ISEC 2013

IEEE Integrated STEM Education Conference

Friend Center
Princeton University
Saturday, March 9, 2013

Program Book

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IEEE Princeton / Central Jersey Section
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8:15 – 3 pm
REGISTRATION IN THE FOYER
SPEAKER PREPARATION ROOM – DEAN'S CONFERENCE ROOM

8:15 – 11:30 am
BREAKFAST IN THE CONVOCATION ROOM

9 am – 3 pm
EXHIBITS IN THE CONVOCATION ROOM AND FOYER
IEEE Future Directions
Bichlien Hoang, Senior Program Director - Life Sciences, IEEE Technical Services
IEEE RepRap 3D Printer Exhibit - 3D for Everyone!
Rebecca Mercuri, Chair, IEEE Princeton / Central Jersey Section and Kevin Meredith, Rider University
Woodrow Wilson National Fellowship Foundation
Ramik Williams, Woodrow Wilson Foundation

9 – 9:20 am

FC 004: Water: An Imperative Human Resource
Y. Sanghavi and A. Balaji, JP Stevens High School
Throughout history, water purification has been an important part of preserving mankind's existence, due to the fact that the human population cannot survive without water. It is evident that centuries ago water was being purified and is still being researched and refined today. Water is essential for life, but can quickly become harmful if not managed correctly. Today, there are a plethora of techniques ranging from simple to complex for water purification. This paper aims to educate the importance of water purification and spread awareness of waterborne disease and techniques.

FC 006: The Roles of Mothers and Parents in Driving Innovation in the American STEM Pipeline
A. Knowles, Verizon Wireless
We continue to hear daily that America is losing its leadership and innovative edge in technology and science to European and Asian countries. One reason often cited is the lack of diversity of students and professionals in STEM careers, since diversity often leads to creativity and innovation. Many studies and research provide reasons for the small numbers of minority students pursuing STEM careers and cures for reversing this trend. The solutions range from highlighting diverse role models, to investing more in math and science in inner city schools, to including stories and examples relevant to the various ethnic groups and females in the STEM curricula, to inserting more STEM activities in the early education curriculum. This paper will focus on what the author believes to be the most important solution to rebuilding the STEM pipeline with minority students to infuse creativity and innovation: re-focusing mothers and parents of minority students to embrace their role in making education, particularly excellence in math, a top priority for their children in kindergarten through high school.

FC 008: Establishing a Cost Effective Embedded Control and Robotics Engineering Program: Linear Optimal Control Design Using LEGOs
R. Sugumaran, H. Nanal, R. Jain, and S. Wadoo, New York Institute of Technology
The cost of establishing a traditional control systems and robotics program usually runs into many thousands of dollars. As a result many undergraduate and graduate STEM institutions are unable to establish these important STEM programs in their curriculum. This paper introduces an alternative method of teaching important control system and robotics concepts using LEGO kits and ROBOTC software. Such a program has been successfully implemented in NYIT's school of electrical and computer engineering. In this paper, the design and optimal control of the LEGO Mindstorms NXT motor system is studied. The system for which we design this controller is pre-identified and control is implemented with a state feedback controller. The system's open and closed loop dynamics are computed and the responses are observed. We first check the observability and controllability criteria for the system. We then design an LQR based state feedback controller and using a Kalman filter observer. The controller is then implemented as an H2 (LQG) optimal controller. The performance of H2 controller is analyzed and simulated. The controllers are then implemented and validated on the prototype

FC 101: Lincoln Laboratory Radar Introduction for Student Engineers
D. Granchelli, A. Fenn, and C. Agbasi-Porter, MIT Lincoln Laboratory
Lincoln Laboratory Radar Introduction for Student Engineers (LLRISE) is a two-week, intensive hands-on, residential workshop for rising high-school seniors from underserved school districts in the New England area. The summer program focuses on radar technology, a subject in which Lincoln Laboratory has a long history and extensive experience. The first LLRISE workshop was held in July 2012 at MIT Lincoln Laboratory in Lexington, Massachusetts, 14 miles west of the Massachusetts Institute of Technology. Students stayed at MIT at the Simmons dormitory and were provided daily transportation for two weeks to the Laboratory.
This paper describes the overall experience these students were provided through lectures and coursework, the prototyping/building phase of the workshop, and enrichment experiences at MIT and in Boston. During the engineering portion of the workshop, students were mentored by Lincoln Laboratory technical staff. Students also received guidance on many social skills such as how to navigate the financial aid process, how to apply to college, and how to develop and deliver an effective presentation.

9:20 – 9:40 am

FC 004: Designing STEM Activities to Compliment Neural Development in Children
B. Wysocki, N. McDonald, M. Fanto, and T. McEwen, Air Force Research Laboratory
This paper explores the effects of incorporating different modes of learning on neural development and suggests methods of maximizing the impact of hands-on activities designed by K-12 educators. The influence of relatively new technologies such as the internet and smart phones on problem solving is considered.

Some examples of design activities that are built on holistic learning are presented.

FC 006: To Introduce Computer Science in One Day: The Throw Platform

J. Cohen, W. Ding, and D. Boisvert, University of Massachusetts - Boston

This paper presents an open source platform, Throw, that is intended to be used for a one day event to increase interest in computer science as well as equip students with tools for self exploration. It is based on three years of hosting a one day event aimed at introducing computer science to 5-8th grade students. One major challenge in computer science education is fostering a commitment to learn, that is powerful and engaging enough for a student to be able to utilize learned skills to turn their ideas into reality and drive them to pursue computing. We present a theory for what is necessary for an effective introduction to computer science as well as present survey results from the first trial of the Throw platform that encompasses this theory.

FC 008: Establishing a Cost Effective Embedded Control and Robotics Engineering Program: Observer Based State Feedback Control Using LEGOs

R. Jain, R. Sugumaran, and S. Wadoo, New York Institute of Technologyan, H. Nanal, R. Jain, and S. Wadoo, New York Institute of Technology

The cost of establishing a traditional control systems and robotics program usually runs into many thousands of dollars. As a result many undergraduate and graduate STEM institutions are unable to establish these important STEM programs in their curriculum. This paper introduces an alternative method of teaching important control system and robotics concepts using LEGO kits and ROBOTC software. Such a program has been successfully implemented in NYIT's school of electrical and computer engineering. In this paper, the concepts of observer based state feedback control are introduced. An observer based state feedback control is implemented on a LEGO NXT motor. The paper starts with exploring the system, which is initially identified. A PID controller is designed for the system. A state space model is then developed and its state feedback control is designed. In the final step, an observer based state feedback control is designed for the system.

FC 101: The Influence of a ROV Themed Engineering Design Workshop on In-Service Teacher Self-Efficacy

T. Goodale, College of Coastal Georgia

This study utilized ROVs (underwater autonomous robots) as a central theme within a United States Department of Education Grant to support 14 teachers in Georgia to learn engineering and technology content and pedagogy associated with the upcoming implementation of Next Generation Science Standards. Employing the "Engineering Design" model teachers explored the nuances involved with robotics, electronics, and prototype construction and operation. Participants were 14 public school teachers that were vastly inexperienced with basic engineering principles or careers. A pre and post assessment of teacher self efficacy towards basic engineering principles and design showed substantial growth in confidence levels of teacher participants. Provided the lack of true engineering content preparation of many in-service teachers, the workshop and curriculum guidance model shows promise to assist teachers in utilizing kinesthetic and real world projects to meet the newly reformed STEM standards.

9:40 – 10 am

FC 004: Best Practices to Design Hands-On Activities for Virtual Computer Laboratories

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

In this paper, we introduce a collaborative virtual computer laboratory and discuss best strategies to foster student learning using virtual computers, particularly in information security that requires substantial hands-on experimentation to master the subject matter. Unfortunately, information security topics are challenging to teach in traditional computer laboratories mainly due to restrictive information technology policies. In recent decades, virtual computing has become a promising solution to address the challenges of providing students with hands-on learning experiences in information security. While the literature mainly focuses on technical aspects of virtual computer laboratories and provides ample examples about how they can be used in information security courses, there is a lack of pedagogical studies. We introduce a framework based on Kolb's Experiential Learning Cycle to design activities for virtual computer laboratories. We provide empirical evidence that if virtual computer activities are designed and conducted according to this framework, student learning can be enhanced even further.

FC 006: Leveraging Mobile Applications to Promote Humanities-STEM Intersections

A. Lewis, New York University

Current trends in education encourage the development of students who are capable of bridging disciplines, integrating multiple modes, and adopting perspectives effectively. Despite this rhetorical appreciation of inter- and multidisciplinary training, academic distinctions persist. In particular, the division between the humanities and the STEM fields is evident in the ways these disciplines approach learning and knowledge. STEM fields tend to promote post-positivist ways of seeing the world while the humanities embrace interpretivist modes of thought. This paper examines a mobile application for vocabulary learning designed to integrate humanities- and science-related processes in an effort to offer multidisciplinary experiences for students. The main implications are that leveraging mobile technologies increases contextualized learning experiences for students, and facilitates the use of multiple disciplines to accomplish a goal. Important to creating an educational tool that incorporates humanistic and scientific knowledge and methods are creating communities of practice, facilitating user-generated content, and promoting of project-based learning.

FC 008: Redesigning an Advanced Embedded Systems Course: A Step Towards Interdisciplinary Engineering Education

V. Subbian and C. Purdy, University of Cincinnati

With rapid advancements and popularity of embedded devices in the digital systems market, undergraduate students in various majors, specifically computer engineering, computer science, electrical engineering, computer engineering technology, and electrical engineering technology, have shown increased interest in learning more about embedded computing systems. Typically, students accumulate knowledge of computing systems through

introductory courses that focus on computer arithmetic, microcontroller-based design and computer organization. This paper presents experiences from teaching and redesigning an advanced embedded systems course that integrates various hardware and software concepts to accommodate the needs of interdisciplinary engineering education.

10 – 11 am
KEYNOTE 1
FC 101

Engineering Education Research: The Growth of a Discipline
Leah H. Jamieson, John A. Edwardson Dean of Engineering and Ransburg Professor of Electrical and Computer Engineering, Purdue University

11 – 11:20 am

FC 004: Introduction of Intellectual Property Courses in the STEM Curriculum
M. Srivastava, Cornell University
The paper explains and emphasizes the need to include mandatory Intellectual Property (IP) courses in the undergraduate and graduate curriculum of STEM students. It prescribes the proposed content of IP to be covered at undergraduate level, and graduate depending on the degree pursued by the STEM student. More importantly, this paper advocates for an Integrated PhD/JD degree to produce highly skilled patent attorneys and agents, to overcome the problem of poor quality of patents, and the high number of patent related litigations. A framework is suggested which would enable STEM departments and law schools to successfully offer this integrated degree, and students to successfully pursue and complete this degree program in a realistic manner without compromising any stakeholder's interest.

FC 006: Role of MOOCs in Integrated STEM Education: A Learning Perspective
V. Subbian, University of Cincinnati
Massive Open Online Courses (MOOCs) have created a major paradigm shift in online education by offering web-based courses at no cost to virtually anyone with access to a computer/laptop with an internet connection. In 2012, MOOCs gained significant attention from media, students, educators, and entrepreneurs. It is continuing to develop into a more popular and widespread educational technology. This paper identifies and discusses few key elements of massively open online education that can influence pedagogy and learning in STEM disciplines. It also examines the potential of MOOCs in improving learning experiences and facilitating interdisciplinary education in STEM fields.

FC 008: Integrating a Science Perspective Into an Introductory Computer Science Course
J. Magee, IV and L. Han, Clark University
Experiences of including a Science Perspective in our university-level introductory computer science course are presented. The Science Perspective has helped in recruitment of students who otherwise might not have considered taking a computer science course. The assignments offered as part of the Science Perspective have been an integral part of our approach to teaching computer science in a way that is interesting and engaging to students by inviting them to explore scientific applications in computing. Our approach uses the Alice 3D animation-based programming environment followed by an event-based graphical Java programming approach. The interactive and visual nature of these approaches has increased student engagement, which has led to better retention in follow-up computer science courses. This approach could also be applicable in teaching computer science in secondary education.

FC 101: A Whole-School Approach to STEM Education: Every Child, Every Class, Every Day
M. Goodwin, III and M. Brawley, Laing Middle School of Science and Technology; P. Ferguson, Trident Regional Education Center; and D. Price and J. Whitehair, Laing Middle School of Science and Technology
A whole-school STEM initiative is being implemented at Laing Middle School of Science and Technology in Mount Pleasant, SC. The essence of this initiative is to use STEM content throughout the curriculum to build technological literacy, and establish the real-world relevance and inter-relationships of all curriculum subjects. Distinctive features of this approach include using the engineering design process in all classes as a method for solving problems; addressing nationally recognized technological literacy standards concurrently with mandated subject-specific standards; and engaging students with cross-curricular problems and projects that involve practical applications of science, technology, engineering, and mathematics.

11:20 – 11:40 am

FC 004: Assessing Professional Skills in STEM Disciplines
S. Kulturel-Konak and A. Konak, The Pennsylvania State University - Berks; I. Esparragoza, The Pennsylvania State University - Brandywine; and G. Kremer, The Pennsylvania State University
This paper puts forward a novel assessment framework, based on the Model of Domain Learning (MDL), to assess student development in various professional skills across Science, Technology, Engineering and Mathematics (STEM) disciplines. New graduates are not only required to have good technical skills but also excel in professional skills to be successful in their career choices. As a response, academic programs have integrated professional skills such as teamwork/communication, ethics, global awareness, creative problem solving, and leadership, into their curricula. However, there are challenges in the assessment of learning outcomes related to professional skills. By designing a uniform assessment framework for all professional skills and developing a set of coherent assessment instruments that can be tailored according to the learning objectives and student level, the proposed assessment framework aims to facilitate the integration of professional skills assessment into an overall program assessment plan. The proposed framework will be tested in various course levels (i.e., first year to senior) from STEM majors at various institutions.

FC 006: BisPhenol-A Assays: A Proposed Curriculum
W. Ward and S. Charuvu, Rutgers The State University of New Jersey
BPA is a potentially toxic chemical having weak estrogenic activity. Hundreds of scientific research papers have been

written about the potential toxicity of BPA in humans and other animals. But, there are numerous research papers alleging its safety. The Environmental Protection Agency has reviewed the BPA-related data as recently as 2012, concluding that the benefits of BPA in commercial applications outweigh its suspected toxicity. Consumers first became aware of BPA when studies showed that BPA can leach from polycarbonate plastic baby bottles into milk and juice. We will demonstrate the BPAssay™, a tool with accompanying lesson plans, which can be used in K-16 classrooms to enhance learning about this compound.

FC 008: An Interdisciplinary Approach to STEM Education Through Reconsideration of a Classic on Education

R. Christie and W. Marszalek, DeVry University

Our paper addresses the issue of STEM education within the larger context of interdisciplinary education. We ask: Is an interdisciplinary approach to education, in particular to engineering education, superior, in some sense, to one that is narrower but deeper in content, a specialized education wherein a person learns about and studies the cutting edge recent discoveries or theories that are understood by only a handful of people in this world? Our thesis is that such an interdisciplinary approach can indeed be superior to, and enhance, a field-specific education. We pose several major questions in regard to STEM education, and then suggest an approach to address these issues from the perspective of a major classic in the field of education. We apply the insights of that classic to these questions, concluding with references to parallel insights from others who have engaged these same issues both in education as well as in the application of our suggested approach in the realm of scientific research.

FC 101: Promoting STEM Education Through Local School-Industry Collaboration: An Example of Mutual Benefits

A. Geyer, J. Sidman, D. Dumond, and J. Rousseau, Aptima, Inc.; R. Monagle and T. Awiszus, McCall Middle School; and D. Petty and S. Glassner, Winchester High School

While many STEM-related efforts focus on implementing new curricula in schools, or promoting interaction among STEM educators from different schools, we describe in this paper another method of promoting STEM education: developing local school-industry relationships. In this particular example, a company working on a government-sponsored robotics project worked closely with a neighboring middle school to accomplish both project goals and promote STEM interest in students. The initial collaboration served as "an initiative that spurred initiatives," and the resulting outcome provided benefits for both the school and the company alike. The school benefitted from exposing students to scientists and engineers working on real-world applications, and from receiving resources from the company to enhance their existing curriculum. The company benefitted from the rewarding work experience that the collaboration offered for its scientists and engineers, and, subsequently, organized a formal STEM committee to pursue similar collaborative opportunities more broadly.

11:40 am – noon

FC 004: Smart Teaching Quantitative Topics Through the VARK Learning Styles Model

S. Moazeni, Princeton University and H. Pourmohammadi, California State University

Effective teaching concerns students' learning styles and its diversity. An adopted teaching strategy must be then aligned with students' learning traits. In this paper, to provide an effective in-classroom learning environment for most students, we propose to develop appropriate instructional presentation methods to match diversity of learning styles. We demonstrate how to align in-class instructions, such as quizzes and other in-class learning activities, with students' learning styles. Our discussion, which primarily focuses on quantitative topics, relies on research in education and applied psychology, and our teaching experience. Here, we utilize the Fleming's VARK learning style model. We then address some shortcomings of identifying students' learning styles through a generic questionnaire, and propose a scheme to dynamically infer them. This automatic student modeling approach can be easily adopted in distance education.

FC 006: Current Trends in Open Social Learning - Synergizing STEM

B. John, V. Thavavel, and J. Jayakumar, Karunya University; J. Poomaselvan, Government College of Technology; and M. Arumugam, Sikkim Manipal University

Open Social Learning is an emerging research area that deals with leveraging open access to the learning content on the web and enabling social networking amongst the learners and mentors to make the learning experience efficient. This paper aims to capture the current direction of research carried out in the area of open social learning. Several published research work were reviewed in the field of Social Learning and Collective Intelligence. This paper intends to address the following three goals. (i) Summarize the flow of research and the popular issues that were most frequently addressed, in the last few years. (ii) Be a useful resource to understand the various approaches that were adopted and their boundaries. (iii) Suggest the future scope in a few aspects to extend the research further.

FC 008: *Conducting Robots* - Bridging the Gap Between Science, Technology, and the Arts in the Undergraduate Curriculum

A. Salgian, T. Nakra, C. Ault, and Y. Wang, The College of New Jersey

While many have explored multidisciplinary approaches to course content delivery in computer science and engineering, very few have combined engineering with fundamentally different disciplines such as the arts, humanities, or social science. This paper presents a multidisciplinary undergraduate seminar entitled "Conducting Robots" that brings together majors from four disparate disciplines: computer science, mechanical engineering, music, and interactive multimedia. The goal of the course is to teach and support interdisciplinary teamwork while student teams build an artificial system that can conduct the college orchestra. The end-of-semester survey shows that students found the course interesting and challenging, motivating them to collaborate with peers across disciplines.

FC 101: Impact of Inquiry Science and Technology Education in the Development of Citizenship Skills: The Case of the Pequeños Científicos Program in Colombia

M. Díaz, M. Roncancio, M. Gómez-Sarmiento, and M. Duque, Universidad de los Andes

Pequeños Científicos (Little Scientists) program in Colombia seeks to transform teaching of science and technology using inquiry activities that promote the improvement of scientific and technological skills as well as the development of social abilities to coexist with others and participate in democratic societies.

This work present a survey made during the second semester of 2012 with in service teachers that have been working in Pequeños Científicos program. Results show that teachers recognize a positive impact of implementation of the project in the environment of the classroom. Aspects as collaborative work and role recognition inside the group were highlighted as important as well as respect for other ideas or opinions. Other situations as recognition of abuse or non-aggressive communication were not influenced by the program. Teachers also report that competences as learning from error improved significantly with Pequeños Científicos.

This work suggests that STEM education can promote not only an improvement in scientific and technological competences but also peaceful environments in the school, and that Pequeños Científicos program is an opportunity to transform student-teacher and student-student relationships in the classroom.

Noon – 1:15 pm
LUNCH AND NETWORKING IN THE CONVOCATION ROOM

12:30 – 1:15 pm
KEYNOTE 2
CONVOCATION ROOM

Recruiting and Retaining Minority Graduate Students in Engineering

Athina P. Petropulu, Professor and Chair, Department of Electrical and Computer Engineering, Rutgers The State University of New Jersey

1:20 – 1:40 pm

FC 004: Fostering Student Learning in Information Security Fields Through Collaborative Learning in Virtual Computer Laboratories

K. Wagner, M. Myers, and A. Konak, The Pennsylvania State University - Berks

This paper discusses the benefits of group work in a Collaborative Virtual Computer Laboratory (CVCLAB) to enhance student learning in information security fields. The CVCLAB integrates virtual machine technologies and pedagogical approaches in a collaborative leaning model to address the challenges in the information security education. A qualitative analysis of student experiences of the CVCLAB was performed using the grounded theory. The outcomes of this qualitative analysis indicated that students who performed challenging activities in groups experienced less frustration and reported higher satisfaction with the activities and learning environment. Finally, the paper recommends strategies to design collaborative activities for virtual computer laboratories.

FC 006: Training K-12 Teachers in STEM Education: A Multi-Disciplinary Approach

S. Green and N. Anid, New York Institute of Technology

Currently, the US ranks 25th in math and 17th in science among our international peers. U.S. colleges and universities will need to train 25,000 new science, technology, engineering, and math (STEM) teachers each year to meet President Obama's challenge to train 100,000 STEM graduates over the next decade. Improving STEM education is critical for the economic stability of the nation. The nation's changing demographics and continued need to remain globally competitive make it clear that colleges and universities must increase the number of teachers trained in STEM New York Institute of Technology School of Education and School of Engineering and Computing Sciences is addressing this urgent need to improve STEM education through a multi-disciplinary approach to train teachers to become effective leaders in STEM education. One hundred and fifty students in the Advanced Certificate in STEM program were recruited to participate in the study. A questionnaire was utilized to collect data on students' perceptions of improved knowledge and skills in teaching STEM subjects after completion of the certificate program.

FC 008: A Fully Revised Introductory Physics Sequence

E. Page, B. Stutzman, L. Allen, R. James, B. Jewczyn, S. Jones, and R. Paolino, United States Coast Guard Academy

The Physics program at the United States Coast Guard Academy has implemented a completely revised introductory physics sequence utilizing state-of-the-art techniques in physics education. With active student engagement based on socio-cultural constructivism at its core, techniques such as Just-in-Time Teaching and Peer Instruction along with the testing effect are paramount to this new model. Here, the design and initial implementation are presented along with faculty analysis of the new model.

FC 101: Arts and Bots: Techniques for Distributing a STEAM Robotics Program Through K-12 Classrooms

E. Hamner and J. Cross, Carnegie-Mellon University

Arts & Bots is a craft-based robotics program focused on expression and creativity in the service of improving K-12 student technological fluency. In this paper, we describe how we transitioned Arts & Bots from an out-of-school program to a successful classroom tool applicable to many school subjects. We focus specifically on partnerships with teachers and professional development strategies.

1:40 – 2 pm

FC 004: Adapting STEM Lectures for Culturally and Linguistically Diverse Classrooms

J. Stanislow, Rochester Institute of Technology and National Technical Institute for the Deaf and R. Kushalnagar, Rochester Institute of Technology

STEM courses, especially the introductory courses, tend to be heavy on learning and mastering sequential concepts. With the increase in culturally and linguistically diverse students, it is important for faculty to minimize mainstream culturally-bound words and linguistic idioms so as to minimize student confusion and maximize student learning. In addition, students with disabilities often have linguistic or cultural differences, such as those who are deaf or autistic.

FC 006: Mentoring High School Students: Lessons Learned
T. Lam, Lockheed Martin
This paper shares my personal experience mentoring 38 high school students who participated in the New Visions Engineering Program since the program was introduced in 2009. I also discuss observations on behaviors of the students I mentored and my own lessons learned. In addition, statistical data is presented to illustrate the program's effectiveness and its trends. Concluding remarks further support the benefits of such highly successful and inspirational programs that integrate science, technology, engineering, and math (STEM) for our future engineers.

FC 008: Development and Description of an Interdisciplinary Course on the Science of Terrorism
E. Page, L. Allen, J. Gray, and S. Bateman, United States Coast Guard Academy
The development and description of an interdisciplinary, team taught course on the Science of Terrorism is presented. Faculty members from Physics, Chemistry, and Marine and Environmental Sciences collaborated to design a course introducing students to the science behind bioterrorism, chemical and toxicological terrorism, nuclear and radiological terrorism and cyberterrorism as well as epidemiological and GIS models. The course concludes with a simulated terror attack for which students need to use their knowledge of the science of terrorism to defuse.

FC 101: SciTech Kids Electronic Art: Using STEAM to Enngage Children of All Ages and Genders
K. Magloire and N. Aly, SciTech
SciTech Kids presents a case study of our workshops that integrate art into our STEM curriculum and introduce young children to the basics of electronics and technology. SciTech Kids Electronic Art (SKEA) is a crafts-based, hands-on approach that allows participants to tinker and produce interactive electronic objects. The SKEA workshops provide a new way of thinking and drawing connections about STEM topics by emphasizing the synergy between engineering, technology and art. The SKEA approach holds great promise since it helps a greater number of young learners, including girls, experience STEAM as an engaging process of inquiry and creates rich experiences for them to become active makers, designers and innovators.

2 – 2:20 pm

FC 004: Active and Interactive Cloud-Based Learning Environments
H. Bajwa and Z. Wu, University of Bridgeport
The biggest challenge in developing an effective online learning environment is to map new technologies to proven teaching pedagogies and learning objectives. Pedagogies of engagement, such as discussions, debates, peer interaction, laboratories and other formats fostering student opinions, are often easily implemented in the classroom environment, but such interactive engagement techniques are rarely implemented in online courses. An effective e-learning platform should be able to promote interactive activities and collaborative learning by engaging students in the learning process.
In this paper we will discuss the functionalities of some state of art online learning platforms. We will identify some shortcomings of current e-learning platforms. We also present the architecture of cloud based active and interactive learning platforms that supports problem based learning (PBL) and active learning strategies.

FC 006: Air-Powered Soft Robots for K-12 Classrooms
B. Finio, R. Shepherd, and H. Lipson, Cornell University
This paper outlines the development of an affordable, sustainable K-12 outreach program based pneumatically-powered soft robots. Recent advances in low-cost 3D printers have helped make these robots available to hobbyists and K-12 classrooms. This paper is intended to serve as a reference for interested students, parents and educators, and a model for other researchers to develop similar outreach programs.

FC 008: Writing in Physics
B. Jewczyn, L. Allen, R. James, E. Page, S. Jones, R. Paolino, and B. Stutzman, United States Coast Guard Academy
In the fall of 2012, the Physics program at the United States Coast Guard Academy (USCGA), in an effort to improve scientific writing and understanding of physics, added three major writing assignments to the Physics I curriculum. These writing assignments are focused on making students familiar with scientific and technical reading and writing. Scientific and technical reading and writing skills are not addressed elsewhere in the core curriculum. The assignments are meant to create a link between the writing classes and the upper major Science, Technology, Engineering and Mathematics (STEM) classes. Students learn to read and summarize technical journal articles and to conduct a final project culminating in a paper and presentation.

FC 101: Anytime, Anywhere, Anyone Instruction: A Tool for Life-Long Learning
T. Piliouras, P. Yu, X. Tian, and S. Yu, TCR, Inc.; N. Sultana, NYU; and J. Lauer and L. Berry, Academy of Information Technology and Engineering
This paper highlights the authors' experiences teaching high school students Science-Technology-Engineering-Mathematics (STEM) and technology literacy skills. Productive learning is engendered by trust, safety, supportive interpersonal relationships between mentors and students, and adaptation of teaching style to match the students' frame of reference. These principles are incorporated in the design of an online learning program called Best We Can Be. We discuss how technology-aided instruction encourages students to explore subject matter beyond their comfort zone. This fosters students' natural curiosity about STEM topics, and helps overcome their anxiety about whether they will be able to learn the subject matter. In Best We Can Be, students participate in structured, hands-on activities illustrating the cross-fertilization of academic disciplines (e.g., bioethics, which encompasses social, health and biological sciences, humanities, law, etc.) and their interdependency in society. We examine technology's enablement of student interactions within secure networks of mentors, experts, and peers. We discuss transformative impacts of broadening student appreciation of the world of possibilities that await them in future educational and career paths. The ultimate goal is for students to become self-motivated, life-long productive learners.

2:20 – 2:40 pm

FC 004: Teaching Statistics to Non-Mathematics Majors: Interdisciplinary Integration with R and EDA

G. Grabarnik, St. John's University and S. Yaskolko, South University

In this paper, we consider statistics as a college level subject from a number of different perspectives. The paper defines statistics, states the goals of introductory statistics courses, and outlines different directions of the course. The paper sketches the main topics of the course and discusses the necessity of real life examples and exercises targeting specific majors. It is a necessity for students to be able to explore data before using standard statistical methods. A number of tools are considered to facilitate work on the problems and exploration process. We argue that R is one of the most appropriate tools for the task, and suggest a way to introduce R into the course as a means of implementing this approach and allowing students to gain a better hands-on experience with real life examples.

FC 006: Stimulating Engineering Design Through the Junior Solar Sprint at Citizen Schools' Extended Learning Time Apprenticeship

B. Hecht, Analog Devices and J. Werner, Citizen Schools

Connecting middle school students with opportunities for "learning by doing" is a cornerstone of the Citizen Schools apprenticeships that bring professionals to teach a weekly apprenticeships during extended learning time. In Citizen Schools apprenticeships, a volunteer STEM expert works with 12-15 students one afternoon a week for 11 weeks to explore a new field and to create a high-quality product or presentation to share at a community event. Citizen Schools recruits, trains, and supports volunteers to lead apprenticeships on topics that range from solar car engineering to stock market investing to electronic textiles. Over half of Citizen Schools' current apprenticeships focus on topics in Science, Engineering, and Mathematics (STEM) fields with 21st-century Skills for students working on directed projects. The Junior Solar Sprint challenges students to design and build a model car using solar power to drive an electric motor. Through this experience, students learn and apply introductory principles of design and gain a first-hand experience in engineering and STEM fields.

FC 008: Manufacturing a Non-Profit Corporation - STEM Higher Education Embraces Entrepreneurialism

E. Flynn, Gateway CC; W. Robicheau, CT Regional Center for Next Generation Manufacturing; M. DeWolfe and J. Bennett, ClearSky, Inc.

The community college and university systems possess unique opportunities to showcase the integration of Science, Technology, Engineering, and Math (STEM) programs into cohesive, collective, and collaborative learning environments. Furthermore, from the support of government funding resources, regional educational consortiums, and local business and industry partners, it will be shown that college engineering teams are as capable as any professional-level business development team in producing tangible, physical project results. Specifically, in this paper a collaboration between a Connecticut non-profit company, ClearSky Inc., and a Connecticut higher-education program, the Life Support and Sustainable Living Program, diagrams the process to take a concept from design to prototype in just a few short months.

FC 101: Collaborations to Improve College and Career Readiness Through Trans-Disciplinary Learning

D. Irwin, L. Logan-King, T. Lewis, and D. Ackroyd, Ballston Spa Central School District

The Ballston Spa Central School District created the "Partnership for Innovation in Education" program to collaborate with higher education, business and industry, and non-profit and government agencies to produce innovative educational experiences that reframe teaching and learning for the 21st Century. An initiative that came out of the Partnership for Innovation in Education was the Clean Technologies and Sustainable Industries Early College High School Program (CTSI ECHS). The Early College High School model combines academic rigor with financial and temporal efficiencies, creating a powerful motivation for students to strive to meet its intellectual challenges. College and high school are blended in the model, compressing the time that is needed to complete the final two years of high school and the first year of college. Students engage this program in an environment that supports their current level of readiness, while encouraging them to extend the limits of their capabilities. In addition to the Early College model, the CTSI ECHS uses an innovative approach of trans-disciplinary learning to provide students with communication, collaboration, and problem solving skills necessary to make informed decisions as they relate to college and career readiness and to be prepared to enter the workforce of the innovative economy.

2:40 – 3 pm

FC 004: Low-Cost Approaches to UAV Design Using Advanced Manufacturing Techniques

E. Flynn, Gateway Community College

Unmanned Aerial Vehicle (UAV) platforms are of major interest to defense, government, and commercial industries. The ability to remotely control an aerial vehicle capable of surveillance, offensive and defensive maneuvering, reconnaissance, or numerous other applications without the need to put a human life in jeopardy is a major attraction to their use. Furthermore, there exists opportunities to make these airborne vehicles largely autonomous, further reducing the need for even remote human operators. However, for all of the significant advantages of UAVs, there are significant negatives: the costs of manufacture and design. Due in part to the substantial amount of complex electronic equipment on board, UAVs become not only a design of aeronautics but an experiment in energy conservation through optimization. A limited range of UAV power becomes a limiting factor of UAV application. The challenge becomes to optimize the size, weight, and aerodynamics of the UAV based on the application. Along with a NASA faculty research grant, the project has been given seven college engineering students with the singular goal of investigating UAV design techniques using advanced manufacturing techniques and STEM principles. In this paper, it will be shown how a college manufacturing lab, paired with a team of student engineers, and guided by an engineering faculty member, will seek to provide tangible, industry-quality results.

FC 006: EPICS High: STEM's Impact on Community Service
S. Dutta and R. Mathur, Bridgewater-Raritan High School
EPICS (Engineering Projects In Community Service) is a nation-wide program that encourages students to be active in their community and use engineering ideas to solve local problems. In 2006, the EPICS program was expanded and is no longer exclusive to colleges and universities. The extension of the program is called EPICS High, a similar program aimed specifically at High School students. Many exciting and interesting projects have resulted from this program, throughout the world. In addition, the integration of STEM (Science, Technology, Engineering, and Mathematics) fields with community service promotes its potential to a younger audience. EPICS High has proven to be an invaluable organization worldwide due to the advantages and opportunities it offers.

FC 008: Integrating Science and Policy: The Case of an Alternative Policy Course
S. Hooshangi, The George Washington University
The future of the energy industry has become the centerpiece of many technical, social and political debates in recent years and yet there is no comprehensive plan to include energy as a core requirement in undergraduate STEM programs. Since the current and future state of the energy industry has a direct effect on the daily lives of individuals, we believe that some degree of familiarity with this industry is of great value to our students; especially to those who major in engineering, sciences or other STEM related fields. As more natural resources are depleted and as the pursuit for alternative sources of energy to replace fossil fuels continues, it is important to prepare the next generation of students for the many challenges that lie ahead. In accordance with the efforts to provide our undergraduate students with an interdisciplinary curriculum, we have designed and implemented an energy course that focuses on the science and technology aspects of the energy industry and also it examines the important role that policies, policy makers and the government play in shaping the future of the energy industry. This paper presents some of the highlights of this cross-disciplinary course, which is an example of a possible synergy between STEM disciplines and the social science fields.

FC 101: History and Technology: Integrating STEM Content into Elementary Classrooms Through History-Based Themes
J. Manwell, Historical Forensics and C. Sullivan, Dartmouth University
Children learn best when they are immersed in and invested in a topic of study. While some skills need to be taught in isolation and in a particular sequence, there is a great value to teaching at the elementary level using integrated thematic units. Themes provide a context for information, helping children see how content is inter-related. Using an inquiry approach engages students even more as they seek answers to their own questions. This is true for the sciences, but it is equally true for social studies. Having students work directly with primary sources supports them to draw their own informed conclusions and be more engaged in the learning process.

3 – 4:15 pm
KEYNOTE 3
FC 101

FC 101: Overview of the Engineering Projects in Community Service (EPICS) in IEEE Programs
Kapil R. Dandekar, Associate Dean for Research and Associate Professor of Electrical and Computer Engineering, Drexel University

AWARDS CEREMONY AND RECEPTION FOLLOWING IN THE CONVOCATION ROOM