ISEC 2016

6th IEEE Integrated STEM Education Conference

Friend Center
Princeton University
Saturday, March 5, 2016

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 '16 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

8:15 – 3 pm
Registration in the Convocation Room
Speaker Preparation Room – Dean's Conference Room

8:15 – 11 am
Breakfast in the Convocation Room

9 am – 4 pm
Posters and Exhibits in the Convocation Room and 101 Area
Posters by K-16 Students
Leading Engineering Technologies, LLC
Cheryl Matthews and Bill Reinhard
MathWorks: World's Leading Developer of Mathematical and Technical Computing Software
PJ Boardman and Akash Gopisetty

9 – 10 am
Keynote in FC 101
Learning How to Learn
Barbara Oakley, Ph.D., P.E.
Professor of Engineering
Oakland University

10 – 10:50 am
UnConference in FC 101
Inclusive and Integrative Learning
Vignesh Subbian, Facilitator

11 am – noon
Paper Presentations

noon – 1 pm
Lunch in the Convocation Room

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

1:30 – 4:25 pm
Paper Presentations

Keynote Speaker

Barbara Oakley, Ph.D., P.E., is a Professor of Engineering at Oakland University in Rochester, Michigan; a Visiting Scholar at the University of California, San Diego; and Coursera's inaugural "Innovation Instructor." Her work focuses on the complex relationship between neuroscience and social behavior. Dr. Oakley's research has been described as "revolutionary" in the *Wall Street Journal*—she has published in outlets as varied as the *Proceedings* of the National Academy of Sciences, the *Wall Street Journal*, and the *New York Times*. She has won numerous teaching awards, including the American Society of Engineering Education's Chester F. Carlson Award for technical innovation in engineering education. Together with Terrence Sejnowski, the Francis Crick Professor at the Salk Institute, she co-teaches Coursera – UC San Diego's "Learning How to Learn," one of the world's most popular massive open online courses with nearly a million students in its first year alone. Her book, *A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)* is a *New York Times* best-selling science book.

Dr. Oakley has adventured widely through her lifetime. She rose from the ranks of Private to Captain in the U.S. Army, during which time she was recognized as a Distinguished Military Scholar. She also worked as a communications expert at the South Pole Station in Antarctica, and has served as a Russian translator on board Soviet trawlers on the Bering Sea. Dr. Oakley is an elected Fellow of the American Institute for Medical and Biological Engineering.

Abstract

Many learners, including students, practitioners in industry, and even professors, are unaware of best practices in learning, particularly in the STEM disciplines. Instead, they suffer under illusions of competence, continuing with learning practices that research has shown to be ineffective. This talk provides activities and insight into best practices in learning as revealed by insights from neuroscience and cognitive psychology. Building on cutting edge research involving the "default mode network," we'll explore how and when learners should access the brain's different learning modes to creatively tackle problem-solving while reducing frustration. We'll also cover common illusions of competence in learning, such as rereading and using highlighting, and learn how to avoid these challenges by applying more powerful techniques such as recall and "chunking." Simple techniques described here can allow learners of all kinds to more easily tackle procrastination, which can be one of the most deeply harmful impediments to learning. This talk is meant to provide practical, immediately useful tools to help improve learners' ability to stay on top of tough course material of any type, and to help workers in industry more creatively tackle their jobs.

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In Memoriam

Annette L. Taylor, a long time volunteer with IEEE PCJS and Princeton ACM - IEEE Computer Society, passed on January 23, 2016. She was an active member of the Steering Committees organizing the Trenton Computer Festival and the Information Technology Professional Conference. Her immediate survivors are her husband, Bill, and daughters Morgan and Sidney. Annette will be missed.

Reviewers

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FC 004 Integrated Outreach Programs - I

Chair: Arthur Kney (Lafayette College, USA)

11:00 Transforming STEM to STEAM (Work in Progress): How a Traditionally Run STEM Camp Successfully Incorporated the Arts into Its Framework

Arthur Kney, J. Christian Tatu, Matthew Marlin, and Xiaoyan Meng (Lafayette College, USA)

Summer learning loss remains an ongoing concern for K12 students. Learning loss varies based on subject matter, with summer learning loss associated with math at the higher end of the scale. Greater effects of summer learning loss are generally associated with lower income families. Additionally, minorities and women remain underrepresented in the STEM Fields. Based on this information and desires to engage with community in effective and scholarly ways, founders of the Lafayette College Summer camp established a summer STEM education venue for young children in 2011. Recognizing that inclusion of the Arts added interest to our general theme and education modules, and served to enhance our education messaging, STEM Camp became STEAM (Science, Technology, Engineering, ARTS, and Math) Camp in 2014. An additional highlight of this camp is the fact that the leadership, ideas, design and organization of all modules is a production led by two undergraduates, one student majoring in Arts-Humanities and a second majoring Science-Engineering. A group of volunteers made up of faculty, local K12 teachers, college and high school students, and community members, support all camp activities throughout the four-day event. This "Work in Progress" manuscript lays out the structure of the camp, goals and objectives, and assessment strategies, as well as initial formal and informal findings.

11:15 Engineering Brightness: Using STEM to Brighten Hearts and Minds

Ian Fogarty (Riverview High School, Canada); Tracey Winey and John Howe (Preston Middle School, USA); Gareth Hancox (Pheasey Park Farm Elementary School, United Kingdom); and David Whyley (Whytech Consulting, United Kingdom)

Students designed and built lights for those who do not have access to clean reliable light. UNESCO estimates 1.5 billion people worldwide do not have access to clean light. One of the many ramifications is the inability to study after sunset. Many students have to choose between sitting in the dark or burning brush, garbage or kerosene which are health, environmental and health concerns. STEM, specifically electrical engineering, was used to solve this real problem for real people. Primary, middle and high school students from Colorado, Canada and the UK collaborated in the design thinking process to produce different prototypes of lights for different situations. Students interacted with community members and local businesses to learn how to assemble circuits, the functioning of electrical components, sewing, 3D printing, world issues, health, language arts and philanthropy. The project motivated students in a novel way. If a student did mediocre work, it is much more devastating than a poor mark because someone else's life was negatively impacted. The work superseded a grade and survived the trash can at the end of the semester. Students were proud to be leaving a legacy, participating even after they moved on to another school. Engineering Brightness, Philanthropic Engineering's flagship project, aims to deliberately engineer brightness on many different fronts including: - in the room of studying students all over the world who otherwise do not have access to clean light. - in the minds of students who bring many skills and aptitudes to bear in the design and production of lights. - in the hearts of students who use their learning to impact the lives of others.

11:30 An Electric Go-Kart Camp to Attract High School Students to a STEM Career

Karl Perusich (Purdue University, USA)

As a way to recruit students in choosing STEM careers when they matriculate a camp was developed around electric go-karts. Open to high school students and run since 2013, the camp is designed to give participants an overview of the physics, electrical engineering and mechanical engineering associated with the design and operation of a battery powered kart. To pique their interest driving time is built into each day of the camp culminating in a 25 mile endurance test on the final day. Since the camp is still evolving the operation, organization and lessons learned will be described. Key insights such as staffing, pricing, recruiting and course material will be discussed.

11:45 Integrating STEM for Teaching and Learning of Foreign Language

Sonali Banerjee (Educators Society for Heritage of India, USA)

Language learning goals, and assessment criteria to monitor learner's progress and proficiency are determined according to standard based performance benchmarks at different levels of language learning. In a standards based

curricula, content in humanities, literature, art, music, cuisine etc. are more favored over content in Science, Engineering, Technology and Math (STEM) to connect language and culture in a meaningful context. Although focus of language learning is not the content, in this paper, some results of integrating STEM content in teaching Hindi Language will be presented. It is observed that in a language classroom, learners find STEM content to be more interesting.

FC 005 Post-Secondary Educational Modules and Tools - I

Chairs: Abu S. Asaduzzaman (Wichita State University, USA) and Hon Jie Teo (New York City College of Technology, USA)

11:00 A Hands-on Approach to the Teaching of Electronic Communications Using GNU Radio Companion and the Universal Software Radio Peripheral

Fan Jiang and Stephan Vajdic (Bloomsburg University of Pennsylvania, USA)

Software defined radios (SDR) are reconfigurable communications systems whose functionalities can be changed by software on a computer without altering their hardware. Because of their flexibility, SDRs not only provide a convenient platform for advanced research on electronic communications, they serve to be superb tools for the teaching of it as well. Designed and manufactured by Ettus Research, a subsidiary of National Instruments, the universal software radio peripheral (USRP) is a popular hardware platform for software defined radios. Along with USRP, Ettus Research also developed the GNU Radio Companion (GRC), a graphical programming environment that can be used to program the USRPs. GRC allows the users to simulate the communications systems first before uploading it into the USRP and thus providing an excellent environment for the teaching of electronic communications. In this paper, we describe an experimental project on hands-on approach to the teaching of communications system at the undergraduate level using GRC and USRP in the Department of Physics and Engineering Technology at Bloomsburg University of Pennsylvania. In spring and summer of 2015, a group of four undergraduate students with no previous exposure to electronic communications were chosen to take part in the project. The main purpose of this effort is to improve the abstract thinking ability and hands-on skills of the students and to keep the students abreast with the state-of-the-art technologies at Bloomsburg University. Student feedback will be used to justify the success of this new approach.

11:15 Project-Based Approach in Teaching Energy-Harvesting Wireless Sensor Networks

Jayesh Bokhiria, Md Anwar Parvej and Melike Erol-Kantarci (Clarkson University, USA)

Use of project-based approaches in engineering education is widely acknowledged. Experiments are a significant part of research and they are also very rewarding when used in teaching. In particular, for complex and higher level undergraduate courses, as well as graduate courses project-based teaching promises to enhance the learning experience. Teaching wireless sensor networks (WSNs) in undergraduate level is challenging and can benefit from testbeds. As the cost of hardware and testbeds are declining, there is a good opportunity to demonstrate the abstract notion of computer communication protocols using testbeds. In that sense, energy harvesting wireless sensor networks is a fairly new technology and can be effectively learnt by using testbeds. In this paper, we present our work-in-progress in integrating a state-of the art energy harvesting kit for the purpose of teaching Radio Frequency (RF) energy harvesting concept. The observations on the testbed lead to promising future directions that can help integrate WSNs into STEM education.

11:30 A Learner-Centered Computational Experience in Nanotechnology for Undergraduate STEM Students

Abu S. Asaduzzaman and Ramazan Asmatulu (Wichita State University, USA)

According to the recent studies, the current state of Science, Technology, Engineering, and Mathematics (STEM) education in the U.S. has not been impressive. In this paper, we introduce an interdisciplinary learner-centered computational experience in nanotechnology for undergraduate STEM students. Three important tasks associated with this work are applying power-aware data-regrouping based parallel computation to analyze nanoscale materials; updating and/or developing "hands-on computational experience in nanotechnology" courses; and assessing students' learning experience and interest in high performance computing (HPC) simulation for nanotechnology. The proposed activities have potential to improve motivation, engagement, and learning of STEM students, enhancing the Engaged Student Learning environment. The tasks described in this work incorporate many-core computing, nanomanufacturing, and energy savings, and are aimed at advancing HPC with fundamental understanding of nanostructured fiber behavior, which in turn will allow the use of effective materials for renewable energy conversion. Activities to address industry-oriented real-world problems will attract new students to the STEM education, as the job market in related fields is growing.

11:45 A Tool for Simulation and Visualization of Distributed Estimation in Wireless Sensor Networks

Zachary Rauen, Nicholas Rolfe, Burak Kantarci, Mahesh Banavar, and William Freitag (Clarkson University, USA)

A Java-based tool has been designed and implement to simulate distributed estimation on a wireless sensor network (WSN) platform. The tool allows users to vary several system parameters of the WSN such as the parameter to be estimated; the amount of and type of noise in the system; types of channel impairments; algorithms for data processing at the sensors; and types of estimators. The simulator has been developed by fulfilling the requirements of usability principles in visual software design, and it produces outputs that have relevance to various sensor network applications such as localization, synchronization, and fault detection. Educational opportunities introduced by the tool are two-fold. It can be used in senior-level undergraduate digital signal processing, communications, and digital controls classes to introduce students basic statistical signal processing concepts such as noise and sample estimation in noise. The current version of the tool has been evaluated via student feedback in a workshop. Preliminary results are promising, and will allow us to make modifications to the simulation tool as necessary.

FC 006 Higher Education Integrated Curricula

Chairs: Laquana Cooke (Rensselaer Polytechnic Institute, USA) and Lucinda Presley (IEEE Success Foundation, USA)

11:00 +Composition and Construction: Piloting an Integrated Curriculum

Mitchell Ogden and John Killingsworth (University of Wisconsin-Stout , USA)

This paper reports the preliminary results of a pilot study in which a freshman composition course was combined with a light construction methods and materials course as an integrated learning community enrolling twenty-one incoming freshman. Composition assignments were designed to be relevant to the construction field with an emphasis on persuasive appeals, genre analysis, audience awareness, and process-based writing. This paper describes some of the particulars of the structure and design of the course, including the pedagogical and institutional considerations. Specific assignments and activities of the course are described. Results include an overwhelmingly positive student response to the integrated model and positive levels of engagement--by students and faculty. Students reported an increased awareness and appreciation of professional communication skills in the construction field. They also reported increased learning and more positive responses to writing instruction as compared to previous English courses. The faculty had a positive experience, developing deep cross-disciplinary competency and new pedagogical opportunities.

11:15 A Case Study of Interprofessional Collaboration Between Engineering and OTA Students at Penn State DuBois

Daudi Waryoba; LuAnn Demi, and Amy Fatula (The Pennsylvania State University, USA)

The DuBois Campus of The Pennsylvania State University has a long history of providing hands-on learning in the courses taken by students enrolled in associate and baccalaureate degree programs. This paper presents a case study of collaborative design projects between first-year engineering and Occupational Therapy Assistant (OTA) students. The projects involved the design and manufacture of assistive devices for elderly and/or disabled persons. Students worked in a team setting consisting of 4 engineering students and 3 OTA students per team and use their understanding of design process (engineering students) and mobility and function (OTA students), paired with a client's occupations, history, and needs to create a piece of adaptive equipment to allow users to engage in desired occupations. To capture students' feedback for quality improvement, questionnaires were designed and filled after the completion of the projects and a year or two years later after completing the course. Comparison of students' responses between the two questionnaires suggested that they benefited from the interprofessional collaboration. Unanimously, they all agreed that these collaborative projects helped them to gain insight into how someone from another profession "thinks" and the importance of utilizing everyone's strengths to better accomplish the goals of the team. The collaboration also helped them to be appreciative of the knowledge people bring from other professions that introduces new ideas to the team, respecting others' thoughts and ideas. Some of them continue to collaborate with other professionals.

11:30 Mathematical Beauty in Rome: A Study-Abroad Program for STEM Students

Joseph Pasquale (University of California, San Diego, USA)

Mathematical Beauty in Rome is a five-week summer study-abroad program at UCSD designed specifically for college undergraduates in STEM majors; it has been offered since 2008. Its subject matter is the architectural geometry and structural engineering of great monuments in Rome. The program is comprised of two courses, one

that takes place in the classroom and the other that takes place at various sites, using Rome as a living laboratory. Some of the major sites that are studied include the Colosseum, the Pantheon, St. Peter's dome, and the Aqua Claudia Aqueduct. There is a one-week excursion to Florence to study Brunelleschi's dome and to Pisa to study the Leaning Tower. Works of art such as Raphael's School of Athens are also studied for their use of mathematical perspective. The paper presents details on the motivations and goals of the program, pedagogical methods based on experiential learning, an example of course content on Colosseum's ground plan geometry, cultural aspects, and assessments.

11:45 Harmonious Integration: Tuning STEM Education with Generative Justice

John Drazan (Rensselaer Polytechnic Institute & 4th Family Inc., USA), Laquana Cooke, and Ron Eglash (Rensselaer Polytechnic Institute, USA)

STEM educational practices not only have limited success in engaging students from underrepresented groups, but also often fail to prepare future scientists and engineers with an appreciation for the social and environmental concerns that underpin their work. Rather than approaching these challenges separately, they can both be addressed by "tuning" STEM education practices to be more socially conscious. We believe that one of the issues with STEM recruitment in unrepresented groups is the lack of societal context in which STEM problems are addressed. Rather than relying on an externally imposed moral framework, we utilize the concept of generative justice to serve as a framework to inform STEM practices. Generative justice refers to an understanding of how value is generated and then circulated within a system. A generative solution to a STEM problem allows the value generated to flow from its point of generation, become augmented with STEM practices, and back to its original source. This framework allows STEM practitioners to identify the value generated within a system and then tune their practices so that maximal value is returned to the community within which they operate. This paper provides a case study of this generative STEM approach in our work on sports science within an urban environment. By starting STEM from the authentic interests and values of the community of underrepresented students, we can create a harmonious tuning between the providers of STEM outreach and its recipients, and train a new generation of scientists and engineers who are not tone deaf to the needs for social justice.

FC 007 Entrepreneurship-Based Programs

Chair: Margret Hjalmarson (George Mason University, USA)

11:00 Creative Problem Solving Builds Entrepreneurial Mindset

Adriana Perez Camacho, Allison Janowski, Abdullah Konak and Sadan Kulturel-Konak (Penn State Berks, USA)

This paper introduces how several hands-on activities fostering the development of creative thinking as a fundamental part of the youth's entrepreneurial mindset are used. Students in various disciplines from the Pennsylvania State University- Berks Campus served as mentors for a primarily middle-school and high-school group of students and teachers during the service-learning workshops conducted in the rural municipality of San José de Cusmapa, Nicaragua. After an introduction to creativity and creative problem solving, the participants were able to devise innovative ideas for the creation of a business for a product or service in their community. The feedback obtained from the participants is evident that the workshop was effective in teaching them how to develop and expand their entrepreneurial mindset through creativity and creative problem solving activities. In this paper, it is discussed how working individually and collectively to resolve a series of creative problem solving activities expanded the students' ideas throughout the different stages of the business creation process.

11:15 Connecting Kids to STEM Through Entrepreneurship and Innovation

Peg Zokowski and Katharine Geramita (SmartKids NY, USA); Jonathan Ashdown (Hudson Valley Community College, USA); Brenda Brooks (SmartKids NY, USA); and Amanda Thompkins (428 LLC, USA)

In this paper, the authors outline preliminary results on the introduction of entrepreneurs and innovators in classrooms, demonstrating the positive impact on both teaching kids STEM, as well as influencing certain demographics to aspire to STEM-related careers. The authors hypothesize that connecting students to STEM in elementary school, primarily through the introduction to STEM-based entrepreneurs and innovators, will ultimately result in a more STEM-inspired and STEM-literate workforce. If this model is followed collectively by educators, business, and government alike, the authors believe that significant progress can be made in mitigating the loss of students interested in STEM during middle school.

11:30 Interdisciplinary Integration of Entrepreneurial Educational Support to Improve Electrical Engineering Graduates' Employability

Danut Ilea and Costela Beatrice Moasa (Transilvania University, Romania)

Electrical engineering education process in the "Transilvania" University from Brasov, Romania has undergone a profound transformation during the Romanian country access in European community. It means that, from a strong focus on "engineering practice and design" before 1990, to the current emphasis on scientific fundamentals and mathematical analysis. The investment in university research also produced a major shift in "engineering culture" away from its traditional roots in professional practice toward an academic science perspective. Another main trend consists in the remarkable insertion in the labor market for the graduates. This paper presents, as an additional interdisciplinary programme financed by European Commission a benefic "entrepreneurial track" for the students of Electrical Engineering & Computer Science Department (EED) from "Transilvania" University of Brasov, Romania. The activities offered students novel attitudes, skills and competencies are reflected in the growing of the labor market "employability indicators". The graduates' assessments were done by using "business employability indicators" based on a combination of academic and non - academic criteria developed by cooperation with great corporations. In the last four years the EED reconsidered the ALUMNI association of Electrical Engineering as one of the data sources. Therefore it was added a real market - orientated indicator for assessing the quality of the electrical engineering graduates in accordance with "corporate responsibilities" both in education activities and usefully for the now days "transformational engineering" concept. Entrepreneurial Competency Standards in Electrical Engineering have been established. The levels of "entrepreneurial competency" were standardized and applied. It is emphasized a positive experience concerned the graduates' employability.

11:45 Teaching Innovation and Sustainability through International Interactive Workshops

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

Thousands of pounds of electronic waste (e-waste) is disposed of worldwide in a polluting, unsafe manner every day. Gradual progress is being made to prevent this issue from worsening throughout the world. However, the problem of e-waste disposal still significantly impacts Kenya. Kenya also faces difficulties with income and employment. In response to the e-waste disposal and economic issues in Kenya, a team from Penn State Berks decided to develop a way for Kenyans to resolve these problems to an extent through jewelry and craft making. An interdisciplinary team composed of two professors and four students, called Creative Minds, travelled to Kenya to conduct interactive workshops on increasing the awareness of sustainability, how to properly manage the disposal of e-waste, and encouraging creativity. The workshops included a number of activities based in engineering and other design disciplines. After this initial travel to Kenya, two Kenyan students visited Penn State Berks. In addition, Penn State Berks' Creative Minds team received an award for having the best innovative solution in a highly esteemed showcase. This paper presents the experiences in this social entrepreneurship project.

FC 004 Community-based Outreach and Pre-College Initiatives

Chairs: Jennifer Jennings Davis (University of Arkansas at Fort Smith, USA) and John Drazan (Rensselaer Polytechnic Institute & 4th Family Inc., USA)

1:30 "Adopt-a-Professor"- A Model for Collaboration in STEM between K-12 and Higher Education

Muhammad Khan and Jennifer Jennings Davis (University of Arkansas at Fort Smith, USA)

Adopt-a-Professor is a program coordinated by Educational Renewal Zone (ERZ) at University of Arkansas Fort Smith (UAFS). The program pairs K-12 teachers with UAFS faculty/staff. The partners collaborate to plan three learning engagements during one school semester. The engagements can take place at a K-12 or higher education institution, local industry or in the community. The main objective of the program is to strengthen K-12 student learning outcomes in all subject areas with a special focus on STEM fields. The participating UAFS faculty and staff offer up-to-date content knowledge in their areas of specialization and also provide access to university's laboratory/equipment resources. The K-12 teachers bring their experience of school practices. The partnerships not only improve understanding of the subject areas by K-12 students but also builds their connection to higher education. This paper discusses the details of the Adopt-a-Professor program. The paper also lays out program implementation in a STEM field with focus on learning engagements in Industrial Electronics and Automation.

1:45 Preparing High School Students for College While Training Engineering Students in "Soft Skills"

Jeffrey Schwartz (Queensborough Community College, USA)

Introductory computer programming courses can be dry, with bored students often working on short, straightforward examples designed as programming drills, the results of which only their professors will ever see and which the students might not appreciate in a broader context. In college engineering programs, students spend much of their time developing their Science, Technology, Engineering, and Mathematics skills, but when they graduate and start their work in the engineering industry they can be ill-equipped to communicate their ideas with other engineers, managers, and clients. The need to develop engineering students' communication skills has come up many times in discussion with industry representatives and at engineering education conferences. High school students, meanwhile, are usually focused on getting through high school and may have no idea what is expected of them when they enter college, which is a problem that the professors at Queensborough Community College have to face with each new group of students. In this work-in-progress paper I will describe why and how I have used the high-impact practice of service learning to help students reduce these deficits. I will describe the strategy I use of having the students in my introductory programming course solve word problems that require more thought in order to be solved. My students then present them as group projects to high school students in the final class session of the semester. The two groups of students then discuss the presentations and the college experience in general. This provides an engaging and memorable experience for all. This paper will describe successes and issues I have had since I started to use this method in the course.

2:00 +Alternating Learning Methods to Construct K-12 STEM Outreach: Invention and Innovation Workshop Case Study

Ralph Tillinghast (US Army & ARDEC, Picatinny Arsenal, NJ, USA); Edward Petersen and Anthony Ur (US Army, USA)

Conducting STEM outreach workshops in K-12 classrooms has been found to be an effect method to inspire young minds in these critical areas. This paper looks to see how utilizing different teaching methods can be used to optimize STEM outreach workshops. This is accomplished by presenting findings based on a workshop that is actively being conducted for STEM outreach with a focus on inventing and innovating. The workshop content and key learning objectives will be outlined. Further this paper will discuss the different teaching methods utilized throughout the workshop. The paper will also present survey results from participants based on the key learning objectives. Lastly best practices will be presented to aid in future workshop development and optimization. Overall the purpose of this paper is to present a detailed outline of the workshop for others to utilize and demonstrate how using alternate teaching methods can optimize the impact on students.

2:15 A Mini Experiment of Offering STEM Education to Several Age Groups Through the Use of Robots

Wei-hsing Wang (Princeton Day School, USA)

This paper reports the use of robots in teaching the essence of Science, Technology, Engineering, and Mathematics (STEM) to students from first grade to 12th grade. This STEM skills learning experience was developed gradually over 4.5 years and tested by over 350 students. Since the sample size is small and the time span

is short, only limited statistics data is available. The main goal of this paper is sharing firsthand experience of using the same set of robots to teach students over 12 grades. This paper starts with general information of the LEGO Mindstorms EV3 robots, the basic methods, and the concept of STEM in very simple terms. This paper then explains how building and programming robots was implemented in different ways for different age and experience groups. There are 5 groups in discussion. The first group is the youngest and without any experience. The second group is older but without experience. The third group is older and with some experience. The fourth group is a group of middle school age (grade 5 to 8) students, mostly with some pre-exposure to robots. The last group consists of high school students. Each group is given an age-appropriate goal. It is observed that they have different challenges to conquer. While using LEGO Mindstorms EV3 (and the previous version, NXT) is well studied, having hands-on experience of building a learning path for students from first grade to 12th grade is of value. Finally, the expectation of education results in the future is touched upon.

2:30 Influencing Factors in Identifying the Optimal Age for Conducting STEM Outreach

Ralph Tillinghast (US Army & ARDEC, Picatinny Arsenal, NJ, USA); Mo Mansouri (Stevens Institute of Technology, USA)

Over the years, a constant growth in the need for more STEM professionals has been seen in order to take on our society's more advanced problems. To address this need, a steady growth in STEM-based outreach has been established to inspire young minds to fill this need for future STEM professionals. These programs can be found in a variety of formats, delivering a wide range of content and targeting specific demographics; all with the goal to stimulate interest and gain excitement in STEM. The purpose of this paper is to provide a discussion on how to best optimize STEM outreach by identifying which specific age ranges could have the most long term impact. This will be undertaken by applying multiple System Engineering philosophies and tools. Such as constructing a conception of the target system, a review of the stakeholders involved and discussion on the systemic forces involved in STEM outreach.

FC 005 Inclusive STEM Outreach Programs

Chairs: Mary Lanzerotti (Augsburg College, USA) and Maura Simister (Manchester Middle School, USA)

1:30 +EFRI-REM at CCNY: Research Experience and Mentoring for Underrepresented Groups in Cross-disciplinary Research on Assistive Technology

Zhigang Zhu (The City University of New York, USA), Wai Khoo (The CUNY Graduate Center, USA), Camille Santistevan (The CUNY Advanced Science Research Center (ASRC), USA), Yuying Gosser (The City College of New York, CUNY, USA), Edgardo Molina (Vista Wearable, Inc., USA), Hao Tang (Borough of Manhattan Community College/CUNY, USA), Tony Ro (The CUNY Graduate Center, USA), and YingLi Tian (The City University of New York, USA)

We have successfully run the NSF EFRI-REM program at The City College of The City University of New York (CUNY) for four years (2012 to 2015) with over 50 research participants (RPs), most of whom are from underrepresented groups, particularly individuals who are disabled, women, veterans and minorities. Each year we started with an 8 to 10-week summer research program and then mentored the participants' education and career paths in the following academic year. We have not only provided exciting cross-disciplinary, student initiated research opportunities in human and machine vision research and applications in assisting visually impaired people, but also shaped an innovative model to support career development of high school students, community and senior college students, graduate students (mentors), high school teachers, as well as community college professors. The EFRI-REM program provides a novel and effective platform to allow more underrepresented students in the greater NYC area to participate in our multidisciplinary research.

1:45 Components and Outcomes of an Interdisciplinary Research Program to Inspire Underrepresented Undergraduate Students in STEM Fields

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

This paper describes components and outcomes of an interdisciplinary undergraduate research program intended to motivate female students to graduate with STEM degrees. This year, the program graduated the first student, who is the first STEM graduate in her family. The program is intended to inspire underrepresented

undergraduate students to graduate with STEM bachelor's degrees by providing participating students with unique mentorship from distinguished leaders in STEM fields while the students simultaneously pursue technical research. The mentorship is provided to the students when they identify and interview leaders whose careers align with the desired career fields of the students. The interviews are conducted in collaboration with the IEEE History Center and American Institute of Physics. Research results produced by the students are presented at national conferences and published in conference proceedings. Transcripts of the interviews are published in perpetuity on the IEEE Engineering Technology and History Wiki. The project will continue within the STEM environment.

2:00 Hooking Them Young: Demystifying Computer Science and Technology Among Underprivileged High School Students

Rajesh Prasad, Carol Traynor, and Sara Smits Keeney (Saint Anselm College, Manchester, NH, USA)

his paper examines three different programs to engage refugee, immigrant and underrepresented high school students for a semester-long college campus experience in the field of science, technology and computing. Most high school students form an opinion what they are going to study before they reach college. The situation gets more complicated for underprivileged high school students whose parents are below the poverty level or are uneducated or are not educated in STEM fields. The outreach programs discussed in this paper may help underprivileged high school students select a STEM discipline in college. By exposing them to science, computing and technologies earlier in their life they may be motivated to choose a career in these fields. The paper discusses three different programs: (i) Biodiversity Mapping using GPS technologies; (ii) Computer Construction; and (iii) A Computational Approach to Problem Solving. All of these programs were designed so that the participants gain a fundamental understanding of the concepts, have fun, and leave with a sense of achievement. We used surveys as well as in-depth interviews to measure student attitude toward STEM disciplines. There was a positive student response in all the programs. These programs are easy to setup and can be replicated at other institution across the country. The work is unique because it focuses primarily on underprivileged immigrant and refugee high school students.

2:15 stem5: An Initiative Shaping the STEM Narrative in Pakistan

Syed Imaad, Bilal Wajid and Irfan Chaudhary (University of Engineering & Technology at Lahore, Pakistan); and Azeem Sarwar (General Motors, USA)

stem5 is a STEM education initiative based at University of Engineering & Technology (UET) at Lahore, Pakistan. The initiative aims to rejuvenate STEM education in Pakistan by engaging university faculty and students in outreach activities targeted towards underprivileged students studying in the public school system. Volunteers include faculty, researchers and students from across various engineering disciplines of the university. This paper presents an overview of the two main outreach activities being conducted under the umbrella of stem5 - science outreach program at public primary schools and summer coding camps for public secondary school students. The science outreach program has been in operation since 2013 and is currently underway in a total of 9 schools in the cities of Lahore and Faisalabad. The summer coding camp is a new addition and was held in Lahore in the summer of 2015. The basic purpose of such camps is to introduce computer science and programming to young students by creating animations and games using Scratch. We conclude by discussing future directions and suggest how the current work may be adopted by other universities in Pakistan to enable synergistic efforts that may influence the narrative for STEM education reform in the country.

2:30 Informal STEAM Education for Gifted Students: Case Study of a Family Academic Program

Catherine Kruchten and Alexis O'Malley (University of Maryland, Baltimore County, USA)

The Math in Art, Art in Math program was designed in conjunction with the Johns Hopkins University Center for Talented Youth in an effort to combine interdisciplinary, informal education with an audience of gifted students and their families. The program leveraged educators' backgrounds in art and mathematics to create an interactive day-long program that allowed students to explore concepts rarely seen in a classroom environment. The research and pedagogy that shaped the development of such a program is presented, with attention given to the characteristics unique to a gifted audience that may have broader implications for the field of education at large. Here we explore the challenges of initial implementation and lessons learned from both the development and implementation of the program. Feedback from participants is also examined in an effort to determine which programmatic elements were most valuable as well as the viability for future interdisciplinary STEAM learning.

FC006 Learning Frameworks and Assessment Models

Chair: Rob Gorbet (University of Waterloo, Canada)

1:30 Behaviorally Anchored Rating Scales for Teamwork Peer Assessment

Abdullah Konak, Steven Magluilo, and Sadan Kulturel-Konak (Penn State Berks, USA)

In team projects, peer evaluations are frequently used to evaluate students' teamwork skills and their individual contributions to project outcomes. Unfortunately, peer evaluations are usually time consuming to conduct due to the large amount of data collected. In order to efficiently assess teamwork skills of students through peer and self-evaluations, we created a web-based tool called Peer Evaluation and Assessment Resource (PEAR). Using the PEAR, instructors are able to see where students need to improve their teamwork skills and give individual feedback. We have used the system in several classes and been able to gain valuable information to help instructors improve their classes. However, we have also identified several problems such as very high peer and self ratings inconsistent with students' expected skill levels. We redesigned a peer assessment instrument from the literature based on behaviorally anchored rating scores in order to address some of these problems. This new instrument has been tested in the PEAR system, and in this paper, the results are compared to the ones obtained using a continuum scale version of the instrument.

1:45 Can Undergraduate Electrical Engineering Students Assess Each Other's Presentations Effectively?

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

Assessment plays a vital role in the education process since it is the first step for continuous improvement. Students are the most important constituency of the education process and their input is very important to be considered. Unfortunately, students usually play a passive role in the assessment process. Therefore, in this paper, we discussed the viability of students' peer assessing each other's project presentations effectively. To do so, we conducted a study to understand the dynamics of students' peer assessment and compared it to the instructor's assessment. We also analyzed what could influence the students' performance while conducting peer assessments and devised recommendation to improve the reliability of peer assessment. To validate our findings, we conducted a quantitative analysis taking into consideration all the pertinent parameters involved in this model. Assessment results indicated that students on average tend to overrate peer performance. Additionally, we found that there is a correlation between the assessment results and the rubrics used for the assessment.

2:00 Examine Dynamics of Communication and Connections among Engineering Professional Skills in Group Discussion: A Network Analysis Approach

Mengxiao Zhu and Mo Zhang (Educational Testing Service, USA)

In this paper, we study the dynamics in group discussions in a scenario-based assessment of engineering professional skills (EPSs). In the assessment, each group of students was evaluated through a discussion on a scenario of a modern engineering problem with no clear solutions. Using social network analysis techniques, we construct two types of networks to model the communication processes, and the connection and integration of EPSs in student-group discussion. Using transcripts of the group discussions, four communication networks were constructed for each group for the beginning, middle, end and overall the discussion to capture who talked to whom. We also coded the transcripts to identify which engineering professional skills were represented during the conversation. For the two groups of students used in this paper as study cases, we find dramatic differences between the high-performing group and the low-performing group. For instance, the high-performing group tends to show denser and more balanced network connections in both communication and EPS networks. Limitations of this study and discussion of the results are also provided.

2:15 STEM Students' Global Awareness Knowledge Assessment

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

Assessing professional skills, such as teamwork, global awareness, ethics and creative problem solving, in the Science, Technology, Engineering and Mathematics (STEM) disciplines encourages growth and experience for students. The paper focuses on the professional skill, global awareness, and gauging students' knowledge about this skill. According to the Model of Domain Learning (MDL), as students progress throughout their education in a domain, the knowledge of the domain becomes more cohesive and deeper. To assess students' knowledge of global awareness, we developed an instrument, i.e., a questionnaire, which gauges what students know about the world and specific nations based upon the following categories: customs and culture, religion, geography, economy, food, languages, history, health, politics and the environment. The preliminary findings are discussed

and analyzed to assess students' knowledge of global awareness. Primary findings will also be used to group the questionnaire items into three developmental stages of the MDL- acclimation, competency, and proficiency.

2:30 Shuffled Licht's Model of Learning for Teaching Mathematics Intensive Concepts to Undergraduate Engineering Students

Farrah Fayyaz (Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Pakistan)

Many concepts and systems in engineering are explained using mathematics. Mathematics is a language for engineers to solve engineering problems. The conceptual learning of many engineering concepts is based on how well engineering students can speak this language. There has been an ongoing debate on how mathematics intensive concepts can be taught to undergraduate engineering students, and how does teaching mathematical concepts to mathematics students differ from teaching mathematical concepts to engineers. This paper aims to add to the body of knowledge by examining how existing learning models for engineering students can be exploited to improve learning of mathematics intensive concepts in engineering. This paper discusses problems in learning mathematics intensive signals and systems courses and categorizes students' problems in different stages of learning an advanced or abstract mathematical concept. Additionally, the paper maps the goals of learning an advanced or abstract mathematical concept on a revised Bloom's taxonomy table and discusses pedagogical sequence of teaching mathematical concept to engineers using Licht's model of learning. The paper concludes that the process of learning the qualitative knowledge of the mathematical concept complements the process of learning the quantitative knowledge and hence the qualitative aspect should be incorporated at all stages of teaching an advanced or an abstract mathematical concept. This paper aims to improve the teaching of mathematics intensive concepts to engineering students by providing a teaching model for engineering educators.

FC007 Diversity-Aware Programs and Studies

Chairs: Henry Griffith (Michigan State University, USA), Natalia Mosina (The City University of New York, USA)

1:30 Work in Progress - Diversity and Connection in CSTEM Integrated Project

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

In this paper we describe "Diversity and Connection in CSTEM" project that is currently being implemented at LaGuardia Community College. This faculty-driven integrated project targets diverse student population in Computer Science, Technology, Engineering, and Mathematics aiming to advance their engagement, connection, and retention in CSTEM. The project's implementation, empowered by pedagogy of integration and technology-intensive educational experiences, cuts across several categories: (a) experiential learning through undergraduate course-based, learning, and research projects that are incremental in their difficulty; (b) social learning with innovative technology/Web 2.0 resources and projects in gateway to CSTEM courses; (c) talks/discussions involving women and other underrepresented groups in CSTEM; (d) professional development for faculty. The authors hypothesize that integration of the proposed activities will help students solidify their knowledge acquired in CSTEM courses, build new skills needed for CSTEM workforce, increase self-confidence and awareness of CSTEM fields, and connect to each other and faculty.

1:45 Developing Teacher Leadership for Equity in STEM Learning

Toya Jones Frank and Margret Hjalmarson (George Mason University, USA)

This paper reports on a STEM teacher leadership program to support teachers in creating initiatives within their schools for STEM learning for all students. Teachers were recruited from across the state to represent a range of environments (rural, urban, suburban), across K-12, and including math and science. The program included a summer workshop and follow-up into the school year. During the summer, they designed a STEM initiative for equity for their schools. They also formed small learning communities to provide feedback and support as they designed and implemented their projects. For the school year, teachers went back to their school to implement a STEM project. The teachers gathered data to guide their choice of project from their schools to understand the performance of subgroups of students. For the project they designed, they also gathered data about the success of their initiative. A focus of all projects was on supporting equity in STEM learning. The projects could be designed as in-class work or as after-school programs with students or parents. Our data analysis includes analyzing their final project reports and their reflections as they worked on their projects. The results are in progress, but we are using a leadership framework that examines how they developed as leaders within their schools and communities by advocating for their students' engagement in STEM opportunities.

Afternoon Session I Papers

2:00 Increasing Gender Diversity Amongst Intending Engineering Majors Using Social Networks: A Work in Progress

Henry Griffith (Michigan State University, USA) and Angela Griffith (Wright State University, USA)

Interventions aimed at increasing gender diversity within the engineering workforce have proven insufficient in aggregate to yield desired results on a national scale. This observation is in contrast with results from various individual programming across the K-16 continuum, where such approaches have been effective in improving awareness and increasing motivation for participation in STEM fields amongst females. One possible explanation for this contradiction is that the success of individual disjoint interventions are attenuated in time by a lack of contextual and temporal continuity between adjacent intervention offerings to which the target population is exposed. While such attenuation mechanisms may be addressed by expanding resource allocations in order to increase the magnitude of such offerings or to improve coordination between them through a centralized framework, social networks may offer an effective low-cost alternative for addressing this deficiency. Namely, by providing virtual access to an array of potential female colleagues at various stages of the educational and professional pathway, such networks may help support potential STEM enrollees between exposures to in-person interventions, thus increasing the efficacy of the aggregate intervention system. The current work seeks to identify the feasibility of such an approach through a survey analysis examining the behaviors of targeted females at various stages of the educational spectrum as it relates to their utilization of social networks. In particular, we seek to identify the feasibility of supporting such interactions through participants' existing social networking footprints, as well as to explore their opinions as it relates to possible privacy concerns.

2:15 +Metatuning: A Pedagogical Framework for a Generative STEM Education in Game Design-based Learning

Laquana Cooke (Rensselaer Polytechnic Institute, USA)

While K-12 STEM Education test scores have been steadily improving over the past decade in the United States, achievement gaps still remain among minorities and women in STEM courses and careers. There are numerous factors that contribute to these disparities, such as poverty, low status and other sociocultural factors in classrooms that impede learning. Difficulties in STEM Education engagement and encumbered participation are often due to decontextualized learning— incongruence between meaningful contexts and learning processes. Game based learning methods are common STEM Ed models that provide youth with extrinsically motivating knowledge frameworks for learning, however, research has proven that even these procedural spaces often are disconnected from students' social and cultural realities. Amidst the STEM Ed achievement gaps problematic are similar disparities found in popular video game spaces, where there is a less than 20% chance that these same disparity groups will navigate computational worlds with protagonists that look like them. These gamers/students are lacking the "under-the-hood" (STEM) knowledge of the very games they engage with on a daily basis. This contradiction is central to this paper and the conceptualization of Metatuning—a game deisgn pedagogical framework that aims to empower students to discover their identities as agents of change, and to see that game design can nurture their internal motivations. In this case study, Metatuning was used to foster an intrinsically motivated learning environment, where a young designer was able to iteratively design a social justice themed game that empowered her as a designer and an aspiring doctor.

FC 005 Post-secondary Educational Modules and Tools II

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

2:55 Knowledge Creation In An Introductory Technology Education Course

Hon Jie Teo and William Roberts (New York City College of Technology, USA)

The purpose of this research is to examine the quality of knowledge creation and the formation of social networks in an online discussion forum for an introductory technology teacher education course. The focus of the study is tri-fold and structured around the core areas of technology education. First, the study aims to examine the quality of knowledge creation in an online discussion forum where learners build knowledge around core areas of technology areas Second, the study seeks to examine the state of social network as learners engage in shared creation of knowledge and advancement of digital artifacts such as images and videos. Third, the study seeks to identify interaction patterns across levels of knowledge creation and illuminate the types of social dynamics that are likely to promote knowledge advancement. At the time of this submission, data collection has just been concluded and the planned coding and social network analysis has yet to begin. Descriptive statistics is derived as part of the preliminary analysis process and reveals the intensity of participation in the discussion forums. Preliminary findings suggest students are afforded opportunities to participate in an artifact-rich environment that promotes engagement with one another and sharing of digital artifacts. This research effort can be a helpful source of information to STEM educators who seek to support and assess knowledge creation in online learning environments. Future work for this work-in-progress include content analysis of discussion messages and social network analysis of interactions in the forums.

3:10 A Web-based, Self-Controlled Mechanism to Support Students Learning SQL

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

Database systems play a very important role in computer science. Most software and mobile applications store and populate data on a server site. Relational databases dominate the professional market which requires students to be familiar with Structured Query Language (SQL). The client-server is the standard architecture in the database industry. Therefore, students are strongly motivated to have more hands-on SQL assignments and projects using a 3-tier architecture in database courses. For the best learning experience, each student should have his own tables and environment so that his data won't interfere with data from other students. However, it is difficult for teachers to manage individual privileges on every student's tables and SQL programs if the students are accessing a common (shared) database. This paper proposes a mechanism that students can use to create their database account and grant proper privileges by themselves. This minimizes the instructor's workload by eliminating the need to manage students' accounts and tables when teaching databases. Our proposal also provides an interface that allows students to perform exercises and allows the instructor to review and share students' real-time answers in class. Our methods will minimize the workload for grading SQL assignments when teaching databases, while providing students with the opportunity to practice with more lab assignments. Students can also verify whether their SQL statements are working or not using the same review module as the instructor. The results show that for assignments on simple SQL statements, grading efficiency is increased by at least 60%. This allows the instructor to increase the amount of assignments by 133%. As a result of this increased practice, the students' grades improved by 12%.

3:25 Use of Automated Feedback in Online Interactive Earth Science Tasks

Mengxiao Zhu and Ou Liu (Educational Testing Service, USA); Liyang Mao (IXL Learning, USA); Amy Pallant (The Concord Consortium, USA)

In formative assessment, constructed response questions are typically used for scientific argumentation, but students seldom receive timely feedback while answering these questions. The development of natural language processing (NLP) techniques makes it possible for the researchers using automated scoring engine to provide real-time feedback to students. As is true for any new technology, it is still unclear how automated scoring and feedback may impact learning in scientific argumentation. In this study, we analyze log data to examine the granularity of students' interactions with automated scores and feedback and investigate the association between various students' behaviors and their science performance. We first recovered and visualize the pattern of students navigating through the argument items. Preliminary analyses show that most students did make use of the automated feedback. Checking feedback and making revisions also improve students' final scores in most cases. We also cluster the activity sequences extracted from the time-stamped event log to explore patterns in students' behavior.

3:40 Hands-on Application-Based Tool for STEM Students to Understand Differentiation

Briana Goncalves, Ausamah Hobbi and Amir H Golnabi (Montclair State University, USA)

The main goal of this project is to illustrate to college students in science, technology, engineering, and mathematics (STEM) fields some fundamental concepts in calculus. A high-level technical computing language - MATLAB, is the core platform used in the construction of this project. A graphical user interface (GUI) is designed to interactively explain the intuition behind a key mathematical concept: differentiation. The GUI demonstrates how a derivative operation (as a form of kernel) can be applied on one-dimensional (1D) and two-dimensional (2D) images (as a form of vector). The user can interactively select from a set of predetermined operations and images in order to show how the selected kernel operates on the corresponding image. Such interactive tools are of great importance and need in calculus for STEM students who seek an intuitive and visual understanding of mathematical notions that are often presented to them as abstract concepts. In addition to students, instructors will greatly benefit from using such tools to elucidate the use of fundamental concepts in mathematics in a real world context.

3:55 Toward a Second Screen Peer Discussion Derivative

Tenshi C Hara, Iris Braun, Felix Kapp and Alexander Schill (Technische Universität Dresden, Germany)

Peer Instruction is a teaching concept conceived to increase students' success in STEM courses (science technology engineering, and mathematics). The concept has been successfully applied to non-STEM courses, however it is more or less limited to on-site courses. Extending courses into the online medium allows students to design their learning based on their interests and demand while maintaining structured presentation and/or discussion of learning material. Peer Instruction's 'peer discussion' phase cannot be non-trivially transferred into the online medium. Such transfer would allow for added value to on-site classes, especially for GEMS (girls in engineering, mathematics, and science) as well as challenged students as barriers keeping them from participating in discussion can be significantly reduced. Potential solutions to facilitate the transfer lie in heavily investigated solutions like clickers, or audience response systems. However, these solutions primarily aim at large audiences, namely readings. Our research investigates transferability of concepts into smaller on-site classes, namely tutorials. It discusses experimental results and concepts for a tech-enhanced peer discussion derivative utilisable in tutorials while providing anonymity and barrier-free access to discussions. At the same time, cognisant incidental utilisation (CIU) is impelled in order to maintain a focus on the actual on-site activities, only providing added value. This added value of tutorials is presented to the students by means of a second screen experience.

4:10 jLegends - Online Game to Train Programming Skills

Konstantinos Tsalikidis (Kavala Institute of Technology, Greece); George Pavlidis (ATHENA Research Center, Greece)

amification and in particular game-based learning is significantly gaining ground during the latest decades. It expresses a different approach to education that is mixing education with gaming, aiming to enhance the learning experience with game mechanics and rules and to provide stronger motivations for lifelong learning. The benefits of learning while playing have been illustrated by many works to this day. This work presents such a game-based approach that has been adopted and used in the development of an online multiplayer platform game, with a purpose to teach or train programming with JavaScript. In effect it is like what is usually called a serious game, or a game with a purpose. The game, jLegends, is online and available for everyone to train and test knowledge on programming and logic, within a role-playing gaming approach. jLegends is built with source-code scalability in mind, in order to be expandable or even become open-sourced in the future.

FC 006 Integrated Outreach Programs II

Chairs: Catherine Kruchten (University of Maryland, Baltimore County, USA), Matthew Morrison (University of Mississippi, USA)

2:55 +Heads in the Game: A STEM High School Concussion Outreach and Research Program

Matthew Morrison, Melinda Valliant, Dwight Waddell, *James M Robinson II, Lauren Woodard and George Humphrey (University of Mississippi, USA)

Participation in youth sports has a demonstrable impact on a young person's health, virtues, and educational success. Growing concerns about the impact of concussions on student athletes has driven a decrease in sports participation. Mississippi faces unique challenges in providing access to education and health care in impoverished and medically underserved communities. The Heads in the Game outreach and research program was developed

to motivate STEM education and empower students through their love of sports. Sixteen rising junior and senior scholars participated in a month-long program where they attended seminars on coding methodologies, biomedical and computer engineering, health and sports performance, concussion protocols and impact detection devices, applications in telemedicine, and principles and practices of scientific research methods. Heads in the Game scholars used the skills gained in order to perform research in student athlete healthcare. Scholars conducted interviews with athletic trainers, medical professionals, and coaches, and applied the skills learned in the seminars towards the development of a program for an improved athletics digital health information infrastructure. We objectively report the results of the student outreach process, seminars, research methods, research accomplishments, and how the scholars have applied what they learned in their communities. We also describe future plans for augmenting the developed curriculum with rural telemedicine and NASA's Human Research Program.

3:10 Using the Engineering Design Process as the Structure for Project-Based Learning: An Informal STEM Activity on Bridge-Building

Luciana R Barroso and Sandra B Nite (Texas A&M University, USA); James Morgan (Charles Sturt University, Australia); Ali Bicer, Robert M Capraro, and Mary M Capraro (Texas A&M University, USA)

The challenges posed by STEM education are highly complex and require the efforts of both formal and informal educational approaches. Informal settings allow for greater flexibility in integrating across the multiple STEM fields as well as allowing greater freedom for students to explore potential topics and skills within STEM. As such, informal STEM learning experiences not only develop a student's interest in STEM but also influence their identity as STEM learners. This paper presents and discusses a bridge design and construction Project-Based Learning (PBL) activity that was conducted as part of a two-week STEM camp run by Aggie STEM at Texas A&M University. The PBL was designed around a real-world scenario that the students could tackle in a smaller scale as an initial prototype solution. An engineering design process was utilized throughout the activity and students had multiple objectives to meet. As the problem had no single solution, students could safely be creative in their approaches and final solution, as they were not focused on finding the one right answer. Learning outcomes of the project were: 1. the reality of problems having multiple acceptable solutions; 2. the realization that existence multiple acceptable solutions does not mean that all solutions are acceptable; and 3. that there is room for creativity in meeting the design specifications with the allowed resources.

3:25 Billund Builds Music: An Engineering Education Initiative in Danish Kindergartens

Amanda L Strawhacker, Amanda Sullivan and Merredith Portsmore (Tufts University, USA)

In a recent educational initiative in Billund, Denmark, almost every student between the ages of three to eighteen years participated in Billund Builds Music, a one-week municipality-wide project to explore music and engineering by designing and creating musical instruments. This endeavor was a collaboration between the Tufts University Center for Engineering Education and Outreach (CEEO), the LEGO Foundation, and Billund's Capital of Children, and LEGO Foundation partner which represents children's voices in civic projects. Approximately 4,000 students and 300 educators from 10 schools across Billund took part in the project. This paper presents preliminary trends and findings from two participating Kindergartens. Results show that in this open-ended Danish Kindergarten setting, 3-5 year-old children were able to build musical instruments and play at least one unique sound on them.

3:40 Engineering and Health Curriculum for K-12 Education

Mridu Sinha, Amr Omar and Medhanie Tesfamariam (UCSD, USA); Yacob Astatke (Morgan State University, USA); and Todd Coleman (UCSD, USA)

In this paper, we introduce an engineering and health curriculum for K-12 students. The hands-on course introduces the students to human physiology and engineering concepts related to wearable health and lifestyle modification. The curriculum encourages students to identify a health related social problem relevant to their community and implement a feasible engineering solution. The low cost hands-on kit, "Funbox" that we put together for the course allows for scalability and easy adoption. The curriculum was piloted in conventional classroom setting at a local San Diego high school followed by several out-of class pilots in underrepresented communities. Here, we present the motivation, description and our experiences from the pilots.

FC007 K-12 STEM Curriculum and Programs

Chairs: Ralph Tillinghast (US Army & ARDEC, Picatinny Arsenal, NJ, USA) and Zhigang Zhu (The City University of New York, USA)

2:55 Dynamic Project-based STEM Curriculum Model for a Small Humanities High School

Chin-Sung Lin (Eleanor Roosevelt High School, USA); Zhigang Zhu (The City University of New York, USA); and Tony Ro (The CUNY Graduate Center, USA)

Reforming STEM education has been an urgent national call for both educational and economic reasons. For Eleanor Roosevelt High School, a small humanities high school in New York City, implementing a large-scale, school-wide STEM education is almost an unattainable goal due to limited STEM resources. However, we have developed a novel, dynamic project-based STEM curriculum model in the past five years. This model will provide students with in-depth exposure to computer science and engineering, broad and rigid training of innovative engineering problem solving, and independent research experience with challenging real-world problems. The curriculum has been vertically integrated over grades to create a cohesive learning experience and to maximize learning outcomes. It can dynamically evolve over time to reflect cutting-edge advancements in the STEM field. One of the most challenging steps in developing the STEM curriculum model is the creation of the 'Research & Development' (R&D) layer of the model. Fortunately, the NSF-founded Emerging Frontiers in Research and Innovation- Research Experience and Mentoring (EFRI-REM) summer program at The City College of New York provides inspirations and insights to these problems. Though this model has been developed in a small humanities high school, it can easily be scaled up or down for schools of various sizes and adopted by schools of different context and resource levels. Based on our experiences, we have further proposed a new STEM research paradigm for college-high school collaboration. This new paradigm will dramatically accelerate the renew rate of high school STEM curriculum and bring long-term impacts to both STEM education and industry.

3:10 It Lives! A STEAM-based In-Class Workshop for Promotion of Creative and Innovation Thinking

Lucinda Presley (IEEE Success Foundation, USA); Becky Carroll (Redwing Research, USA); Rob Gorbet (University of Waterloo, Canada)

As information, technology, and globalization expand exponentially, innovation and creative thinking skills have become vital. The It Lives! project is developing and testing models and curriculum that address the need for these thinking skills in students of all demographics by integrating formal and informal learning experiences. The classroom approach uses problem-based hands-on learning, integrating Art with traditional STEM domains, and is designed in collaboration with classroom teachers to be aligned with mandated curriculum. This paper describes the in-class workshop and reports on the results of pilots in three classrooms from Grade 5 to Grade 8 levels, in the U.S. and Canada. We find that the approach engages students and survey data show that students increase in a number of positive measures, notably their ability to connect art and creativity to engineering problem solving, their comfort and confidence with hands-on problem solving, and their appreciation for the importance of group work.

3:25 Motivating Students Through Providing a Middle School STEM Rotation Class

Maura Simister (Manchester Middle School, USA)

Today, STEM is taught, perceived, and practiced in many different ways. There is a need to design embedded curriculum that represents all of the disciplines of STEM. "The reason behind all of this is simple: if we do not design lessons and units that will strengthen students' commitment to learn, then we cannot expect them to take an active or in-depth approach to learning" (Silver & Perini, 2010, p.324). This will empower students to become conscientious and well-informed global citizens. All children, regardless of academic level, should be exposed to a STEM education in order to increase the diversity of students in STEM careers. "Lack of motivation is commonly recognized as a significant problem in American education" (Brophy, 2010, p.301) A classrooms social climate, the students' own expectations of their performance, and the value in which the student places on his education are the main issues that deter motivation in student. A dynamic classroom should be full of engaged students who are collaborating, communicating, and performing to solve relevant problems in which students can relate. This can be achieved when teachers reflect on how things work, or do not work, in the classroom. Gathering data and analyzing the results will help teachers to improve students' level of motivation. The teacher is the key component in creating an environment using appropriate strategies that will engage students to attain a growth mindset. In this paper, I will share how the results of a climate survey can empower me to regulate my learning activities and styles to provide my students with a STEM environment that is favorable to engagement and motivation.

3:40 Curriculum Development for Computing Education Academy to Enhance High School Students' Interest in Computing

Wook-Sung Yoo, Sameer Shaik, and Spoorthi Pattaparla (Fairfield University, USA)

Addressing the documented shortage of students in the United Sates choosing to enter computing and engineering fields, Computing Education Academy (CEA) was established at Fairfield University in 2013 to expose the high school students to key computing concepts and basic computer programming through hands-on activities and to motivate students to enter post-secondary education and career opportunities in computing. Curriculum of CEA was developed with 24 class modules combined with lecture and lab activities providing basic computing skill development in first semester and Android App development in second semester. Based on the survey results after the completion of CEA in 2013-4, additional class modules combining Arduino circuit design and Android App Development components were added in the first semester CEA curriculum to help students better prepared for second semester. Survey results indicated obtaining higher levels of understanding of computing and mobile development through CEA. Details of CEA curriculum and evaluation results are described and future enhancement is suggested.

3:55 Beyond Marshmallow Towers and Toothpick Bridges: Progress and Strategies for a Whole-School STEM Program

Melvin Goodwin III, Jacqueline G Healy, Kristen Jacksa and James Whitehair (Laing Middle School of Science and Technology, USA)

This paper describes strategies and activities that have been used in a Whole-School STEM Initiative at Laing Middle School of Science and Technology in Mount Pleasant, SC to bring hands-on STEM experiences into every subject in the school's curriculum. A key feature of this program is an emphasis on problem-solving with STEM tools, as opposed to emphasizing specific content of the STEM disciplines. Examples include descriptions of activities that have been used in English language arts, social studies, and science classes, as well as how the engineering design process can be used in every class as part of daily instruction.

Industry and Professional Community Workshop Sessions - I

Room: FC 008
Chair: Katalin Frolio (Linearizer Technology, USA)

11:00 Building collaborative relationships between school day and afterschool programs
Mike MacEwan (NJSACC, USA)
Afterschool programs provide a natural space to support and supplement student learning that occurs during the school day. This interactive workshop will provide information about the current state of STEM in afterschool programs, discuss collaborative relationship building strategies and explore some existing STEM resources that have been created specifically for afterschool programs.

11:45 IEEE Educational Activities Board (EAB) Pre-University Activities
Nagi Naganathan (Avago Tech, USA)
This talk will feature informal STEM education activities sponsored by the IEEE Educational Activities Board.

Industry and Professional Community Workshop Sessions - II

Room: FC 008
Chair: Nagi Naganathan (Avago Tech, USA)

1:30 MathWorks Demonstration
Akash Gopisetty (MathWorks, USA)

MATLAB is used on more than 5000 universities and schools world-wide. MATLAB combines math, graphics, and programming in an environment that is easy to use and get started. It is used by millions of engineers and scientists to solve challenging real world problems. Learn about how you can use MATLAB to accelerate the pace of STEM discovery and learning.

FC 004 Special Session

Chairs: Susan Donohue (University of Virginia, USA) and Vignesh Subbian (University of Cincinnati, USA)

2:55 Looking ahead to ISEC '17: Resources for STEM Integration

Industry and Professional Community Workshop Sessions - III

Room: FC 008
Chair: Nagi Naganathan (Avago Tech, USA)

2:55 IEEE Sponsored Coding Clubs in NJ Public Schools
Jyoti Sharma (NOKIA & IEEE WIE Chair North NJ, USA)
One of the most important 21st-century skills that the K-12 students need in colleges and during their careers is the ability to program or code. These skills are currently not being taught as part of the regular school curriculum in most of the public schools. We addressed the need to expose the kids to different programming languages in a Northern New Jersey Public School in Millburn. The Coding Club is sponsored by the North New Jersey Section of the IEEE and has been made possible due to the active participation and joint collaboration of the IEEE members, K-12 School Administrators, K-12 School teachers, University Professors and Graduate students. We currently have 120 students in grades 4-12 enrolled in the program and more than 300 students on the waitlist. The elementary kids are learning Scratch and the Middle and High School kids are being taught Java Programming. The club runs for 8 weeks and students meet once a week for one hour to learn Coding language taught by the Graduate students and IEEE volunteers. In this workshop, we discuss the key takeaways from organizing a Coding Club for students in Grades K-12 and future plans to expand the clubs.

The Integration of Arts Education With STEM and Its Effect on Attitudes Towards STEM

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

The purpose of this project was to compare STEM and STEAM education, and was built on previous work that aimed to involve students ages 11-13 in a fun and engaging course — integrating LEGO Mindstorms Robotics (NXT), the LeJOS software (Java), an online Learning Management System (LMS) — and inspire them to pursue STEM courses and careers. The current work aims to determine whether the addition of arts education aids and enhances the STEM learning process, interest in STEM careers, and pursuit of higher STEM learning. This was determined by surveying students about the influence of art education on the aforementioned topics.

Phytoplankton Air Pollution Neutralizer

Arijit Dutta and Andrew Hu (Bridgewater Raritan High School, USA)

Air pollution has been a growing problem in today's world. This will continue to exacerbate the amount damage dealt to the environment as more and more fuels are burnt to satisfy the growing population. In order to solve this problem, we decided that we must create a cost effective machine that will sufficiently convert polluted air into clean and fresh air. Our poster consists of namely a potential real machine, a mini model, and an experiment. Potential Real Machine: The real machine was created to show what our machine would look like ideally with the funding we would need to make it. We included the materials of the real model, the cost of the materials, and the instructions on how to make the machine. Mini Model: We created a mini model to show an example of what the actual machine should resemble. We included the materials needed for the model and instructions on how to make it. Experiment: We conducted an experiment on whether the amount of phytoplankton affects the amount of oxygen produced. This information will help us when determining the amount of phytoplankton put into the real and mini model. We chose phytoplankton because it produces 70% of the world's oxygen and they reproduce quickly.

How Long Would It Take to Evolve a Dragon? Computational Estimation of Time Lengths Needed to Evolve a Species into Another

Daria Chaplin, Kris Cho, Jan Cygan, Evan George, Bach Nguyen, Alex Pirc and Carol Reynolds (Vestal High School, USA); and Hiroki Sayama (Binghamton University, USA)

The objective of this research project is to develop an algorithm that can calculate the estimated evolutionary time for existing species to evolve into another form, using a multivariate regression model applied to the data of currently or previously existing species. We selected several animal species to serve as reference points, each of which was mapped onto a specific point in a "feature space" that we defined based on the species' body systems and attributes. A few examples include jawless fish, placoderms and lungfish. We also collected data about how many years the evolution took between those points in the feature space. We are currently developing a simple linear multivariate regression model from these data sets, assuming that all environmental conditions are ideal for evolution and that the effects of each attribute on the evolutionary time is independent. Once the model is completed, we will apply it to estimate the evolutionary time required to evolve a species like a Komodo dragon to a "true" dragon, which we define as a four-legged species with a tail, two wings, with the ability to fly. To the best of our knowledge, no existing literature has given such an estimate yet.

Engineering Brightness: Using STEM to Brighten Hearts and Minds

Ian Fogarty (Riverview High School, Canada) and Tracey Winey (Preston Middle School, USA)

Students designed and built lights for global students who did not have access to reliable clean light and as a result, could not study after sunset. UNESCO estimates 1.5B people worldwide do not have access to clean light and that has major negative ramifications towards the Millennial Goals for Education. School could be used to educate not only the students who are receiving lights, but also the students who are engineering the lights. Primary, middle and high school students from Colorado, Canada and the UK, collaborated in the designing process and produced different light designs to solve real problems for real people. The Colorado Lantern was a 3D printed plug-in rechargeable light designed by Preston Middle School. The Riverview High School Podium and Clam lights were 3D printed table top solar rechargeable lights. The Pheasey Park Elementary and RHS collaboration yielded a few versions of a wearable light. Engineering Brightness, Philanthropic Engineering's (http://p-e.io) flagship project, aims to deliberately engineer brightness on many different fronts including: * in the rooms of studying students all over the world who otherwise do not have access to clean light. * in the minds of students who bring many skills and aptitudes to bear in the design and production of lights. * in the hearts of students who use their learning to impact

the lives of others. The project provided novel motivation for studying. If the work was mediocre, it was much more devastating than a poor mark, as someone else's life was negatively impacted. The work superseded a grade and survived being thrown out at the end of the semester. We are proud to be leaving a legacy, and plan to keep participating, even after we move on to another school. Our work has been featured in a documentary, numerous television news articles, the front page of NSTA and asked to present at WeDay Alberta. As students, we would like to present the design evolution, our current prototypes, the impact we are making in nine countries and our future plans to recruit more schools to help engineer brightness around the world.

Programming for Girls

Ceren Konak (Linden Hall, USA)

Many women are not in Information Technology careers for multiple reasons. We wanted to create a workshop that targeted middle school girls who do not have many opportunities to learn computer programming. We decided that having female high school and college students with help teach this workshop would allow them to inspire and better connect with the middle school students. For our workshop, we used Scratch- programming language since it is very user friendly and it does not require prior knowledge of computer programing to use it. Many of the girls came into the workshop with less confidence with using technology and less interest in pursuing technology related careers than the boys. For our workshop, we taught the students different parts of Scratch by showing them the function of each part and asking them to create a mini project from what they learned. After we got through the important aspects of Scratch, we asked the students to create their own game. Despite the girls thinking that their experience in using technology was much less than the boys, by the end of the workshop the girls created games that the boys could not. Thereby, the girls realize that programming can be fun and just because they are girls doesn't mean that Information Technology jobs are not for them.

Methods of Repurposing Heat

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

This paper intends to explore the repurposing of waste heat for consumer use. Cogeneration has already been well established in big industry for well over half a century - yet to this day, waste heat generated by consumers remains untapped. Cogeneration is based on the the law of conservation of energy: that energy can neither be created nor destroyed, but it can be converted between different forms. In this specific experiment, our focus is primarily on the conversions between heat energy and electrical energy. Efforts have been made using Peltier elements, which operate based on the Peltier effect: "an effect whereby heat is emitted or absorbed when an electric current passes across a junction between two materials." Most of these efforts however have been concentrated in refrigeration technology and on the Seebeck effect: "a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances." In essence, the focus has been on thermoelectric cooling and heating rather than power generation. Through testing the effectiveness of the Peltier elements to convert waste heat emitted by common household objects such as computers and power adapters, we have demonstrated the potential of these devices. This practical implementation of Peltier elements is an application of modern physics which hopefully through further work reaches a point where it can impact people's daily lives.

Similarities Found in Neurological Disorders Based on Mutated Genes

Amanda Chen and Melanie Mendoza (Newburgh Free Academy, USA), and Lori Sheetz (United States Military Academy at West Point & Network Science Center, Center for Leadership and Diversity in STEM, USA)

According to the UN World Health Organization, nearly one in every six of the world's population is affected by a neurological disorder. This research study focused on neural networks and analyzed the connections between neurological disorders defined by similar single nucleotide polymorphisms (SNP). By utilizing The Genome-wide Associ-ation studies, SNPs associated with a select group of neurological disorders were generated. Drug molecules that target these SNPs were gathered from the DrugBank. The results showed that Schizophrenia and Bipolar disorder were the most genetically similar based on the SNPs associated with them. Also, Schizophrenia had the highest number of SNPs associated with it as well as the highest betweenness rank. The gene TRNAI25 was the gene found among four of the disorders and it is implicated in various biological roles such as coding, decoding, regulation, and expression of genes. The drug, Felodipine, targets two SNPs, one associated with Schizophrenia and the other with Bipolar Disorder. Neurological disorders are being visualized through patient CT or MRI scans; however, this study focused on the shared SNPs in different neurological disorders generated from

preexisting data. With this project, genetic similarities were found within a select group of neurological disorders and may further biological research in neurological disorders through the use of network science.

Design of Luminosity Sensor Experiment on a CubeSat Satellite for Middle and High School Students

Turner Bumbary (8th Grade Student - Rachel Carson Middle School, USA) and Jennifer Maybury (Rachel Carson Middle School - Fairfax County Public Schools, USA)

The poster is a description of a project to design, test, and run an experiment in space (Low Earth Orbit - LEO) on a CubeSat satellite launched by Spire Corporation in September 2015. Ardusat and the Association of Space Explorers sponsored a national contest to select fifteen schools to invent, create, and explore running custom experiments in space. Rachel Carson Middle School (Fairfax County Public School in Virginia) was awarded the opportunity to run two experiments (in January and March 2016) on the Lemur Satellite. The experiment will use the Lemur Luminosity Sensor to measure different frequencies and strength of infrared and ultraviolet light in space. The purpose of the experiment is to understand how light is affected by distance and spectrum of light in space. The data collected will be used to support satellite-to-satellite communication for a mesh space communication network for an array of multiple CubeSat satellites. The multiple satellites could use light communication as an out-of-band (non-Radio Frequency) communication network. The advantage of using infrared light communication is the high bit rates and low error rates. Data collection on useful distance and interference will be analyzed to determine the best light wave pulses and acceptable angles for the luminosity sensor to capture data adjusting for sensitivity. Data will be captured four times per hour over fifteen days to determine the different bands and wavelengths of light in space. Based on the data, the best bands (e.g. H, J, K, L, M bands) will be determined for satellite-to-satellite light communications. The team will attempt to determine a CubeSat constellation appropriate for a mesh network of satellites in low earth orbit. The model will attempt show the elimination of latency in communications while determining the minimum number of satellites needed to provide coverage of CubeSat in LEO.

Relationship between the Musculoskeletal System and High School Sports Injuries

Davie Mariano (Newburgh Free Academy, USA) and Lori Sheetz (United States Military Academy at West Point & Network Science Center, Center for Leadership and Diversity in STEM, USA)

With participation in high school sports rising, the amount of injuries sustained to high school athletes have increased. As a way to prevent injuries of high school athletes, this study sought out to investigate the attributes to a sports injury, the common injury sites for each individual male and female sports and the muscle that should be strengthen the most in order to prevent an injury to occur. This project utilizes AnNA (anatomical network analysis) to show the relationships between the musculoskeletal system and high school sports injuries. An injury was defined as trauma to the musculoskeletal system. The study focused on the synovial joints of the human body, so head injuries were not accounted for. To do this we collected information from three data sets and constructed three networks. The results showed that there are more attributes than just the amount of muscle and bones are present at an articulation to account for a sports injury, most common injury sites in female sports was the ankle, but varied in male sports, and the gastrocnemius muscle should be strengthen the most. The results also showed that the anatomical differences between males and females play a huge role in where the common injury sites for male and female sports are.

Protein Association and Nucleotide Sequence Similarities Among Human Alpha Papillomaviruses

Jessica Asante, Destini McMillan and Juan Peticco (Newburgh Free Academy, USA), and Lori Sheetz (United States Military Academy at West Point & Network Science Center, Center for Leadership and Diversity in STEM, USA)

Human papillomavirus, HPV, is one of the most common sexually transmitted infections in the world, accounting for 50 to 55 percent of all cervical cancers. It is an 8000 base pair latent virus that infects stratified epithelial cells.The Human Papillomavirus Alpha genus strains that contain E5 proteins were compared by E5 protein subtype to depict which E5 proteins are found in cancerous and or noncancerous strains. This research also identifies the nucleotide sequence similarity percentages of the cancerous and noncancerous strains of the Human Papillomavirus Alpha genus. The raw data, which includes the nucleotide sequences and the protein content of the strains, was obtained from the website PaVE: Papillomavirus Genome Database. The E5 Protein Association Network and the Nucleotide Sequence Similarity Percentage Network visualizations were created on ORA using adjacency matrices. The E5 Protein Association Network demonstrates that the E5 alpha protein is the only protein encoded by the cancerous strains, and the majority of the noncancerous strains contain the E5 beta protein. The Nucleotide

Sequence Similarity Percentage Network illustrates that clusters formed after filtering out all links less than 70 percent similarity, clusters which contain both cancerous and noncancerous nodes. This indicates that malignancy is not a trait based solely on nucleotide sequence or protein content. This research supports the claim that malignancy of Human Papillomavirus Alpha strains is determined solely by neither protein association nor nucleotide sequence.

4th Family STEM Program Sports Science

Anthony Prato, Hunter Best and Isaiah Scurry (4th Family, Inc., USA), and John Drazan (Rensselaer Polytechnic Institute & 4th Family Inc., USA)

The adolescents of our society are showing a declining interest in the disciplines of math and science. Science carries an almost negative perception amongst the youth of today. This phenomenon is especially apparent in our community: Albany, New York. Our goal was to spark interest in STEM fields within inner city kids. We related sports -a very popular topic with the kids- to science. This showed them that science is fun when you can apply it to something you're interested in. Our personal motivations for doing this stemmed from a want to give back to our community. We wanted to make the wonders of science readily available to kids coming up through the local public school systems. Ultimately, we wanted to make our community a better place when we were finished.

Hillsborough High School iSTEM Club Quadcopter

Peter Doroshenko, Anthony Hebert, Arjun Khare, Chitra Parikh, Connor Sweeney, Jay Medapara, Madison Marrocco, Angela Pandit, and Jerry Silver (Hillsborough High School, USA)

Hillsborough High School's iSTEM club has been designing and building a quadcopter from component parts. The project began in March 2015 and is projected to end in March of 2016. Students planned the project and the club purchased necessary items such as a power distribution board, receiver, controller board, battery and charger, pumps, motors and propellers. The iSTEM club is supported by our advisor, Mr. Silver from the high school and Dr. Naganathan from the IEEE. The quadcopter is powered by lithium batteries that deliver power by pulse width modulated controllers. The team assembled the mechanical parts and then mounted the brushless motors and controller board. Next, we will test the functioning of the system on the ground with propellers removed. This will be followed by flight tests. Students learned system design, electrical and mechanical assembly, and most importantly how to work on a complex project together. Students learned how to solder electrical connections and to procure the necessary components. One student took responsibility to track all expenses on a spreadsheet. The quadcopter is assembled and ready to test.

Notes

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Save the Date!

7th IEEE Integrated STEM Education Conference

Saturday, March 11, 2017

Princeton University