ISEC 2015

5th IEEE Integrated STEM Education Conference

Friend Center
Princeton University
Saturday, March 7, 2015

Program Book

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Acknowledgment

Many thanks to H. Vincent Poor, Ph.D., Michael Henry Strater University Professor of Electrical Engineering and Dean of SEAS, Princeton University; Andrea Mameniskis, Assistant to the Dean; and Michelle Horgan, Senior Conference and Event Manager, for your kind hospitality in hosting ISEC '15 and to Andrea and Michelle for all of their hard work!

We also appreciate very much the contributions of the volunteer reviewers, session chairs, conference staff, and "friends of the conference." The conference benefits greatly from the gifts of your time, skills, and knowledge.

Calendar of Events

8 – 3 pm
Registration in the Convocation Room
Speaker Preparation Room – Dean's Conference Room

8 – 11 am
Breakfast in the Convocation Room

9 am – 4 pm
Posters, Demonstrations and Exhibits in the Convocation Room and 101 Area
Posters by K-16 Students
5eBoard by 5eTek: A Revolutionary, Accessible Solderless Circuit Board
Erli Chen
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
MathWorks: World's Leading Developer of Mathematical and Technical Computing Software
PJ Boardman and Akash Gopisetty

9 – 9:45 am
Invited Talk in FC 101
IEEE Educational Activities Board Report
Focus on Informal STEM Education for K-12
Saurabh Sinha, Ph.D., Executive Dean of the Faculty of Engineering and the Built Environment, University of Johannesburg
Douglas Gorham, Ed.D., Managing Director of the IEEE Educational Activities Department and Secretary to the IEEE EAB

9:45 – 10:30 am
UnConference in FC 101
Trends in STEM Integration
Vignesh Subbian, Facilitator

10:40 am – noon
Presentations

noon – 1 pm
Lunch in the Convocation Room (Overflow Seating in FC 109)

1 - 1:30 pm
Special Focus on Posters and Exhibits

1:30 – 2:30 pm
KEYNOTE IN FC 101
Everyone Can Engineer: Why All Kids Should Study Engineering - Even Before They Can Spell It
Christine M. Cunningham, Ph.D., Director of Engineering is Elementary and Vice President, Museum of Science, Boston, MA

KEYNOTE SPEAKER

Dr. Christine Cunningham is an educational researcher who works to make engineering and science more relevant, accessible, and understandable, especially for underserved and underrepresented populations. A vice president at the Museum of Science, Boston since 2003, she founded and directs Engineering is Elementary™, a groundbreaking project that integrates engineering concepts into elementary curriculum and teacher professional development. To date, EiE has served 5.8 million children nationwide and 70,000 educators. Cunningham has previously served as director of engineering education research at the Tufts University Center for Engineering Educational Outreach, where her work focused on integrating engineering with science, technology, and math in professional development for K-12 teachers. She also directed the Women's Experiences in College Engineering (WECE) project, the first national, longitudinal, large-scale study of the factors that support young women pursuing engineering degrees. Cunningham is a Fellow of the American Society for Engineering Education. She holds B.A. and M.A. degrees in biology from Yale University and a Ph.D. in Science Education from Cornell University.

Abstract: State and national science standards increasingly emphasize engineering concepts and skills as part of K-12 STEM instruction. This presentation shows what engineering looks like when elementary students are doing it, using a striking collection of candid short videos from classrooms around the country to illustrate how engaging in classroom engineering develops habits of mind that can support young students' academic success in other subjects. Pedagogical strategies that teachers can use to support the development of robust engineering experiences for children will also be presented, along with research results showing that classroom engineering activities successfully engage diverse students in science and engineering learning.

2:40 - 4:30 pm
PRESENTATIONS

In Memoriam

H. Robert (Bob) Schroeder
Chair, Princeton / Central Jersey Chapter of the IEEE Education Society

Bob Schroeder, a life-long resident of the Trenton, NJ area, passed on October 22, 2014. He was a founding member of the Princeton / Central Jersey Chapter of the IEEE Education Society, serving as its chair. He retired as the communications and warning officer for the New Jersey Office of Emergency Management, New Jersey State Police, and led a technology consulting company, Adro!t.

Bob was an enthusiastic supporter of and a director/officer in many area organizations. He was also a classically trained organist, a professional photographer, and a tennis and Corvette enthusiast.

He earned the BSEE from Trenton State College in 1976.

Among his many honors is receiving ARRL's 2009 Bill Orr (W6SAI) Technical Writing Award.

Given his devotion and expertise in technical writing and engineering education as well as his service to the conference, the Program Committee is proud to name ISEC's Best Paper Award in his honor.

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Presented Papers

10:40 AM - 12:00 PM

STEM Outreach (P-20) in FC 004

Chair: Ralph Tillinghast (US Army & ARDEC, Picatinny Arsenal, NJ, USA)

10:40 ***Engaging Undergraduates in Research that Speaks their Language***

Shweta Jain (York College CUNY & Graduate Center of CUNY, USA)

Undergraduates are influenced by modern technology such as smart-phone apps, social networks and the Internet. Technology is perceived to be "cool" and students are often interested in gaining expertise in them. However, most of them lack access to the tools/knowledge needed for a developer level involvement and several lack the opportunity to experience the research that creates the "cool stuff" of the future. This research project aims at providing both the tools and the opportunity to undergraduates at a minority serving institution. Through two phases: training and research that spanned from July to November 2014, several undergraduates were engaged in cutting edge Internet and mobile networks research and android application development on the MobilityFirst future Internet architecture. The training phase consisted of two 8-week long workshops. The first workshop was to discuss current research in Future Internet Architecture while the second provided training in JAVA programming language and Android application development. In the research phase, four teams have been working toward developing applications that generate and communicate content in a peer-to-peer network. This p2p network uses Wi-Fi Direct and/or MobilityFirst future Internet architecture for communication

10:55 ***Online EECS Curriculum for High School Students***

Joseph D. Steinmeyer (Massachusetts Institute of Technology, USA)

One way to increase the reach of STEM exposure and education programs is through the use of online environments. There are numerous challenges in pursuing such a solution, however. Here we present an online EECS-themed curriculum we developed and ran in the summer of 2014 that introduced rising high school seniors to core concepts in EECS. The course placed significant emphasis on short, yet complex exercise modules that relied on both software and hardware engineering concepts and attempted to develop a virtual laboratory setting in an effort to reproduce the benefits of laboratory presence of residential programs. Three different online environments were used in tandem to create an online community. We discuss the creation of the curriculum, show several examples of exercises carried out by students, present analysis of student behavior throughout the course, and discuss student feedback from this course as compared to residential programs. It is our intention that this work could provide the basis for future similar curricula, enabling cost-effective broader outreach of STEM programs at the K-12 level.

11:10 ***Using Robotics Educational Module As An Interactive STEM Learning Platform***

Francis Tuluri (Jackson State University, USA)

In traditional teaching methods of teaching science and engineering, students lack experience of applying physical principles to real time physical situation required in these disciplines of study. Students are not engaged to create interest in learning through interactive activities. Lack of interest combined with shortage of practical experience in learning eventually leads them to failure to keep up with the grades expected of them or even can lead to increased rates of attrition in science and engineering disciplines. To overcome this problem, we present a novel and versatile interactive learning tool using data logging capabilities of Robotic Educational Module of Lego NXT. In the present work, we describe the method of Robotics-based educational tool to study electrical conductivity of liquids, body resistance, and Newton's law of cooling. The details of the method – designing and building a robo-based physical system, programming, data collection, analyzing data, calculating and interpreting results are given. The method has been demonstrated to K12, and undergraduate student participants of summer camps. The Robotics-based educational tool can be used for teaching or for learning and can be extended to several other areas of science and engineering.

11:25 ***Lincoln Laboratory's Experiential STEM Programs for High School Students***

David Granchelli and Chiamaka Agbasi-Porter (MIT Lincoln Laboratory, USA)

One of MIT Lincoln Laboratory's strategic directions is science, technology, engineering, and mathematics (STEM) outreach. The Laboratory aims to develop STEM programs that couple traditional academic classroom lectures with experiential hands-on activities. The opportunity for students to build and test engineering components based on theory that they have been taught is a very effective formula for STEM learning and development. This paper focuses on two Lincoln Laboratory STEM programs for high school students: Lincoln Laboratory Radar Introduction for Student Engineers (LLRISE) and Cyber Patriot. Both programs involve intensive classroom lectures and hands-on activities that require the students to execute final requirements.

11:40 ***Engaging Students with Open Source Technologies and Arduino***

Mercy Bodarky (Outreach & IBM Research, USA); Lorraine Herger (IBM Research, USA)

Timing is critical when trying to engage students in various engineering career paths. While many "National Engineers Week" programs exist for primary and middle school students, there is a lack of hands on activities for students in the 9th-12th grades. It is often difficult to devise experiments for this age group that are interesting and not juvenile. Yet, it is during these crucial years that most students are lost to science, math and engineering. Engaging students and presenting opportunities for invention and excitement is important in the teen years, when peer pressure and the distractions of friends, social events, and activities are particularly high.1. There are a number of open source programming and affordable hardware platforms that can be used to implement low cost and interactive programs to promote innovation with various age groups. In this paper we share our work, as well as how we learned to make the workshops more effective. We have created various Arduino projects that can be customized to grade levels ranging from grades 7-12, and even college undergraduate students. The various projects we describe in this paper have been used to interact with students of different grade levels to engage in basic elements of engineering and computer programming. The classes should be set up to work in groups to promote shared innovation, teamwork and collaboration with peers. The open source and hardware experimenting exposed the students to various career paths ranging from software engineer, to electronic engineers and basic elements of various other engineering paths. This paper is designed to demonstrate the promotion of the engineering profession in schools through the use of Arduino Uno, Raspberry Pi Gemma kits, and Flora kits. The programs are also designed to accommodate classroom setting, workshops, or as an in-class field trip.

Post-Secondary Education in FC 006

Chair: Matthew Morrison (University of Mississippi, USA)

10:40 ***Web-Animations: An Interdisciplinary Approach for Biology and Information Technology Students***

Adrian Heinz and Allison D'Costa (Georgia Gwinnett College, USA)

Interdisciplinary collaboration is becoming increasingly important not only to the scientific community but also to the corporate environment since many real world problems involve collaboration from professionals across disciplines. In this work, we engaged students using a multidisciplinary project that encompassed students from two Information Technology (IT) courses and one Biology course. Students from these courses collaborated to create animations aimed to demonstrate biology concepts. Students worked in teams throughout the semester and presented the completed animation in class. The finished animations were later used in biology classes as teaching and learning tools. The purpose of this project is to create an active learning environment that promotes interdisciplinary collaboration. By the end of the project, students learn to collaborate and communicate effectively with peers of other STEM disciplines, by creating a biology web-based animation as an end-product. In this way, they learn to appreciate the value of interdisciplinary teamwork and also realize that animations can be useful teaching and learning tools. Preliminary survey data show positive student feedback regarding learning from peers, using technology and interdisciplinary teamwork. This paper shares our experience in planning and implementing the project.

10:55 ***Topical Guide Objectives: A Teaching Method for Encouraging Excellence in Undergraduate STEM Student Performance***

Matthew Morrison (University of Mississippi, USA)

In this paper, a novel formalized teaching method is presented for encouraging excellence in undergraduate student performance. This approach is a modified implementation of the teaching method used at the Naval Nuclear Power Training Command, which was made more appropriate for civilian engineering undergraduate students. The objective of this method is to prepare students academically, creatively, and morally, and to engender ideals of integrity, professionalism, and lifelong learning and teaching. The presented teaching method has three stages. First, students are required to perform daily assignments, which constitute the fundamental definitions, equations and concepts of the course material are broken up into "Topical Guide Objectives" (TGOs). This stage ensures students are taught the necessary background material - a major factor in engineering dropout rates - and gives the students opportunity to become familiar with how the professor phrases questions for quizzes and exams. Second, students are given example questions in class that use the TGO fundamentals to solve complex problems. Third, students are presented with "Combining Concepts" questions, which included quotes from industry leaders in order to test a student's ability to critically think, and encourages performance-based learning as opposed to rote memorization. This method was implemented at the University of South Florida for five undergraduate Computer Architecture courses, one section of Foundations of Engineering, and subsequently in one section of the Advanced Digital Systems course at the University of Mississippi. Using the same grading scales as previous semesters, students achieved a 13.8% improvement in median performance and covered significantly more material. Many students said they used the methods learned in the course to improve their study habits in subsequent courses. Additionally, many students expressed that they were better prepared for job interviews in the material covered in my course.

11:10 ***Enriching Engineering Curricula with a Course on Cutting-Edge Computer Technologies***

Wenbing Zhao (Cleveland State University, USA)

This paper reports the design and implementation of a special topics course on Kinect Application Development. The primary objective of the course is to enrich the Electrical and Computer Engineering curricula by teaching cutting edge computer technologies to keep our programs current and exciting to students. This course differs from traditional Electrical and Computer Engineering courses both in the content covered and in the way it was taught. This course covers both fundamental computer vision technologies that made Kinect possible as well as the rich Application Programming Interfaces provided by the Kinect Software Development Kit. Furthermore, the course consists of both traditional lecture-based instructions and active learning components with lab exercises and team-based projects. The course offers students an opportunity to practice real-world software engineering as well as solving multidisciplinary problems.

11:25 ***Teaching for Transfer through Engineering Design***

Fred Figliano and Gina Mariano (Troy University, USA)

This is a qualitative study with the aim of fostering the transfer of Science, Technology, Engineering, and Math (STEM) content while working through engineering design problems. Teaching for transfer offers a vehicle to foster the transfer of STEM content through the abstraction of knowledge in each individual discipline. Many theoretical approaches to explaining knowledge transfer are rooted in a belief that knowledge becomes generalizable through its abstraction. This study used a case study design. Student participants in this study were engaged in pre-engineering design-based activities and ranged from freshman to seniors. This study also took place in a low-income school district that has a high minority population. This group of students allowed for a unique lens, which looked at underrepresented groups and their experience with engineering design. Data were collected through the use of a design log. Student work was aligned with teaching for transfer lessons to identify whether the instruction was fostering the transfer of STEM content. Preliminary findings indicate that when students are overtly made aware of STEM content connections they understand how each discipline can work together to solve a real world problem. Findings such as these have broad applications for curriculum development in the future. If teachers have the tools to teach for transfer and train students how to transfer knowledge they will be better equipped to solve more complex engineering design problems as they get older.

11:40 ***Infusing the Creative-Thinking Process Into Undergraduate STEM Education: An Overview***

Raphael Diluzio and Clare Bates Congdon (University of Southern Maine, USA)

In this project, we develop and deliver a workshop to teach undergraduate Science, Technology, Engineering and Mathematics (STEM) faculty the creative thinking process and help them to develop modules for their classes. Leaning on ideas back to Plato's Theaetetus, we divide the creative process into seven discrete stages, and have developed exercises to help STEM faculty to explore and internalize these concepts. While we believe that many scientists invoke the creative process in their work regularly, we also believe that learning the creative process and practicing creative-process thinking can help STEM faculty and students to invoke this process more fluidly, expediently, and effectively. Initial feedback from the workshop indicates that the nine faculty who participated in the workshop report an increased understanding of the creative thinking process and increased comfort level with incorporating these ideas into their classes, among other things.

Diversity and Inclusion in STEM fields in FC 008

Chair: Mary Lanzerotti (Augsburg College, USA)

10:40 ***Future Scientists: How Women's and Minorities' Math Self-Efficacy and Science Perception Affect their STEM Major Selection***

Taghreed A. Alhaddab (Seton Hall University, USA); Suleman Alnatheer (Stevens Institution of Technology, USA)

Current Science, Technology, Engineering, and Mathematics (STEM) research have focused mainly on traditional cognitive outcomes, such as high school math and science test scores or Scholastic Aptitude Test results. Few studies have considered a non-cognitive approach embedded within a career choice analysis. This research focuses on students' perception of high school science levels of preparation and their math self-efficacy as means to measure non-cognitive abilities impact on career choice. The study used a nationally represented sample taken from the National Center of Education Statistics, Educational Longitudinal Study of 2002/06. The aim of this study was tri-fold: (a) to investigate the influence of students' perception about their high school science preparation on their postsecondary majoring, (b) how students' math self-efficacy impacted their STEM majoring odds, and (c) how the influence of such perceptions and self-efficacies differ by students' race and gender. With a sample size of (n=4449) the Hierarchical Logistic Regression analysis revealed interesting findings. First, Math self-efficacy and high school science preparation perceptions found to be significantly impacting all participants' odds of majoring in STEM. Although all female participants' chances of majoring in STEM were affected by math self-efficacy and perceptions about high school science preparation, subgroup analysis revealed an interesting finding. Female minority students' college choice decisions (majoring in STEM or not) seem to be

impacted only by their math self-efficacy. These findings indicate that increasing minorities' and female minorities' math self-efficacy level through K-12 interventions would increase their chances of majoring in STEM disciplines. Similarly, enhancing minority students' science preparation during high school years will result in such desirable outcome.

10:55 ***Imbalance of Power: A Case Study of a Middle School Mixed-Gender Engineering Team***

Jean Griffin, Carol Brandt, and Elliot Bickel (Temple University, USA); Christine Schnittka (Auburn University, USA); Jessica Schnittka (University of Colorado, USA)

This paper presents an intensive case study of a middle school mixed-gender team participating in an after-school environmental engineering workshop. The curriculum was part of a STEM program in which youth were engaged in a studio approach to design-based engineering. Data includes video of a girl-boy team working together (both 6th graders) tasked with creating a working model of a solar car. Additional data was provided through interview transcripts of the girl and boy, along with pre- and post-test results of their learning of key scientific concepts. Discourse and observational analyses based on videotape documentation reveal power imbalances in the working relationship of the pair favoring the boy. These imbalances are most apparent in the amount of time that each spends handling the engineering equipment and in the nature of the dialogue, which is characterized in large part by directives rather than by constructive collaboration. These imbalances appear to reflect longstanding societal gender norms and may provide clues as to how females may feel excluded from engineering activities and why so few females enter the field of engineering. Recommendations for facilitation, instructional designs, and assessments are made with the goal of fostering equitable and harmonious mixed-gender collaborations in engineering activities.

11:10 ***Interdisciplinary Research Program to Inspire Underrepresented Undergraduate Students in Science, Technology, Engineering and Mathematics (STEM) Fields***

Elizabeth Hiteshue (University of Pennsylvania, USA); Kelsey Irvin (Washington University in St. Louis, USA); Mary Lanzerotti (Augsburg College, USA); Sheldon Hochheiser (IEEE History Center, USA); Michael Geselowitz (IEEE & Rutgers University, USA); Derrick Langley and Richard K. Martin (Air Force Institute of Technology, USA); Charles Cerny and Bradley Paul (Air Force Research Laboratory, USA); Bhargab Chattopadhyay (University of Texas at Dallas, USA)

This paper describes a dual-role interdisciplinary undergraduate research program in STEM fields intended to motivate female students to graduate with STEM degrees. The goal of the dual-role approach is to provide unique mentorship from distinguished technical leaders to female students while the students simultaneously pursue STEM research as a team. The students receive mentorship from distinguished female leaders in STEM fields through conducting an Oral History Project in collaboration with the IEEE History Center. Research results produced by the students are presented at national conferences and published in national conference proceedings, and oral history transcripts of the distinguished leaders are published on the IEEE Global History Network.

11:25 ***Educational Robotics to Promote 21st Century Skills and Technological Understanding among Underprivileged Undergraduate Students***

Amy Eguchi (Bloomfield College, USA)

This paper presents a case of a liberal art college which serves predominantly African American and Hispanic populations, many of whom are non-traditional and working students from nearby low-income communities. It introduces the difficulties that they face because of the lack of skills that the students come in with, a general education course that provides learning experience aiming to foster critical thinking, problem-solving, and collaboration skills as well as creativity and innovation through the integration of robotics as a learning tool and trans-disciplinary approach in a learner-centered, collaborative, project-based learning environment, and the students have achieved the learning outcomes that the course set.

11:40 ***A College Lead Informal Learning Engineering Education Program for School Aged Youth***

Alistar Erickson-Ludwig (Drexel University, USA)

Minority students and those of low socio-economic status are underrepresented in the engineering field. Early exposure to the engineering field may improve the chances that these types of students will consider pursuing academic studies and career placements in this field. Now in its fourth year, Drexel University, College of Engineering hosts elementary through high school aged students in the gifted program at the Southeast Delco School District (DELCO). Students tour engineering labs, hear from current college students, watch demonstrations, and engage in small group activities that focus on engineering concepts like robotics, circuits and human centered design. This example of an informal learning program between a college, spearheaded by the IEEE Student Chapter at Drexel University, and four area DELCO schools, has allowed grade school students to begin thinking about college, have informal college mentors, and learn the basics of engineering. Through mostly qualitative and some quantitative data, the outcomes of this mutually beneficial relationship between a college and local public schools, especially targeting underrepresented minority students, indicate that pre-college

students have benefited from these visits in a multitude of ways. Often these visits reinforce concepts the students have already learned and expand their perception of engineering.

Innovations in Curriculum and Pedagogy in FC 110

Chair: Yin Pan (Rochester Institute of Technology, USA)

10:40 ***Integrating Biology, Design and Engineering for Sustainable Innovation***

Brook Kennedy (Virginia Tech, USA); Jacquelyn Nagel (James Madison University, USA); Arthur Buikema (Virginia Tech, USA)

Bio-inspired design, Biomimicry or Biomimetics is a broad methodology that encourages learning from nature to generate innovative, impactful, and responsible solutions to humankind's problems. As an integrative approach it can be used to teach students across the STEaM disciplines problem-solving, design, innovation, and sustainability concepts, as well as strengthen their ability to develop solutions to cross-disciplinary problems. In the Spring 2014 semester, we co-taught a course entitled Integrating Biology and Design for Sustainable Innovation at Virginia Tech. The course promoted true interdisciplinary collaboration by integrating teams with backgrounds in life sciences, engineering and design to solve a challenge through a semester long design project. In this paper we discuss our experience teaching the interdisciplinary course, as well as the framework for the course and best practices such that others can implement a similar course at their University. Above all, courses like these are significant in that they take a step towards accelerating sustainable design innovation, an area that has received considerable focus and effort yet whose progress for tangible outcomes has been insufficient.

10:55 ***+Enhancing the CS1 Student Experience with Gamification***

*Gina Sprint and Diane J. Cook (Washington State University, USA)

Introductory courses offer several opportunities to inspire students to pursue a degree in STEM majors. Attracting and retaining students involves engagement and enjoyment at the individual, team, and class level. We explored the effects of these factors with a gamified approach to programming practice in an introductory computer science course. Gamification involves the use of game design elements in a non-game context to engage and motivate students. We present a novel learning game and the results of play-testing with 12 CS1 students. Students were surveyed prior to and after the gamified programming session. Positive feedback was obtained from the students and the educators observed high participation, interaction, and successful team programming efforts. We objectively report student satisfaction with the game, lessons learned by the educators, and suggest future work for stimulating students in introductory STEM courses.

11:10 ***Gamified Digital Forensics Course Modules for Undergraduates***

Yin Pan, David Schwartz and Sumita Mishra (Rochester Institute of Technology, USA)

Cyber security and forensics are among the most critical areas of national importance with a rising demand for knowledgeable professionals. In response to the increasing need for advanced studies in forensics, we propose game-based modules using the game-based learning approach that enable first-year students to learn basic digital forensics concepts without pre-requisite knowledge. This paper focuses on the design and development of an interactive game framework and the educational digital forensics modules that will be plugged into the game framework in a real computing environment. In contrast to the traditional teaching approaches, this modular approach will use game-based learning and visualization techniques to engage students to learn abstract concepts and to explore forensics investigation technologies and procedures through interactive games. The general design of the game framework can be replicated and adapted by other science education programs.

11:25 ***Technology-Oriented Pre-Calculus: Developing Integrated Path Toward Student Success in STEM Pre-Gateway Course***

Natalia Mosina (The City University of New York, USA)

Research on learning in STEM disciplines suggests that students' problem solving ability comes from the creation of increasingly complex connections among diverse learning sources. This paper revisits the notion of integration in teaching and learning in a broad sense, discusses integration of various strategies to enhance learning, engagement, and success of students taking STEM pre-gateway course, Pre-Calculus, at a two-year minority serving college. It is emphasized that integrative learning, as an active student-centered process, is intertwined with an integrated approach to instruction. Several practices in teaching technology–oriented and applied project-based pre-calculus that resulted in improved student performance, engagement, and self-confidence are discussed. The paper calls for integration of effective approaches in one integral system, raises questions about optimal combination of working strategies, and, among other things, contributes to nowaday deficient empirical study of integration. Development of a particular integrated path toward students' success in freshmen math pre-gateway to STEM is described. Experiences and outcomes are shared.

11:40 ***Sense of Achievement: Initial Evaluation of an Integrated Engineering Design Cornerstone Module***

Emanuela Tilley and John Mitchell (University College London, United Kingdom)

Pressure from industry, professional bodies and students for a reform to the curriculum and delivery style of engineering education in the United Kingdom has been mounting for a number of years. Although there have been many excellent individual initiatives, developments that span a whole school or faculty, those encompassing a number of disciplines and departments are rare. This paper describes the curriculum development and evaluation of a year 1 module for the new Integrated Engineering Programme, which spans across the UCL faculty of engineering sciences in the UK. It describes the motivation for change, some of the approaches adopted and the achievements documented by the students.

2:40 PM - 4:30 PM

Pre-College Initiatives and Outreach in FC 004

Chair: Shakila Merchant (NOAA-CREST Center & The City College of New York, USA)

2:40 ***The Program of Excellence in STEM: Involvement of Traditionally Underrepresented Students in STEM Education Through Research and Mentoring at Florida A&M University***

Clayton Clark, II (Florida Agricultural and Mechanical University & FAMU Sustainability Institute, USA); Tiffany Ardley and Jason Black (Florida Agricultural and Mechanical University, USA)

The Program of Excellence in STEM (PE-STEM) at Florida A&M University (FAMU) is designed to provide a model for increasing the recruitment, retention and graduation of STEM majors at the institution through mentoring and research involvement. In addition to also providing advisement and professional development of participants, the program focus is on area high school students and entering college freshmen with the goal to increase the participation of these students from underrepresented groups in STEM disciplines. PE-STEM uses a 3-tiered approach concentrating on recruitment, retention and graduation, including a nearly four-week long Summer Academy, as well as monthly workshops throughout the academic year. One of the aims of the interdisciplinary PE-STEM program is provide a student cohort with mentoring from faculty and undergraduate students, as well as the opportunity to participate in actual on-going research in STEM-related disciplines under the direction of faculty. These activities are monitored to determine their actual effectiveness on the attitudes toward, participation in, and desire to pursue degrees in STEM-related fields of the participating students.

2:55 ***High School Initiative in Remote Sensing of the Earth Systems Science and Engineering (HIRES)***

Shakila Merchant (NOAA-CREST Center & The City College of New York, USA); Reza Khanbilvardi (NOAA-CREST Director, USA); Emiko Morimoto (Outreach Coordinator, USA)

Recent attention to K12 education in science, technology, engineering, and mathematics (STEM) has revealed challenges in students' performance and persistence, particularly for groups that are underrepresented STEM fields. The United States is currently facing a dual of dearth of STEM learners' lack of learning environments and hands-on opportunities especially for underrepresented communities. Although these challenges are daunting, recent education policy developments are creating an unprecedented opportunity to address them. Individuals, educators, stakeholders and decision-makers across the nation are increasingly seeking methods and strategies to bolster scientific capabilities and the capacity of our teachers and students. This is vital to increase the national STEM talent pool and workforce necessary to sustain the economy and ensure that the U.S. remains a world leader in science and technology. CUNY Remote Sensing Earth System (CREST) Institute expanded the existing successful Summer High School Internship Program (SHIP) to create an exemplary science and engineering mentoring program for HS students from underrepresented communities within the five borough of NYC and make them "college ready" especially in fields of Remote Sensing of the Earth. The overarching goals of the project was to expand the number of HS students able to participate in summer research; to introduce pre-college credit bearing courses in MATLAB, GIS and Remote Sensing and introduce students to integrative research and learning modules through hands-on research projects. The objectives of this program was to motivate, inspire, engage and increase the underrepresented minority/underserved and STEM disadvantaged HS students in inter-disciplinary fields of Earth Systems, and Environmental Sciences and Engineering; to engage students in scientific research alongside faculty and graduate mentors; to bring excitement to students/interns through cutting-edge research and help set a STEM career pathways from high school to college. The authors look forward to sharing their summer 2014 High School experience through this presentation.

3:10 ***Utilizing Science and Engineering Professionals in the Classroom: How Your Workforce Can Positively Impact STEM and Your Company's Bottom Line***

Ralph Tillinghast (US Army & ARDEC, Picatinny Arsenal, NJ, USA); Edward Petersen, Shahram Dabiri, Maria Cecilia Gonzalez and Samantha Rizzuto (US Army, USA)

With the growing need to inspire young minds in the STEM areas, Science and Engineering professionals along with their employers are working to identify the best possible method to accomplish just this. Currently many approaches have been utilized, such as summer camp programs, in school visits, large STEM events and student mentoring programs. This paper takes a focused look at how placing Science and Engineering professionals in the classroom may be the most robust and cost effective approach for STEM outreach. This paper outlines methods, approaches, benefits found, results and lessons learned from in-school pilot programs related to this approach. Overall this paper is intended to aid educators, Science and Engineering Professionals and their employers to broaden STEM and STEaM education.

3:25 ***Professional Development for Network Science as a Multi-disciplinary Curriculum Tool***

Lori Sheetz (United States Military Academy at West Point & Network Science Center, Center for Leadership and Diversity in STEM, USA); Veronica Dunham and Judith Cooper (Newburgh Free Academy, USA)

To be successful in the 21st century, students must have a fundamental knowledge of complex networks that allows them to explore the interconnectedness of our world. Network science, a relatively new field of study, represents a fundamental shift away from reductionism to a more complex real world approach looking at interactions between components. It is a tool that assists researchers and students to make connections needed to solve complex challenges and integrate abstract ideas. While this field has primarily engaged students at a graduate level, recently a growing number of new undergraduate courses have been offered and for a small number of high school students there have been opportunities to participate in research. However, initiatives have reached a relatively small number of students. In an effort to bring network thinking to more students, a professional development course was developed to introduce more teachers to network science and show how it can be utilized as a multi-disciplinary tool within their current curriculum thus reaching a greater number of students.

3:40 ***Integrating Robotics Education in Pre-College Engineering Program***

Shouling He, Jonathan Zubarriain and Nicholas Kumia (Vaughn College of Aeronautics and Technology, USA)

In 2014, Vaughn College of Aeronautics and Technology has developed a five-week pre-engineering intensive summer program. The program provided high school students with hands-on experience in the Robotics and Mechanics to advance them in the pursuit of a degree in engineering. Correspondingly, the program also enhanced students' technical writing skills and the fundamental knowledge of mathematics and physics needed in engineering. Different from other pre-college engineering programs which focus more on mathematics and physics education, in this program, engineering and engineering project design and implementation have been intensively discussed through building and programming a mobile robot. High school students were encouraged to creatively develop their own project in a team while the collaborative learning and effective communication skill are particularly addressed. The student survey showed that the intensive summer program has increased students' comprehension of engineering and awareness towards engineering-related careers, which are critical for high school students to choose engineering as a future career.

3:55 ***Selected Examples of Cooperation Between Universities and Schools in STEM Education***

Iva Bojic (University of Zagreb, Croatia); Tomislav Jagušt and Ana Sović (University of Zagreb, Faculty of Electrical Engineering and Computing, Croatia)

"SUZA - from school to science and the academic community" is the official popularization program for science, technology, engineering and math at University of Zagreb, Faculty of electrical engineering and computing. Volunteers in the program are professors, researchers and students from the Faculty. Although, the program is relatively new, it counts more than 20 activities during a school year. Some of the activities are specialized for K-8 or K-12 students or for their teachers. The activities are hosted at the Faculty, or in children's school. In this paper, we present several approaches how we popularize computer science. It depends on the age of the students and their previous knowledge. For K-8 students we organize visits to our faculty research groups and laboratories. Further, SUZA participate in Computer Science Education Week - Hour of Code event. For K-12 students we host students fair in electrical engineering and computing educational sector and several specific mini workshops to gain some hands-on experience. At the same time, we educate their teachers how to use robots for education in the schools. In this paper we present teacher workshops "When science is boring, who is it boring to?" and "Autonomous robotic systems and their role in modern society". During the next school year, the presented activities would be continued.

Educational Modules and Technologies in FC 006

Chair: Ching-yu Huang (Kean University, USA)

2:40 ***Academic Aide – Free Online Math Question Database for Academic Improvement***

Jian Bin Guo, Lukas Leung and John J. Magee, IV (Clark University, USA)

Lack of funding is a common problem for many public schools and small private tutoring centers. Some schools have a policy that prevents students from taking textbooks home to study. Sometimes teachers will take money out of their own pocket to let students use existing online services to improve education quality. However, those internet services are not guaranteed to have materials that are best fit for individuals' teaching style. In some cases, the best fit material simply does not exist on the internet, and creating it would take many hours. We have created Academic Aide to combat this exact problem. Academic Aide is a free online database that allow users to generate and share content in a well organized manner. We allow users to create problems that fit their needs and upload it to the website. People from around the world can access to these problems at no cost. If the type of problem is not available on the website, the user can simply create their own. We believe that Academic Aide will be a place for people to learn from each other, create their own content and share it with people around the world. Academic Aide is the result of a project-based learning approach for undergraduate computer science students.

2:55 ***An Integrated Automatic Compiling System for Student Feedback on Java Programs***

Ching-yu Huang and Patricia A Morreale (Kean University, USA)

In colleges today, learning computer languages is becoming more popular not only because the current job market highly demands jobs requiring these skills, but also because many STEM fields require programming skills. Java is one of the most widely used languages in client-server applications because of its rich API, portability, simplicity, and object-oriented features. To learn their first programming languages, students must write many programs for practice on the path to mastery. More programming assignments increase the workload of faculty. This paper presents an integrated online system to help instructors manage programming assignments effectively, providing immediate compiling and runtime messages, and display of the results when the students submit the program. This immediate feedback improves the student learning experience, with targeted information and encourages student success.

3:10 ***Promoting Mobile Computing and Security Learning Using Mobile Devices***

Wanqing You, Kai Qian and Dan Lo (Southern Polytechnic State University, USA); Prabir Bhattacharya (University of Cincinnati, USA); Wei Chen and Tamara Rogers (Tennessee State University, USA); Johng-Chern Chern (Chicago State University, USA); Junfeng Yao (Center for Digital Media Computing of Xiamen University, P.R. China)

It is of vital importance to provide mobile computing and security education to students in the computing fields. As the mobile applications become increasingly popular and inexpensive ways for people to communicate, share information and take advantage of convenient functionality in people's daily lives, they also regularly attract the interests of malicious attackers. Malware and spyware that may damage smart phones or steal sensitive information are also growing in every aspect of people's lives. Another concern lies in insecure mobile application development. This kind of programming makes mobile devices more vulnerable. For example, some insecure exposures of the APIs or the abuse of some components while developing apps will make the applications suffer from potential threats. Although many academic institutions have started to or planned to offer mobile computing courses, there is a shortage of hands-on lab modules and resources that can be integrated into multiple existing computing courses. In this paper, we present our development on mobile computing and security hands-on Labs and share our experiences in teaching courses on mobile computing and security with students' learning feedback using Android mobile devices.

3:25 ***Establishing a Cost Effective Control and Robotics Program***

Vikrant Sood and Sabiha Wadoo (New York Institute of Technology, USA)

As part of a series of papers that explore the extent to which LEGO kits can be used to introduce important control system and robotics concepts to both undergraduate and graduate engineering students, this paper attempts to build a delay based wireless control system using LEGO kits. The paper introduces a method that takes into account the delay that gets added due to switching from wired communication to wireless. By replacing the wire with a wireless connection, the system becomes a wireless control system (WCS). The impact of delay on the wireless control system is observed. The control effort required before and after delay is compared.

3:40 ***Developing an Artificial Intelligence Bot for Othello***

Arvind Vijayakumar (Bridgewater-Raritan Regional High School, USA)

In this paper, I describe the Othello AI project completed by Arvind Vijayakumar during the 2014 summer Leap program at Carnegie Mellon University. We will first look at the basic components of two-player game AI. We will then look at

basic properties of Othello AI design in the context of the project. Then we will examine the development of the Othello bot from the earliest to the latest versions. The performance of the bot relevant to humans and other bots will be analyzed and discussed. Finally we will look at future possible improvements to MyPlayer, the Othello Artificial Intelligence bot.

Educational Research in FC 008

Chair: Rami J. Haddad (Georgia Southern University, USA)

2:40 ***How Student Gender, SAT Score, and Interest In Science Relates to Performance in Introductory Engineering Technology Coursework***

Marjaneh Issapour (Farmingdale State College, USA); Angela Kelly (Stony Brook University, USA)

This pilot study explores the relationship between engineering technology students' performance in their first engineering class and their SAT score, interest in science, and gender. This study is based on data collected from an introductory electric circuits theory class in fall of 2013. The students' SAT scores (both composite and math and verbal as separate items) were obtained and their interest in science was measured by their selection of high school science electives beyond what was required for graduation - both Living Environment and Earth Science are high school courses that typically fulfill the NYS Regents requirements. It is particularly interesting to note whether the students took Physics and/ or Chemistry in high school. The broader impact of this study for the engineering education community is to help gain a better understanding of factors in high school preparation or background that may affect their performance as freshmen in the engineering technology curriculum. The results of this study may be used to assist enrollment management, recruitment, and course scheduling at the college level. These results may also be used by high school counselors to advise students interested in pursuing engineering and technology careers. This study will inform efforts to improve retention in engineering technology majors.

2:55 ***Can Computational Thinking Predict Academic Performance?***

Rami J. Haddad and Youakim Kalaani (Georgia Southern University, USA)

This paper introduces the notion of predicting academic performance based on Computational Thinking. The integral role that Computational Thinking modalities play in engineering disciplines can serve as an accurate indicator of the student future academic success. Therefore, this study investigated the students' performance in a Computational Thinking course offered at the freshman level to predict student academic success. To achieve this goal, a two-year study of the correlation between the students' accumulative grade point averages and their grades obtained in this course was conducted. The performance of nine hundred and eighty two students in forty sections was assessed over the two-year period. It was concluded that the students' future academic performance is strongly correlated to their Computational Thinking skills assessed at the freshman level. This clearly suggests the viability of using Computational Thinking skills as a fairly accurate predictor of students' academic success. These results have also implied that the assessment of Computational Thinking can be used as an early intervention tool to improve the students' retention, progression, and graduation rates in STEM related disciplines.

3:10 ***Investigating a Scenario-Based Performance Assessment of Engineering Professional Skills***

Mo Zhang (Educational Testing Service, USA); Ashley Ater Kranov (Washington State University, USA); Steven Beyerlein (University of Idaho, USA); Jay McCormack (Rose-Hulman Institute of Technology, USA); Patrick Pedrow (Washington State University, USA); Edwin Schmeckpeper (Norwich University, USA)

Professional skills are critical for success in the multidisciplinary, intercultural, and cross-functional team interactions that characterize 21st century engineering careers. Despite consensus around the need for developing professional skills, engineering programs have been struggling to define, teach, and measure those skills. This paper describes the investigation of the functioning of a group-based performance assessment of engineering professional skills called EPSA. The EPSA consists of a scenario that presents a contemporary engineering issue with no clear-cut solution, and an analytical scoring rubric with five dimensions corresponding to the skills identified as 3f - 3j in ABET Criterion 3 Student Outcomes. This investigation dealt with two persistent problems in performance assessment: the extent to which student performance varied unexpectedly as a function of the assigned scenario, and whether complex performances could be disaggregated through the use of rubric dimension scores. Data were collected from 20 discussion groups at three engineering colleges in the US. The analyses were conducted using a two-stage nested mixed-effects model. Because of the small sample size, results are best viewed as preliminary and in need of replication. The findings tentatively suggest that EPSA scores discriminate among student groups and that differences in group performance related to scenario appear to be minimal. Further, student groups exhibited different proficiency profiles across the five EPSA dimensions. Results may suggest the need for more emphasis on engineering professional skills at the undergraduate level.

3:25 ***Placement Tests and Their Effects on Students Achievement and Retention in Math and Science***

Genady Ya. Grabarnik (St. John's University, USA); Serge Yaskolko (South University, USA)

In this paper we analyze the outputs of placement tests for a wide range of campuses and years and respective results in following math and science classes both in terms of grades earned and retention rates. The paper considers an integrated approach for the whole sequence of math and science classes the student needs to take to succeed in her/his program. It outlines current "state of the art" in the area and introduces an extensive data collected, together with its discussion and interpretation. The paper considers both "typical" and "exceptional" bodies of data, separated based on two major criteria: accepting/rejecting placement test recommendations and consecutive performance.

3:40 ***Integrated STEM Learning within Health Science, Mathematics and Computer Science***

Marjorie Droppa (Keene State College, USA); Wei Lu (Keene State College, USNH, USA); Shari Bemis (Keene State College, USA); Liette Ocker (Sam Houston State University, USA); Mark Miller (Keene State College, USA)

In this integrated STEM learning module we developed a data collection tool and used innovative analysis methods to investigate the relationship between academic achievement and risky wellness behaviors among college students. Exploratory factor analysis (EFA) was performed using data from college students (n = 1,499) at a large north-central university. Advanced machine learning analysis techniques found a strong connection between student wellness behavior and academic achievement and that this relationship can be predicted using wellness behavior data. The real world research project in this study integrated educational activities among Mathematics, Computer Science, and Health Science creating an interdisciplinary learning experience within Science, Technology, Engineering and Mathematics (STEM).

3:55 ***Teamwork Efficacy and Attitude Differences between Online and Face-to-Face Students***

Kara Vance, Sadan Kulturel-Konak and Abdullah Konak (Penn State Berks, USA)

Professional skills, such as teamwork, global awareness, creative problem solving, and ethics, are essential for the Science, Technology, Engineering, and Mathematics (STEM) fields. The focus of this paper is teamwork. This paper discusses how efficacy and attitudes affect teamwork for the Technology field, specifically the students majoring in Information Sciences and Technology programs, either virtual or face-to-face. Although online education has significantly grown, the literature discussing the incorporated online teamwork remains limited. Virtual and face-to-face teams have some similarities, but many key differences as well, such as communication, trust, and geographical boundaries. To gauge team efficacy and attitudes for virtual and face-to-face teams, we developed a survey and collected data. Our findings showed that online students had more negative attitudes toward teamwork than face-to-face students did, while both groups had a similar level of teamwork efficacy.

Perspectives, Policies, and Issues in STEM Education in FC 110

Chair: Teresa Piliouras (TCR, Inc., USA)

2:40 ***Scientific Storytelling: From Up in the Clouds to Down to Earth…A New Approach to Mentoring***

A. Cropper (Raytheon Company, USA); Rafael Luna (Harvard Medical School, USA); *Elizabeth Mclean (University of Rhode Island, USA)

The challenge today with an increasing volume and complexity of information is the actual connections we make with the information, its value and how it impacts us. This paper intertwines three topics as they relate to communicating scientific knowledge and the use of the arts to heighten our ability to connect to the information, so as to transition from up in the clouds to down to earth, i.e. from the intangible to the tangible. Educators, teachers and an evolving breed of mentors play an important role in the transition from a hierarchical arena to one of reciprocal interactions, mutual learning and respect, openness to novel ideas and encouragement to think outside the box. The topics to be explored are the following: the outlining of a story – from up in the clouds to down to the earth, the art of Scientific Storytelling and the uncovering of the 'scoop' in the story: translating knowledge into action. The motivation behind this paper is to embrace non-conventional forms of learning and impart acquired skills and know-how using traditional storytelling in innovative learning modules. The methods presented in this paper provoke new insights and conversations, while exploring the cross pollination of the sciences that enables others to connect to our stories.

2:55 ***Students Helping Students: The Benefits of Peer Tutoring in Mathematics***

Grace Sommers (Bridgewater Raritan High School, USA)

The majority of research analyzing the benefits of tutoring on student achievement has been focused on the use of certified adult tutors. However, over the past several months, I have attained high success rates working outside of this model. A student myself, with no formal training, I have tutored a variety of middle school and high school students. Focusing on mathematics ranging from pre-algebra to calculus, I have seen the benefits of peer tutoring firsthand. My work both inside and outside of school suggests that a friendly, individualized tutor-tutee relationship is essential for success. This requires a

tutor who respects and believes in the tutee, who in turn must be receptive to advice and aid. Students, free from the social divisions between adult tutors and their tutees, have the best chance at establishing this strong relationship. Peer tutoring has its own challenges, such as the lack of official experience among volunteers, the difficulties presented by school scheduling, and the need to establish structure while also listening to the tutee's preferences. However, when implemented well, peer tutoring is a valuable tool for helping students overcome their struggles in both fundamental skills and higher-level concepts. Through one-on-one instruction and help, these students can discover the logic of mathematics and the opportunities it provides.

3:10 ***Experiences of a STEM K-5 Educator***

Bahare Naimipour (University Of Illinois & Sound Answers Inc., USA)

This work reflects the positive and negative practices and experiences of an engineer with experience in STEM education activities at the K-5 level. As children, one of the most common questions we heard asked was: "Where do we need Math in real life?" A valid question since most school children are not taught the long term career possibilities of STEM fields. Through a healthy balance between theory and practice, along with constant reminders of the successful possibilities a strong STEM background can hold for students, I believe that STEM interest and success can be achieved. Fundamental STEM education practices need to be reassessed to improve STEM education interest. Some of these possible solutions are summarized in this work.

3:25 ***Reflections on Academic Culture & the Role of Technology and Major Stakeholders***

Teresa Piliouras and Pui Lam Yu (TCR, Inc., USA); Aaron Kershenbaum (Center for Clinical Epidemiology and Biostatistics, USA); Jasmin Werner (Rutgers, USA); Deqingyuzhen (New York University, USA); Jeanne Lauer (Academy of Information Technology & Engineering, USA); Phillip Hirsch (Rippowam Middle School, USA); Julie Mann (Rebellmann, USA)

This paper discusses the importance of academic culture and its impacts on students and their motivation. Cultural challenges and obstacles to educational reform are explored. The expanding role of technology in educational instruction and driving cultural change is examined. Technology enables customization and innovation in teaching and assessment. However, it also poses privacy risks as more and more data are being collected and shared. The ultimate success of educational reform demands meaningful dialogue between critical stakeholders in the educational process – students, parents, teachers, administrators, policy makers, governments, and society as a whole. Technology provides opportunities to facilitate the expression of divergent viewpoints thereby encouraging greater collaboration and more informed discussion about educational reform.

3:40 ***On the Mitigation of Natural Disasters Through Engineering***

Dhruv Kathuria and Shravan Kumaran (Bridgewater Raritan High School, USA)

Engineers hold special responsibility when designing buildings or other compositions due to the fact that they must take into account the structural integrity of their designs not only during typical conditions but also during extreme circumstances. They thus hold the most direct responsibility in alleviating the extent of the aftermath of a possibly calamity. In the past, engineers have failed to properly take into consideration such factors, worsening the effects of catastrophes that, while not preventable, were more damaging than they could have been. While engineers may not be able to prevent natural events, they can certainly combat natural disasters, by reducing the damage and destruction caused by natural occurrences.

3:55 ***Expanding High School STEM Literacy through Extra-Curricular Activities***

Sahaj Garg (Bridgewater-Raritan High School, USA)

As the movement to expand education in STEM fields grows, there must be a commensurate expansion of extra-curricular opportunities for STEM related fields. STEM extra-curricular activities inherently have a larger effect in increasing the amount of STEM graduates than additional focus in the classroom because they help students develop interests and allow them to gain the experience that is necessary for careers. In order to give students the opportunity to pursue their interests outside the classroom, the IEEE STEM club of Bridgewater-Raritan High School, known as iSTEM, was established. This club gives students the opportunity to pursue their interest in four major ways: by inviting guest speakers, by encouraging student research, presentations and entrepreneurship, by creating hands-on projects, and by offering competitions. A combination of these four will increase interest in STEM, a growing field. There is currently a lack of state level organizations and national organizations to bring together STEM clubs similar to the way Future Business Leaders of America brings together business clubs nationwide. To fill this void, we have created NJ iSTEM, a statewide organization that allows schools across the state to meet up in events such as a hackathon and a state conference. Although we have not yet created a nationwide organization, this is a future option open to exploration.

The Application of LeJOS, Lego Mindstorm Robotics in an LMS Environment to Teach Children About Programming and Robotics at an Early Age

Ankith Rao (Thomas Jefferson High School for Science and Technology, USA)

This project is designed to enhance the interest of teenagers in the fields of robotics and programming. LeJOS© and Lego® Mindstorms® Robotics were used to create and implement a Java programming curriculum in a Learning Management System (LMS). Skills in the STEM fields are required to succeed and grow in the modern job market, so children should learn about technology and programming early on. The project goal was to create a comprehensive and easily reproducible learning program that taught kids about programming and robotics in an engaging way. The course was targeted towards children ages 10-13 with no prior programming or robotics knowledge. The usefulness of the course was tested at a local middle school and an after-school center, measuring how fast students completed the course, how difficult they thought it was, and the effect of the course on students' desire to pursue programming and robotics. Survey results showed more kids were enthusiastic about pursuing programming or robotics as a career as opposed to before taking the course. The course met a 90% student satisfaction rate. For future work, a larger sample size and a refined curriculum should be implemented for an even better success rate. Also, implementing and testing the validity of this course in schools would be a big step, to see how it works in a large scale learning environment. Assistance for acquiring resources was provided by Science Cosmos®, a STEM education facility in Virginia.

Comparison of Programming Performance: Promoting STEM and Computer Science Education

Andrew Huang (High Technology High School, USA)

Computer programs, constructed to facilitate the development of the technological world, are created with different objectives for different target platforms. As a result, different languages may exhibit significantly different run times when performing specific tasks. In a world where computer programming is instrumental in STEM education, computer languages are often utilized to perform mathematical calculations in classrooms. In this experiment, I compared different run time speeds for Python, C, and Java on Cygwin, Linux, and MacAir to compare the languages' run times. The purpose of this research paper and poster is to demonstrate, test, analyze, and utilize knowledge of the varying speeds of languages to promote the educational use of computer languages. This data can be applied by utilizing certain languages when paired with different platforms to enhance and accelerate student learning in the classroom.

4th Graders Creating Robots with Sensors

Lisbeth Uribe (The School at Columbia, USA); Amy Eguchi (Bloomfield College, USA)

Children, even as they are learning to take their first steps are already developing a more intimate relationship with technology that we ever did. Sadly, their relationship with technology is primarily based around consumption, not creation and invention. The educational robotics curriculum for grades 2, 3 and 4 at The School at Columbia is designed to shift this paradigm by giving students access to tools that inspire them to program and invent, becoming tool builders and not merely tool users. By 4th grade, the students at The School at Columbia are ready to add input devices, such as touch, distance, sound and light sensors, to their programs. With robotics, new skills and concepts are tangible. Children are eager to dive into these new technologies and embrace the challenge of making real what they have imagined. Robotics gives students the opportunity to find new ways to work together, express themselves, problem-solve and think innovatively. Working with and learning from one another is critical to building new knowledge and understanding.

An Interactive Desktop VR-based Visualization Framework for Programming Instruction

Magesh Chandramouli and Justin Heffron (Purdue University Calumet, USA)

Programming skills are becoming increasingly important in both academia and industry. While this signifies numerous opportunities for students, it also inherently involves the challenge of preparing students suitably for these opportunities. Students, especially those at the beginner level, encounter difficulties when learning to program and the lack of efficient tools to overcome such difficulties can affect students' motivation. Over time, this creates to a drastic and negative impact in their attitude towards 'learning programming', which is undesirable for student success in engineering education. To rectify this, a suitable approach that can motivate students needs to be developed to change students' mindset towards learning programming. Rather than viewing programming courses as a means to complete coursework requirements, students should be made to realize the "power of programming." Learning and gaining experience in programming necessarily involves the development of computational/critical thinking and problem solving skills.

RoboTeam Dance

Lisbeth Uribe (The School at Columbia, USA); Amy Eguchi (Bloomfield College, USA)

RoboTeam is an after school competitive robotics club for grades 4 through 8 at The School at Columbia. Each year, 20-35 students compete in RoboCupJunior competitions at the local, regional and, if we qualify, international level. RoboTeam has competed in regional and international RoboCupJunior competitions since 2005. All 4th through 8th grade students are eligible and prepared to engage in competitive robotics because The School at Columbia has integrated educational robotics into the curricula of grades 2 through 4. RoboCup is an annual competition for creators of intelligent and autonomous robots in elementary, secondary, college and graduate schools from around the world.

A Mobile Tool for Collecting Scientific Experimental Data

Katherine Herbert (1 Normal Ave & Montclair State University, USA); Anjelique Melendez, Wyatt Sanders, Asif Uddin and Benjamin Smullyan (Montclair High School, USA)

During the Summer of 2014, I and many other students from Montclair High school enrolled in the Weston Science Summer program. In this program, we were split into small groups and worked with College professors as mentors. We were given 6 weeks to address an issue and come up with solution for this issue. I worked with four other students (state the students) were given the opportunity to work with Dr. Katherine Herbert to come up with a Mobile Application for scientific data collection. Dr. Herbert is a professor and researcher at Montclair State University. Dr. Herbert's research involves looking at how computational data sciences can address problems in sustainability sciences. As part of a group we decided that we wanted to create a prototype mobile application for scientific data services. We wanted the application to allow a user to create a data schema of his or her choice, store multiple schemas for multiple individuals, allows users to enter and save data that conforms to the schema, and to visualize the scientific data for the user.

4th Grade Robotics Projects

Lisbeth Uribe (The School at Columbia, USA); Amy Eguchi (Bloomfield College, USA)

Children, even as they are learning to take their first steps are already developing a more intimate relationship with technology that we ever did. Sadly, their relationship with technology is primarily based around consumption, not creation and invention. The educational robotics curriculum for grades 2, 3 and 4 at The School at Columbia is designed to shift this paradigm by giving students access to tools that inspire them to program and invent, becoming tool builders and not merely tool users. By 4th grade, the students at The School at Columbia are ready to add input devices, such as touch, distance, sound and light sensors, to their programs. With robotics, new skills and concepts are tangible. Children are eager to dive into these new technologies and embrace the challenge of making real what they have imagined. Robotics gives students the opportunity to find new ways to work together, express themselves, problem-solve and think innovatively. Working with and learning from one another is critical to building new knowledge and understanding.

Influence at the 1787 Constitutional Convention

Luz Corrales and Doreen Dacilas (Newburgh Free Academy, USA)

The purpose of this research project was to use network analysis to determine the most influential delegates, states, and regions at the 1787 Constitutional Convention by looking at sources of observable influence. - Are states or regions equally represented on committees? Are committees a source of observable influence? - Does population of a state or region determine influence? - Are individual delegates, states, or regions who attended the Annapolis Convention more influential than those who didn't attend? The team hypothesized that: The states and regions would not be equally represented and that the committees would be a source of influence. A state or region with a larger population would have a higher influence score. Those who attended the Annapolis convention would have a higher influence score than those who did not.

RoboTeam Rescue

Lisbeth Uribe (The School at Columbia, USA); Amy Eguchi (Bloomfield College, USA)

RoboTeam is an after school competitive robotics club for grades 4 through 8 at The School at Columbia. Each year, 20-35 students compete in RoboCupJunior competitions at the local, regional and, if we qualify, international level. RoboTeam has competed in regional and international RoboCupJunior competitions since 2005. All 4th through 8th grade students are eligible and prepared to engage in competitive robotics because The School at Columbia has integrated educational robotics into the curricula of grades 2 through 4. RoboCup is an annual competition for creators of intelligent and autonomous robots in elementary, secondary, college and graduate schools

from around the world. The students who competed in the Rescue events have submitted a poster.

Quantification of Character and Plot in Contemporary Fiction

Ugwuogo Onwuka, Ivette Pineda and Tess Stepakoff (Newburgh Free Academy, USA)

During the summer of 2013, a group of high school Juniors from Newburgh Free Academy joined the program NetSci High (2013-2014) and had the opportunity to spend ten days at Boston University to learn more about network science. While there, the students learned about what networks are, how they are used, and why they are important. Consequently, they planned to combine a shared interest of literature and network analysis to explore contemporary fiction. After much discussion and the direction from Mrs. Sheetz, their mentor from the Network Science Center at West Point, the students endeavored to develop a model for a character and plot analysis of the novel Harry Potter and the Sorcerer's Stone by J.K. Rowling. Character significance would be quantified through network metrics such as betweenness and degree centrality. Additionally, temporal and spatial visualizations of the character interactions would facilitate the analysis. The team, consisting of Ugwuogo Onwuka, Jr., Ivette Pineda, Tess Stepakoff, and indirectly Mrs. Sheetz, began in September 2013 after deciding on the popular novel. The objective of the research was to determine character centrality as well as overall network complexity in this contemporary novel.

RoboTeam Dance

Lisbeth Uribe (The School at Columbia, USA); Amy Eguchi (Bloomfield College, USA)

RoboTeam is an after school competitive robotics club for grades 4 through 8 at The School at Columbia. Each year, 20-35 students compete in RoboCupJunior competitions at the local, regional and, if we qualify, international level. RoboTeam has competed in regional and international RoboCupJunior competitions since 2005. All 4th through 8th grade students are eligible and prepared to engage in competitive robotics because The School at Columbia has integrated educational robotics into the curricula of grades 2 through 4. RoboCup is an annual competition for creators of intelligent and autonomous robots in elementary, secondary, college and graduate schools from around the world.

RedNet, a Different Perspective of Reddit

Jack Burke and Ben Wagner (Newburgh Free Academy, USA)

Modern social media frequenters traditionally surround themselves around specific topics or interests, like a television show or sport, which breeds interaction with the people who you have mutual interests with. This is prevalent in social networks like Facebook where users like certain pages that are oriented around a topic, or Twitter users that tag their tweets using hashtags to illustrate a subject, and users of Reddit do the a similar thing with topic-specific sub-categories called subreddits. There are almost 400,000 subreddits which cover almost any category leading Reddit to label itself the "front page of the internet". Our interest in Reddit inclines us to ask: RQ1: Do popular comments, submissions, and subreddits have centrality measures proportional to their karma? RQ2: Does content defined as popular according to Reddit tend to cluster and fall in the same area in the network as other popular content? We expected to find that karma is directly proportional to centrality measures and that all popular content nodes will fall in the same general area as each other. If content is popular in a social network, it tends to have great influence which allows us to predict this.

Superconductors – "Resistance is Futile"

Aman Shah and Tilak Bhatnagar (John P Stevens High School, USA)

Superconductors are substances that when brought down to extremely cold temperatures do not provide any resistance to the flow of an electric current. Within our poster, we shall provide detailed information on the two main types of superconductors: type I, the conventional, and type II, the " high temperature " superconductors. In addition, we will detail the seemingly fictional phenomena of levitation caused by magnetic fields and the Meissner effect. We shall also look into steps being taken towards increasing the critical temperature required for substances to enter a superconductive state, such as "self doping," and metamaterials. These steps show potential toward unlocking a superconductor that could function at room temperature - which would change the face of technology as we know it today.

Assessing Students' Global Awareness

Somer Chipperfield (The Pennsylvania State University - Berks, USA); Sadan Kulturel-Konak and Abdullah Konak (Penn State Berks, USA)

Professional skills are an important part of students' college education but they are very hard to assess. This research shows the steps that have been taken to assess global awareness of students who are in science, technology,

engineering and mathematics (STEM) disciplines. First, we present a review of existing rubrics or assessments tools from the literature to measure global awareness along with a discussion of their strengths and weaknesses. Then, the research focuses on creating assessment tools and rubrics that will evaluate a student's stage of competency (i.e., acclimation, competency and proficiency) in the three different components (i.e., interest, knowledge and strategic processing). Next, we introduce global awareness competencies and learning outcomes expected from STEM students, with a special emphasis on measuring students' interest levels. After defining specific global awareness skills, abilities, and knowledge in each learning outcome area, we define assessment items to measure them. Then, how these assessment items can be mapped into a standard assessment framework based on the Model of Domain Learning is discussed. The focus of the first assessment is on students' interest level of global awareness. The goal of our assessments is to make our tools modular and easy to map into the proposed framework to easily capture students' growth in global awareness. Finally, we present our preliminary findings about students' global awareness development through their education.

Comparing Two Human Disease Networks: Gene-Based and Symptom-Based Perspectives

Yousuf H Shah (Vestal High School, USA); Ibraheem Rehman (Cornell University, USA); Cheryl Limer (SUNY Brockport, USA); Zach Eaton (University at Buffalo, USA); Carol Reynolds and Alan Troidl (Vestal High School, USA); Kristie McHugh (Ohio Northern University, USA); Hiroki Sayama (Binghamton University, USA); Genki Ichinose (Anan National College of Technology, Japan)

Goh, *et al.*'s human disease network introduced a novel, network-based perspective to the understanding of human diseases and medicine. Their network was built using genes that are commonly associated with two diseases as links between them. In contrast, many diseases and ailments have traditionally been diagnosed by physicians based upon their observed and experienced symptoms. While symptoms have the potential to be great indicators of specific diseases, they are not always accurate. Certain symptoms are universal to many diseases. How are diseases, symptoms and genes correlated? Is it possible to identify genes that account for certain symptoms? If we could find correlations and discrepancies between them and analyze the data using network analysis, we could improve the accuracy of diagnosing genetic disorders on a solely symptom basis. In this study, we hypothesized that there would be a positive correlation between the numbers of symptoms and genes shared by a pair of diseases. To test this hypothesis, we created a new network depicting disease-symptom relationships and compared it to Goh *et al.*'s network depicting disease-gene relationships. We found that the two networks had very different structures, and that there was essentially no correlation between genetic and symptomatic similarities between diseases. Our methodology and findings may inform medical researchers and practitioners about sets of confusing diseases that require particular attention in diagnosis and treatment. The major limitations in this research are the inability to obtain real-life data and the uncertainty of whether the theoretical results obtained apply to actual medical cases.

Urban Heat Island Effect: Analyzing the Correlation Between the Intensity of Sunlight and Temperature in Manhattan

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Cities may experience a higher air temperature at ground level compared to their rural surroundings in a phenomenon known as the Urban Heat Island (UHI) effect. The objective of this study is to analyze the relationship between the intensity of sunlight and ground-level air temperature on a summer day in Manhattan. The sun not only radiates visible light, but among other things, also heat energy. This analysis was done using the computer program Matlab and data collected during summer 2013 from sensors placed as a part of the Manhattan Urban Heat Island Project at The City College of New York.

Designing Better Assessment Engines: Improving Next Generation Learning Management Systems

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The current generation of assessment tools used in K-12 education are limited in the type of questions they use. Some kinds of higher order questions cannot be effectively handled by current assessment systems. In addition, Learning Management Systems place a heavy burden on teachers to generate online assessments. We analyze a number of such systems how many clicks and page traversals are required to create a quiz with a single question and then describe a new design of a more powerful assessment tool that allows for more advanced question types, better questions and also reduces the labor to create and maintain assessments. Our team is currently developing LiquiZ, an experimental assessment system. LiquiZ has features designed for many fields of learning, but with a focus on STEM and the ability to assess learning from non-traditional instruction and project-based learning.

Notes

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