary analysis describes a replicable model for innovative engineering learning in an informal context.

3:20 – 3:40 pm

**FC 004: Implementing a Whole-School STEM Program: Successes, Surprises, and Lessons Learned**

**M. Goodwin, III, M. Cooper, A. McCormick, C. Patton, and J. Whitehair, Laing Middle School of Science and Technology**

This paper describes results from a two-year-old Whole-School STEM Initiative at Laing Middle School of Science and Technology in Mount Pleasant, SC. This Initiative uses engineering design and technological tools to address mandated curriculum standards in all subjects, including Fine Arts. The program's goal is to teach students to solve a wide variety of problems using appropriate tools from science, technology, engineering, and mathematics. Over a three-year period, the program expects to address all Standards for Technological Literacy benchmarks, and to provide hands-on experience with ten core technologies. Preliminary results from formal assessments, as well as subjective perspectives of students, parents, and educators are described.

**FC 006: Simulated Professional Poster Session as a (semi) Authentic Learning Experience**

**B. Jewczyn, S. Jones, and E. Page, United States Coast Guard Academy**

One of the major forms of scientific and technical communication is a poster session found at many scientific and technical conferences. Most students are not exposed to this type of communication early in their academic careers, and those who choose to enter into a non-technical major may never be exposed to this style of presentation. We report the results of a program to increase scientific literacy through the wide-scale implementation of a professional poster session-style presentation in an introductory physics course. Student groups were required to complete a term project and produce a poster that was displayed in a poster-style setting. In addition, student groups were required to make a ten-minute presentation to faculty teams as well as peer-review other posters. Both faculty and students overwhelmingly supported the initial implementation of this program.

**FC 008: "Others may see someone eating a cookie - I see the start of a protein kinase cascade reaction"**

**T. Piliouras, K. Liu, Y. Jia, P. Yu, and Q. Zeng, TCR, Inc; J. Lauer, M. Attre, and J. Ortiz, Academy of Information Technology and Engineering High School**

This paper shares the authors' experiences in Science-Technology-Engineering-Mathematics (STEM) from our respective vantage points as student, educator, researcher, and industry professional. We share a passion for STEM subject matter, and a desire to encourage others to explore it as a way of enriching one's life and society as a whole. In this paper, we explore influences that hinder and promote interest in STEM, and resulting implications on what is needed to engage and

retain students' life-long interest. The importance of soft skills in developing STEM proficiency is also discussed.

**FC 101: Do Design Experiences in Engineering Build a "Growth Mindset" in Students?**

**K. Reid, Ohio Northern University and D. Ferguson, Purdue University**

Research investigating characteristics that tend to indicate student success in engineering have shown that affective (noncognitive) characteristics such as motivation may have equal to better predictive capabilities than cognitive characteristics such as high school GPA. The mindset of students, whether 'fixed' (success is due to inherent intelligence) or 'growth' (success is due to effort) can indicate whether a student believes in their ability to solve problems and succeed. Research has shown students tend to move away from a growth mindset and toward a fixed mindset during their first year of study. Our research indicates that introducing open-ended design projects into the curriculum may tend to lessen or eliminate the shift toward fixed mindset. Students assigned open ended, socially relevant engineering projects were compared to students without such projects; students without the open ended experience showed a much greater propensity toward fixed mindset. We hypothesize that these findings may inform introductory engineering and technology courses, including those in high school meant to prepare students for study in STEM areas.

**FC 109: "Anything is Possible" - Teaching Entrepreneurship in an Interactive K-12 Workshop**

**N. Cioffi, S. Kulturel-Konak and A. Konak, The Pennsylvania State University - Berks**

The Center for Entrepreneurship and Economic Development (CEED) at the Penn State Berks Campus conducts Entrepreneurship Workshops facilitated by college student mentors for middle and high school students from inner-city Reading, PA. These workshops serve to incubate early entrepreneurship exposure, promote creative problem solving, and to highlight how entrepreneurship attracts students from multidisciplinary backgrounds. Following an overview of business planning, the Penn State Berks Engineering Entrepreneurship students create their own condensed business model presentations that examine the simulated exercise of "Problems with Pizza." In this paper, we explore how the mentor-taught workshops influence K-12 students' perceptions of entrepreneurship as a feasible, alternate career choice and how to creatively approach common problems. The paper builds on the current literature of influencing students' entrepreneurial self-efficacy and provides a successful example of student mentor teaching, specifically the positive effect that it has on students' attitudes towards entrepreneurship. The paper also further builds the case for entrepreneurship exposure starting at the middle and high school levels.

3:40 – 4 pm

**FC 004: Informal Engineering Education: Lessons Learned from the NASA's BEST Students Project**

**C. Kruchten, University of Maryland - Baltimore County; G. Robbins, South River High School; and S. Hoban, University of Maryland - Baltimore County**

The NASA's BEST (Beginning Engineering, Science, and Technology) Students project was designed to introduce students to principles of engineering through hands-on, inquiry- and project-based lessons conducted within the framework of

the Engineering Design Process. The NASA's BEST curricula have been implemented in numerous informal education settings across the United States and, more recently, internationally at the Abu Dhabi Science Festival in the United Arab Emirates. Here we explore the logistical, preparatory, and management efforts necessary to provide such educational opportunities to young learners, identify challenges to broad-scale implementation of informal STEM education programs, and examine the potential benefits to using such programs to help build strong STEM literacy skills and practices. Examples are provided of NASA's BEST content being incorporated into informal STEM education programs in the United States, and a larger-scale implementation at the 2013 Abu Dhabi Science Festival.

**FC 006: The KumbhThon Technical Hackathon for Nashik: A Model for STEM Education and Social Entrepreneurship**

**B. Hecht, IEEE Boston Section Education and Region 1 Industry Chairs; T. Jouttenus, edX; M. Jouttenus, Somerville Public Schools; J. Werner and R. Raskar, MIT Media Lab; S. Khandbahale, Global Prosperity Foundation; and P. Bell, Entrepreneurial Advisor**

Local needs in urban settings create opportunities for STEM students and professionals to work together with city stakeholders to develop original innovative solutions. In preparation for the upcoming Kumbh Mela festival to be held in Nashik, India in 2015, a technical hackathon was convened with students and faculty, technology professionals and entrepreneurs as mentors and instructors. Over the 72-hour event, teams ideated concepts, created rapid prototypes, and tested hardware, software, and social entrepreneurship business models. Stakeholder inputs gathered prior to the event guided the project goals. Top projects were advanced through rapid prototyping and demonstrations. Through this experience students applied principles of design to solving real-world local needs and provided innovative solutions for improved resilience and responsiveness.

**FC 008: Comic Books, Graphic Novels, and a Novel Approach to Teaching Anatomy and Surgery**

**C. Babaian, Bucks County Community College**

Art has been an integral component of the exploration of the human body for thousands of years, and drawing part of our evolutionary history and one of our best adaptations for communicating and acquiring knowledge. As a biology educator and artist, I had been using drawing for my entire career to bring students closer to the natural world and assist them in deepening their understanding of form. I have used a variety of teaching techniques in biology and anatomy. More recently I discovered that I could transfer my visual narrative of biology using drawing and comic books to my anatomy classes and to surgical residents and medical students. This merger of fine art and life sciences resulted in a fine arts show, two published papers, and pedagogy of a comic book and graphic novel genre that taught anatomy drawing to medical and anatomy students through surgical narrative.

**FC 101: Including User Devices and Context into STEM Education for Minorities**

**A. Ordonez, University Foundation of Popayán**

Learning process can be enhanced by offering students, resources that are closer to their reality. Besides, the wide use of Mobile devices brings the opportunity to go beyond classrooms and computer based learning objects. The AUTO4L Framework for personalized automated composition of Web

resources based on the user context. AUTO4L is highly applicable to STEM classrooms. The philosophy of AUTO4L allows to students and teachers working collaboratively in order to create dynamic learning resources. AUTO4L integrates these resources with user preferences and context. AUTO4L offers a personal experience based in Mobile devices. This paper discusses the ways in which AUTO4L could be used to extend STEM beyond walls.

**FC 109: Experiential Project-Based Learning for University Students in K-12 STEM Initiatives**

**R. Kline, J. Hill, L. Birney, S. Sarris, and J. Gauthier, Pace University**

One available tool for increasing interest among K-12 students in STEM (Science, Technology, Engineering, and Math) concepts and topics is the use of computer science programming processes that lead to the development of programs designed for use on mobile computing devices such as tablets and smartphones (technology "apps") to be used both by students and their teachers. University students majoring in computing sciences are a valuable resource in developing such technology, particularly in collaboration with local leaders in K-12 school STEM subjects, engaged university faculty mentors, and key members of outside organizations devoted to promoting STEM education. We document our experiences in creating one such large project, the STEM Center Collaboratory at Pace University, which brought together these complementary groups and had as one of its goals to design and develop such resources.

4 – 4:20 pm

**FC 004: Pathways to STEM Higher Education - The College of Technology**

**E. Flynn, W. Robicheau, K. Wosczyzna-Birch, and J. Birch, The Regional Center for Next Generation Manufacturing**

The College of Technology (COT) is a nationally-recognized educational model that creates unique opportunities for Connecticut community college students to showcase the integration of Science, Technology, Engineering, and Math (STEM) programs in cohesive, collective, and university-matriculating learning environments. Furthermore, from the support of government funding resources, regional educational consortiums, and local business and industry partners, it will be shown that COT students are capable of receiving industry training, professional training, scholarships, internships, and ultimately, effortless Connecticut university transfer. In this paper, two STEM pathways will be explored (including 2-year engineering technology and 4-year engineering science programs); along with STEM-based higher-education programs such as the National Science Foundation (NSF) project center: the Regional Center for Next Generation Manufacturing (RCNGM) and the NSF project grant: the Life Support and Sustainable Living (LSSL) Program.

**FC 006: EPICS High: Digital Literacy Project in India**

**S. Dutta and R. Mathur, Bridgewater-Raritan High School**

Digital literacy is the ability to effectively and analytically navigate, evaluate and create information using a variety of digital technologies. It requires one to recognize that ability, to operate and transform digital media, to distribute it widely, and to easily adapt it to new forms. Digital literacy does not replace traditional forms of literacy, but builds upon the foundation of the traditional forms of literacy. However, Digital literacy is not prevalent in many rural areas of the world. With support from

IEEE-EPICS, the IEEE Student Club of Bridgewater-Raritan High School successfully implemented a Digital Literacy Project in the rural Indian village of Paushi. In this paper, we narrate our experiences, which we hope can provide useful information for future projects.

**FC 008: General Anatomy and Physiology Curriculum in High School: A Student's Perspective**

**D. Rangarajan, Bridgewater-Raritan High School**

General Anatomy and Physiology is a significant course in a student's science curriculum, which provides a foundation for those who wish to pursue a career in the medical field. There is a vast amount of information that is taught concerning many different topics of study. Within our class, this information was delivered using many different methods. This paper provides a student's perspective of a High School General Anatomy and Physiology Course, and the effectiveness of each strategy used. We have outlined the syllabus and teaching mechanisms utilized, while offering suggestions and opinions as to how the course has proved successful, and what can be done to further improve it.

**FC 101: Enhanced Learner Centered Pedagogy Strategy: Promoting STEM with Underrepresented Populations**

**B. John, V. Thavavel, and J. Jayakumar, Karunya University; A. Muthukumar, Sikkim Manipal University; and K.J. Poornaselvan, Government College of Technology**

An efficient Pedagogical Strategy in an Open Social Learning environment is required for effective learning on the web. Increased collaboration among the learners and mentors makes the learning experience efficient. This paper proposes an enhanced Pedagogical strategy for searching content through the use of ontologies and the learner's profile. The proposed system makes use of ontologies and learner profiles for crawling, indexing and organizing content. The content is then filtered based on the learner and "learner like" learners' profile to provide a rich Open Social Learning experience. Natural Language Processing is then used to semantically categorize the learning content. It has been shown that this proposed pedagogical strategy, using the ontologies and user profiles for search, Natural Language Processing for programmatic content categorization and graph database to identify learning styles of the underrepresented learners, provides an enhanced learner centered online learning experience.

**FC 109: Make the World a Better Place: An Association-Industry-Academia Partnership**

**L. Martinich, Competitive Focus; and T. Lehr, and D. Sangam, IEEE**

This paper presents details of a program initiated by the IEEE Central Texas Section Education Society Chapter to stimulate passion among high school students for careers in Science, Technology, Engineering and Math and to increase the participation of girls in STEM fields. The program includes participants from professional associations, industry, and academia. We describe the elements of this program (including the use of a fabrication lab or makerspace, mentoring, outreach events, curriculum design, metrics, and a replication handbook), the benefits to and contributions of each of the participants (the IEEE Central Texas Section, Tech Shop, Dripping Springs High School, and Texas State University), and the near-term and long-term objectives.

**POSTER SESSION ABSTRACTS**

**EDS-ETC: STEM, SNAP Circuits, and VELLOP**

**J. Lombardini, IEEE EDS, and T. Holland and H. Webster, VELLOP**

See the entry for FC 004 at 10:40 am.

**Learning About Electronics: The Diode**

**J. Silver, Advisor, T. Naganathan, and B. Wang, STEM Club, Hillsborough High School**

Our club has begun focusing on the functioning of electronic components. We are starting our research with the functioning of a diode. Our poster will document our research which includes establishment of a signal using both a signal generator and an oscillator circuit using SNAP breadboards. Our poster will document our understanding of the functioning of diodes in circuits and the measurements we made. Future work will focus on a similar study of the functioning of NPN and PNP transistors.

**Our STEM Career Paths**

**E. Froehlich, K. Masden, and E. Schettini, Princeton High School**

We outline our academic and personal plans to achieve our desired careers in genetics, medicine (surgery), and zoology in our poster.

**Science Week: Our Student Investigative Projects**

**M. Eastburn, Riverside Elementary School**

Student Investigative Projects for grades 2 - 5 at Riverside Elementary School are presented. The posters were made by the students. The second grade investigated which substance out of five would melt ice the fastest; the third grade created an experiment that studied which type of fish learned to associate food with music the fastest; the fourth grade investigated electricity in nature; and the fifth grade researched fruit fly genetics.

**Silk Fibroin Microspheres as Controlled Release Drug Delivery**

**R.A. Rastogi, Westford Academy (MA)**

Advances in biological engineering have led to renewed effort in developing potent and more sophisticated therapeutic agents. Controlled release drug delivery systems offer a better approach to delivering therapeutics: employing devices that encapsulate drug and release it at modulated rates for duration. Such systems ensure availability of the drug at target site for the optimum time and duration, tailoring of release rates, protection of fragile agents, and increased patient comfort. Silk fibroin/polyvinyl alcohol microspheres compose one such delivery system, sporting numerous advantages including biocompatibility, biodegradability, versatility, strength, and flexibility.

**Sleep: The Best Medicine**

**Y. Sanghavi and A. Balaji, John P. Stevens High School**

Sleep has always been an indispensable part of human nature, yet it is astonishing that the majority of society has a poor understanding of it and fails to understand the significance of it. Yet, as an essential operation in our daily schedule, sleep has a plethora of purposes ranging from revitalize the body after a stressful day of work to consolidating memories in order to sharpen one's mind. Evidently, a majority people are unaware of how imperative it is to attain a proper night of sleep, and how detrimental it is towards one's health to attain a poor night's of sleep. This poster aims to educate society on sleep and to spread awareness of the importance it holds.

## Session Chairs

Room	Track	Time	Session Chair
Convocation	K-12 Student Posters	9 am - 3 pm	Aparna Rajagopal
FC 004	K-12 STEM Pedagogy	10 – 11 am	Star Willmarth
FC 006	K-12 STEaM	10 – 11 am	Raziq Yaqub
FC 008	Postsecondary/Higher Education Programs	10 – 11 am	Vignesh Subbian
FC 101	K-12 Robotics	10 – 11 am	Bob Schroeder
FC 109	Women in STEM	10 – 11 am	Jerry Silver
FC 004	K-12 Integrated STEM Education	2 – 4:20 pm	Vignesh Subbian
FC 006	Issues and Perspectives in STEM Educations	2 – 4:20 pm	Laura Hanlan
FC 008	Integrated STEM in Postsecondary Education	2 – 3:20 pm	Pravin Raghuvanshi
	K-12 Student-Educator Combined Perspectives	3:20 – 4:20 pm	
FC 101	3D Printing/Design in Education	2 – 3 pm	Elias B. Kpodzo
	Educational Research	3 – 4:20 pm	Nagi Naganathan
FC 109	K-12 STEM Outreach	2 – 4:20 pm	Francis O'Connell

## Volunteers

Thank you to our Session Chairs, Exhibitors, Registrars, and K-12 students for their contributions to making ISEC '14 run smoothly!

## Notes