APS March Meeting 2016
Baltimore, Maryland
http://www.aps.org/meetings/march/index.cfm
Tuesday, March 15, 2016 11:15AM - 2:15PM –
Session F14 FEd: Integration of Research and Teaching Excellence: Cottrell Scholars 310 -
Richard Wiener, Research Corp

11:15AM F14.00001 From Particle Physics to Education: The Role of Tinkering MATS SELEN, Univ of Illinois — Urbana — The love of tinkering is perhaps the single most universal trait among scientists. From designing an experiment to building a computer application to solving a differential equation, the cycle of “observe - explain - test - revise” is at the root of the scientific creative process. Driven by the love of tinkering, we have developed a small low-cost wireless lab system with the goal of putting real scientific instrumentation in the hands of anyone with a desire to innovate and explore. I will describe how this came about and how it has changed our view of introductory physics labs at the University of Illinois.

11:51AM F14.00002 Excellence and Diversity in Physics, and the Quest for Other Worlds, KEIVAN STASSUN, Vanderbilt Univ — A major concern for American competitiveness today is the full engagement of US citizens in the STEM enterprise. Of particular concern is the ongoing under-representation of African Americans, Hispanic Americans, and Native Americans, who comprise 35% of the US college-age population but only 2% of physical science PhDs awarded in the US. Since 2004, with initial funding from an NSF CAREER grant and then from a Research Corp Cottrell Scholar award, the Fisk-Vanderbilt Masters-to-PhD Bridge Program has attracted 98 students, 79 of them under-represented minorities, 50% of them women, and with a PhD retention rate of 90%. Fisk has become the top producer of Black U.S. recipients of the master’s degree in physics, and Vanderbilt has become the top research university to award the PhD to under-represented minorities in physics, astronomy, and materials science. Among the many “fIrsts” of the program are: the first member of the Sioux Nation to earn an advanced physics degree, the first Native Hawaiian woman to receive the prestigious NSF Graduate Research Fellowship, the first African American to receive NASA’s top Hubble Postdoctoral Fellowship, and the first African American woman to publish an astronomy paper as first author in the prestigious journal Nature. Indeed, this latter example represents the groundbreaking discovery that the sizes and ages of stars—and therefore the sizes and ages and compositions of the planets that orbit those stars—are measured directly and accurately via the “flicker” of the stars’ light. This discovery has transformed the ability of astronomers to understand the physical nature of the exoplanets that are now being found by the thousands around distant stars.

12:27PM F14.00003 Undergraduate research: A win-win for both students and faculty†, TOM SOLOMAG, Bucknell University — Undergraduate students benefit significantly from opportunities to do research with faculty, both at predominately undergraduate institutions (PUIs) and also at major Research I universities. If done well, these research opportunities can also benefit the faculty mentor, especially at PUIs with heavy teaching loads. In fact, the experience works best for the student if it also benefits the faculty. In this talk, I will discuss my experiences working with undergraduate research students, some of whom have been as productive as advanced graduate students. I will discuss situations where things have worked very well for everyone concerned, as well as some mistakes that I made in the past that resulted in bad research experiences. This discussion will be provided in the context of an experimental program in nonlinear dynamics, a field that is well-suited to participation by undergraduates.

†Supported by NSF Grants DMR-1361881 and PHY-1156964.

1:03PM F14.00004 Interdisciplinary biophysics major with a comprehensive research-based capstone, RAE ANDERSON, University of San Diego — No abstract available.

1:39PM F14.00005 Untypical Undergraduate Research: Player Motion Analysis in Sports, DINAH LOERKE, University of Denver — There is significant concern about the degree of attrition in STEM disciplines from the start of K-12 through to the end of higher education, and the analysis of the “leaky pipeline” from the various institutions has identified a critical decline - which may be as high as 60 percent - between the fraction of students who identify as having an interest in a science or engineering major at the start of college/university, and the fraction of students who ultimately graduate with a STEM degree. It has been shown that this decline is even more dramatic for women and underrepresented minorities (Blickenstaff 2005, Metcalf 2010). One intervention which has been proven to be effective for retention of potential STEM students is early research experience, particularly if it facilitates the students’ integration into a STEM learning community (Graham et al. 2013, Toven-Lindsey et al. 2015). In other words, to retain students in STEM majors, we would like to encourage them to ‘think of themselves as scientists’, and simultaneously promote supportive peer networks. The University of Denver (DU) already has a strong undergraduate research program. However, while the current program provides valuable training for many students, it likely comes too late to be effective for student retention in STEM, because it primarily serves older students who have already finished the basic coursework in their discipline; within physics, we know that the introductory physics courses already serve as gatekeeper courses that cause many gifted but ‘non-typical’ students to lose interest in pursuing a STEM major (Tobias 1990). To address this issue, my lab is developing a small research spinoff program in which we apply spatiotemporal motion analysis to the motion trajectories of players in sports, using video recordings of DU Pioneer hockey games. This project aims to fulfill a dual purpose: The research is framed in a way that we think is attractive and accessible for beginning students who have not yet finished the basic physics course sequence, and we hope to use it to attract untypical and retain undecided students in physics. Secondly, since mathematical techniques for trajectory analysis are independent of scale, we hope to harness the creativity and analytical intuition of undergraduates to simultaneously benefit our core biophysical research program.

Tuesday, March 15, 2016 2:30PM - 5:30PM –
Session H14 FEd: Reichert Award 310 - Tim Stelzer, Univ of Illinois - Urbana

2:30PM H14.00001 Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction: Advanced Instructional Labs: Why Bother? VAN BISTROW, University of Chicago — What are we teaching about physics in the traditional lecture course? Plenty! By offering the Advanced Laboratory Course, we hope to shed light on the following questions: How do we develop a systematic process of doing experiments? How do we record procedures and results? How should we interpret theoretical concepts in the real world? What experimental and computational techniques are available for producing and analyzing data? With what degree of confidence can we trust our measurements and interpretations? How well does a theory represent physical reality? How do we collaborate with experimental partners? How do we best communicate our findings to others? These questions are of fundamental importance to experimental physics, yet are not generally addressed by reading textbooks, attending lectures or doing homework problems. Thus, to provide a more complete understanding of physics, we offer laboratory exercises as a supplement to the other modes of learning. The speaker will describe some examples of experiments, and outline the history, structure and student impressions of the Advanced Lab course at the University of Chicago Department of Physics.
3:06PM H14.00002 Investigating Student Ownership of Projects in Upper-Division Physics Laboratory Courses

JACOB STANLEY, University of Colorado - Boulder — In undergraduate research experiences, student development of an identity as a scientist is coupled to their sense of ownership of their research projects. As a first step towards studying similar connections in physics laboratory courses, we investigate student ownership of projects in a lasers-based upper-division course. Students spent the final seven weeks of the semester working in groups on final projects of their choosing. Using data from the Project Ownership Survey and weekly student reflections, we investigate student ownership as it relates to students’ personal agency, self-efficacy, peer interactions, and complex affective responses to challenges and successes. We present evidence of students’ project ownership in an upper-division physics lab. Additionally, we propose a model for student development of ownership through cycles of frustration and excitement as students progress on their projects.

1This work was supported by NSF grant nos. DUE-1323101 and DUE-1334170.

3:42PM H14.00003 8 Years of ALPhA’s Impacts / 45 Years of Developing Experimentalists with Few Resources: A Talk in Two Parts

LOWELL MCCANN, Univ. of Wisconsin - River Falls — In 2007, faculty with a shared interest in the health of advanced physics laboratory courses (those offered beyond the first year of college) created ALPhA, the Advanced Laboratory Physics Association. Over the past 8 years, ALPhA activities have involved faculty from a sizeable fraction of the physics departments in the United States. In the first part of this talk, I will overview ALPhAs efforts and its impact. In the second part of the talk I will discuss the advanced laboratory curricula at the University of Wisconsin River Falls, which was developed over several decades with minimal resources for maximum impact.

1Supported by NSF grant DUE-1122993.

4:18PM H14.00004 Student-Driven Engagement: An Interdisciplinary-Team Research-Learning Renewable Energy Laboratory Experience for Undergraduates

MARK TUOMINEN, University of Massachusetts Amherst — How does engagement and deep learning happen? Every science department seeks to cultivate an excellent level of scientific skills and knowledge in its undergraduate students. Yet, this is not sufficient to thrive as a professional. Engaging directly in real-world challenges can foster a professional mindset: a high level of self-efficacy, a genuine sense of relevance, and proactivity. This talk will describe pedagogical developments of a junior-year renewable energy laboratory course at the University of Massachusetts Amherst that is part of a four-year Integrated Concentration in Science (iCons) program. Over the four years, the interdisciplinary iCons students—from 24 various majors—work through case studies, selection and analysis of real-world problems, inception and development of potential solutions, integrative communication, experimental practice, and capstone research. The team dynamic is a central aspect of the experience, yielding significant educational and developmental benefits. The third-year energy course uses adopts a culture of a small vibrant R&D team, in which significant contributions are made by students to the class. Projects in the spring, 2014 Optics course included experiments with ultracold lithium atoms in a magneto-optical trap, optical tweezers, digital holography and adaptive optics. Projects in the spring, 2015 Lasers course included ultrafast optics with a mode-locked erbium fiber laser, quantum optics, surface plasmon lasers (led by Nathan Lindquist) and a low-cost, near-infrared spectrometer. Several of these projects are related to larger scale, funded research in the physics department. The format and experience in Lasers and Optics is representative of other upper-level courses at Bethel, including Fluid Mechanics and Computer Methods. A physics education research group from the University of Colorado evaluated the spring, 2015 Lasers course. They focused on student experimental attitudes and measurements of student project ownership.

Wednesday, March 16, 2016 11:15AM - 2:15PM — Session L14 FEd: Impacts and Experiences with Hybrid and Online Courses

310 - Michael Schatz, Georgia Institute of Technology

11:15AM L14.00001 Fully On-line Introductory Physics with a Lab

MICHAEL SCHATZ, School of Physics, Georgia Institute of Technology, Atlanta, GA, USA — We describe the development and implementation of a college-level introductory physics (mechanics) course and laboratory that is suited for both on-campus and on-line environments. The course emphasizes a You World is Your Lab approach whereby students first examine and capture on video (using cellphones) motion in their immediate surroundings, and then use free, open-source software both to extract data from the video and to apply physics principles to build models that describe, predict, and visualize the observations. Each student reports findings by creating a video lab report and posting it online; these video lab reports are then distributed to the rest of the class for peer review. In this talk, we will discuss the student and instructor experiences in courses offered to three distinct audiences in different venues: (1) a Massively On-line Course (MOOC) for off-campus participants, (2) a flipped/blended course for on-campus students, and, most recently, (3) a fully-online course for off-campus students.

11:51AM L14.00002 A Flipped Pedagogy for Expert Problem Solving

DAVID PRITCHARD, MIT — The internet provides free learning opportunities for (Wikipedia) and procedural (Kahn Academy, MOOCs) knowledge, challenging colleges to provide learning at a higher cognitive level. Our “Modeling Applied to Problem Solving [T] pedagogy for Newtonian Mechanics imparts strategic knowledge — how to systematically determine which concepts to apply and why. Declarative and procedural knowledge is learned online before class via an e-text, checkpoint questions, and homework on edX.org (see http://relate.mit.edu/physicscourse); it is organized into five Core Models. Instructors then coach students on simple "touchstone problems", novel exercises, and multi-concept problems - meanwhile exercising three of the four C's: communication, collaboration, critical thinking and problem solving. Students showed 1.2 standard deviations improvement on the MIT final exam after three weeks instruction, a significant positive shift in 7 of the 9 categories in the CLASS, and their grades improved by 0.5 standard deviation in their following physics course (Electricity and Magnetism).


Online activities to optimize in person learning. TIM STELZER, Univ of Illinois - Urbana — Students' unprecedented access to content on the web is providing a unique opportunity to transform the role lectures in education, moving the focus from content delivery to helping students synthesize the content into knowledge. We have introduced a variety of activities to facilitate this transformation at the University of Illinois, including web-based preflight assessments of student understanding before lecture, peer instruction (clickers) to assess and facilitate student understanding during lecture, and web-based multimedia pre-lectures designed to provide students with content before lecture. In this talk I will discuss the pedagogical motivation for introducing these activities, and the impact they have had at the University of Illinois.

Lessons from two decades of hybrid and online physics courses at Michigan State University, GERD KORTEMeyer, Michigan State University — In Fall 1992, at Michigan State University we first offered online homework to one section of an introductory physics course; students received randomized assignments as printouts and entered answers through Telnet sessions, frequently using text terminals. Now, over two decades later, all of our introductory physics courses have significant online components, and students can choose between different formats, including hybrid courses with free online textbook materials, as well as courses that are completely online. What have we learned over the years about which formats are most effective for which students? What are the respective learning outcomes? Which logistical models work best for homework, exams, videos, and textbook materials? What about academic integrity? In our talk we will reflect on how our courses have been developing over the years, report educational research results, relate anecdotes and experiences, and point out pitfalls that we have encountered.

Apples vs. Oranges: Comparison of Student Performance in a MOOC vs. a Brick-and-Mortar Class, MICHAEL DUBSON, University of Colorado at Boulder — In the fall of 2013, my colleagues and I taught the calculus-based introductory physics course to 800 tuition-paying students at the University of Colorado at Boulder. At the same time we taught a free massive open online version of the same course (MOOC), through Coursera.com. The initial enrollment in the MOOC was 10,000 students, of whom 255 completed the course. Students in both courses received identical lectures with identical embedded clicker questions, identical homework assignments, and identical timed exams. We present data on participation rates and exam performance for the two groups. We find that the MOOC is like a drug targeted at a very specific population. When it works, it works well, but it works for very few students. This MOOC worked well for older, well-educated students, who already had a good understanding of Newtonian mechanics.

From Start to Finish: Retention of Physics Undergraduates, DONNA HAMMER, TIM UHIER, University of Maryland — The University of Maryland Physics Department's NSF Scholarships in Science Technology, Engineering and Mathematics (S-STEM) project is a unique program that aims to reduce the attrition of students that occurs in the “pre-major-to-major” gap — i.e., students who begin at the university intending to study physics, but do not graduate with a physics degree. To increase the retention of admitted students, the UMD S-STEM program is designed to provide student with financial assistance, a strong sense of community, academic support, and career planning. We will discuss how the program has been integrated into the curriculum and culture of the physics department, and focus on developing key components of the program: a nurturing environment, dedicated mentorship, early research experience, and professional development.

A Brick-and-Mortar Class, MICHAEL DUBSON, University of Colorado at Boulder — In the fall of 2013, my colleagues and I taught the calculus-based introductory physics course to 800 tuition-paying students at the University of Colorado at Boulder. At the same time we taught a free massive open online version of the same course (MOOC), through Coursera.com. The initial enrollment in the MOOC was 10,000 students, of whom 255 completed the course. Students in both courses received identical lectures with identical embedded clicker questions, identical homework assignments, and identical timed exams. We present data on participation rates and exam performance for the two groups. We find that the MOOC is like a drug targeted at a very specific population. When it works, it works well, but it works for very few students. This MOOC worked well for older, well-educated students, who already had a good understanding of Newtonian mechanics.

Explaining the Gender Gap: Comparing Undergraduate and Graduate/Faculty Beliefs about Talent Required for Success in Academic Fields, KIMBERLY BAILEY, AMPALAVANAR NANTHAKUMAR, SCOTT PRESTON, CAROLINA C. LIIE, State University of New York at Oswego — Recent research has proposed that the gender gap in academia is caused by differing perceptions of how much talent is needed to succeed in various fields. It was found that, across the STEM/non-STEM divide, the more that graduate students and faculty see success in their own field as requiring as requiring talent, the fewer women participate in that field. This research examines whether undergraduate students share these attitudes. If these attitudes trickle down to the undergraduate population to influence students to choose different fields of study, then undergraduate beliefs should reflect those of graduate students and faculty. Using a large survey of undergraduates across the country, this study aims to characterize undergraduate attitudes and to determine variables that explain the differences between the attitudes of these two populations. Our findings suggest that the two populations have similar beliefs, but that undergraduate beliefs are strongly influenced by information about the gender ratio in each field and that this strong influence greatly differs between STEM and non-STEM fields. These findings seek to help direct future research to ask the right questions and propose plausible hypotheses about gender the imbalance in academia.

Perception, Attitude and Instructional Preferences on Physics in High School Students: An Exploration in an International Setting, MINI NARAYANAN, ABDUL GAFOOR, Department of Education, Calicut University, India — Questionnaire survey explored perception, attitude and instructional preferences with respect to gender and nationality in high school students of India and USA, a sample of 1101 Indian and 458 US students. Descriptive Statistics techniques were adopted for analysis. Male and female students in USA were at the high and low ends of the spectrum, respectively, in perception and attitude. Preference on instructional strategies was found to be independent of nationality, exposed strategies, opting science, class size and facilities. Responses from both countries indicate preference for an integrated instructional strategy that has strong teacher involvement in a student-centered framework. A thoughtful and properly designed instructional strategy could provide sufficient elements in modifying students epistemological beliefs. Understanding the nature and process of physics along with a better learning outcome is usually not possible by administering student-centered or teacher-centered strategies alone in their purest form. This study provides adequate support in obtaining two equally significant but contrasting goals in Physics Education Research, to gain conceptual development with increased interest and attainment in learners, through integration.

Supported by NSF PIRE and CAREER programs, Maryland Space Grant Consortium, and UMD Departments of Physics and Astronomy
8:48AM R7.00005 Examining the Needs and Dispositions of Sumter School District High School Students with Regards to Studying Physics, Part 1, JESSICA KOHLER, University of South Carolina Sumter — Out of a total student population of 4740 in the Sumter School District (SSD) in Sumter, SC, only 167 were enrolled in a physics course in Spring 2015. That was 3.52% of the total student population in the district. As advised by Lori Smith, Coordinator of Science and Fine Arts of SSD, enrollment in physics courses was insufficient. Since physics is the basis of all sciences and a prerequisite for engineering courses, not having enrolled and succeeded in a physics course during high school could impede a student's success in such majors during college. This project aimed to examine the needs and dispositions of high school students in SSD with regards to studying physics by exploring the reasons behind their decisions to enroll or not enroll in a physics course during their high school careers. The project also found out how they believe their physics classes could be improved. This was achieved by conducting an electronic survey among voluntary participants from the seniors. A quantitative analysis of the results is presented. These results are intended to help to improve the physics program in SSD as well as shape the University of South Carolina Sumter's outreach efforts in the local high schools to encourage students to enroll in college physics courses.

"Examining the Needs and Dispositions of Sumter School District High School Students with Regards to Studying Physics, Part 1",
"Examining the Needs and Dispositions of Sumter School District High School Students with Regards to Studying Physics, Part 2",
and
"Examining the Needs and Dispositions of Sumter School District High School Students with Regards to Studying Physics, Part 3"
in this consecutive order. Please also schedule us for the latest time possible on Friday, 3/18/2015.

9:12AM R7.00007 Examining the Needs and Dispositions of Sumter School District High School Students with Regards to Studying Physics, Part 3, HUI-YIING CHANG, University of South Carolina Sumter — Out of a total student population of 4740 in the Sumter School District (SSD) in Sumter, SC, only 167 were enrolled in a physics course in Spring 2015. That was 3.52% of the total student population in the district. As advised by Lori Smith, Coordinator of Science and Fine Arts of SSD, enrollment in physics courses was insufficient. Since physics is the basis of all sciences and a prerequisite for engineering courses, not having enrolled and succeeded in a physics course during high school could impede a student's success in such majors during college. This project aimed to examine the needs and dispositions of high school students in SSD with regards to studying physics by exploring the reasons behind their decisions to enroll or not enroll in a physics course during their high school careers. The project also found out how they believe their physics classes could be improved. This was achieved by conducting an electronic survey among voluntary participants from the seniors. A quantitative analysis of the results is presented. These results are intended to help to improve the physics program in SSD as well as shape the University of South Carolina Sumter's outreach efforts in the local high schools to encourage students to enroll in college physics courses.

Thursday, March 17, 2016 8:00AM - 11:00AM — Session R53 FEd FIAPIAP: Building New Pathways in Physics Innovation and Entrepreneurship Education Hilton Baltimore Holiday Ballroom 4 - Job Ganem, Loyola University Maryland

8:00AM R53.00001 Tinker, Thinker, Maker and CEO: Reimagining the Physics Student as Engineer, Inventor, and Entrepreneur, CRYSTAL BAILEY, American Physical Society — Physics degree holders are among the most employable in the world, often doing everything from managing a research lab at a multi-million dollar corporation, to developing solutions to global problems in their own small startups. Employers know that with a physics training, a potential hire has acquired a broad problem-solving skill set that translates to almost any environment, as well as an ability to be self-guided and -motivated so that they can learn whatever skills are needed to successfully achieve their goals. Therefore it's no surprise that the majority of physics graduates find employment in private sector, industrial settings. Yet at the same time, only about 25% of graduating PhDs will take a permanent faculty position—while academic careers are usually the only track to which students are exposed while earning their degrees. In this talk, I will examine the role of physicist as innovator and how this role intersects with other similar STEM disciplines (such as engineering), and provide some insight into how implementing physics innovation and entrepreneurship (PIE) education will benefit both physics departments and the students they serve, regardless of students' eventual career choices. Additionally, I will provide resources to help faculty mentors give their students better information and training for a broader scope of career possibilities, and information about how educators can get involved in the growing community of PIE educators.

8:36AM R53.00002 Impact of the Joint Task Force on Undergraduate Physics Programs for Innovation and Entrepreneurship Education in Physics, DOUGLAS ARION, Carthage College and Galileoscope LLC — The Joint Task Force on Undergraduate Physics Programs has worked diligently to develop recommendations for what physics programs could and should be doing to prepare graduates for 21st century careers. While the 'traditional' physics curriculum has served for many years, the demands of the new workforce, and the recognition that only a few percent of physics students actually become faculty - the vast majority entering the workforce and applying their skills to a very diverse range of problems, projects, and products - implies that a review of the education undergraduates receives is in order. The outcomes of this study point to the need to provide greater connection between the education process and the actual skills, knowledge, and abilities that the workplace demands. This presentation will summarize these considerations, and show how entrepreneurship and innovation programs and curricula are a particularly effective means of bringing these elements to physics students.
9:12AM R53.00003 Introducing a Framework for Physics Innovation and Entrepreneurship (PIE) Education.1, BAHRAM ROUGHANI, Loyola University Maryland — A desired outcome for Physics Innovation and Entrepreneurship (PIE) education is preparing physics majors with an innovative and entrepreneurial mindset who are capable of opportunity recognition and adept in leveraging physics knowledge to address specific needs. Physics as a discipline is well-recognized to prepare students who become problem solvers and critical thinkers, gifted in dealing with abstract ideas and ambiguities in the context of complex and real-world problems. These characteristics when enhanced through appropriate combinations of curricular, co-curricular, and extra-curricular programs can prepare physics majors for careers and future challenges that may involve translating physics knowledge into useful products and services either as part of a technical team within an organization or through startups. A viable PIE education model prepares graduates for various career paths in addition to the traditional options such as pursuing graduate studies or becoming a science teacher. Having a well-defined “third option” for physics will benefit the robustness of the physics discipline through recruitment and retention of prospective students who in principle are interested in physics as a subject, but in practice they may overlook physics as their preferred major primarily because they are uncertain about a viable career path based on an undergraduate physics education.

1The “Pathways to Innovation” at Loyola is established based on the program developed by VentureWell and Epicenter (NSF Supported).

9:48AM R53.00004 Resources to Support Physicists as Versatile and Progressive Innovators. RANDALL TAGG, University of Colorado Denver — Physicists are trained first with broad fundamental knowledge and then through experience with exquisitely refined and specialized models and instrumentation. This is a superb platform from which to address real-world problems when it is augmented by ready access to additional practical resources. We have explored a systematic three-part approach to providing those resources: (1) creating an organized environment that stockpiles technical artifacts, tools, and instruments; (2) developing curriculum for on-demand learning of new technical competencies; (3) providing a community of like-minded physicists who enjoy connecting physics with innovation. For physicists early in their training or careers, we hope that this is a particularly attractive basis for exploring a wider range of professional options.

10:24AM R53.00005 Lessons Learned in Student Venture Creation. EDWARD CANER, Case Western Reserve University — The Physics Entrepreneurship Master’s Program (PEP) at Case Western Reserve University is now in its 15th year of operation. PEP is a 27 credit-hour Master of Science in Physics, Entrepreneurship Track. The curriculum can be tailored to the needs of each student. Coursework consists of graduate-level classes in science, business, intellectual property law, and innovation. A master’s thesis is required that is based on a real-world project in innovation or entrepreneurship within an existing company or startup (possibly the student’s). PEP faculty help students connect with mentors, advisors, partners, funding sources and job opportunities. In this talk I will chronicle several pitfalls that we have encountered with our “real world” student projects and start-up businesses, several of which met their complete demise despite showing great promise for success. I will discuss how we have learned to avoid most of these pitfalls by taking surprisingly simple actions.

10:36AM R53.00006 Advancing Successful Physics Majors - The Physics First Year Seminar Experience. JASON DEIBEL1, DOUGLAS PETKIE2, Wright State University — In 2012, the Wright State University physics curriculum introduced a new year-long seminar course required for all new physics majors. The goal of this course is to improve student retention and success via building a community of physics majors and provide them with the skills, mindset, and advising necessary to successfully complete a degree and transition to the next part of their careers. This new course sequence assembles a new cohort of majors annually. To prepare each cohort, students engage in a variety of activities that span from student success skills to more specific physics content while building an entrepreneurial mindset. Students participate in activities including study skills, career night, course planning, campus services, and a department social function. More importantly, students gain exposure to programming, literature searches, data analysis, technical writing, elevator pitches, and experimental design via hands-on projects. This includes the students proposing, designing, and conducting their own experiments. Preliminary evidence indicates increased retention, student success, and an enhanced sense of community among physics undergraduate students. The overall number of majors and students eventually completing their physics degrees has nearly tripled.

1Associate Professor, Department of Physics
2Chair, Department of Physics

10:48AM R53.00007 Towson University’s Professional Science Master’s Program in Applied Physics: The first 5 years. RAJESWARI KOLAGANI, Towson University — It is a well-established fact that the scientific knowledge and skills acquired in the process of obtaining a degree in physics meet the needs of a variety of positions in multiple science and technology sectors. However, in addition to scientific competence, challenging careers often call for skills in advanced communication, leadership and team functions. The professional science master’s degree, which has been nick-named as the ‘Science MBA’, aims at providing science graduates an edge both in terms of employability and earning levels by imparting such skills. Our Professional Science Master’s Program in Applied Physics is designed to develop these ‘plus’ skills through multiple avenues. In addition to advanced courses in Applied Physics, the curriculum includes graduate courses in project management, business and technical writing, together with research and internship components. I will discuss our experience and lessons learned over the 5 years since the inception of the program in 2010.

3The author acknowledges support from the Elkins Professorship of the University System of Maryland

Thursday, March 17, 2016 11:15AM - 2:15PM – Session S7 FEd: Physics Education 303 - Robin Selinger, Kent State University

11:15AM S7.00001 The Impact of Network Embeddedness on Student Persistence. JUSTYNA ZWOLAK, ERIC BREWE, Florida International University, INSPIRE TEAM — Society is constantly in flux, which demands the continuous development of our educational system to meet new challenges and impart the appropriate knowledge/skills to students. In particular, in order to improve student learning (among other things), the way we are teaching has significantly changed over the past few decades. We are moving away from traditional, lecture-based teaching towards a more interactive approach using, e.g., clicker questions, modeling instruction (MI), and other engagement strategies. A current, major challenge for universities is to increase student retention. I am examining the use of network analysis to investigate academic and social experiences of students in and beyond the classroom. There is a compelling case that transformed physics classes, such as ones that use MI, promote persistence by the creation of learning communities that support the integration of students into the university. I will discuss recent results connecting the MI approach to network structures in the students’ interactions and how students’ position impacts persistence in taking a subsequent MI vs. traditional lecture-based course.
11:27AM S7.00002 Using Video Analysis and Biomechanics to Engage Life Science Majors in Introductory Physics, JEFF STEPHENS, Misericordia University — There is an interest in Introductory Physics for the Life Sciences (IPLS) as a way to better engage students in what may be their only physical science course. In this talk I will present some low cost and readily available technologies for video analysis and how they have been implemented in classes and in student research projects. The technologies include software like Tracker and LoggerPro for video analysis and low cost high speed cameras for capturing real world events. The focus of the talk will be on content created by students including two biomechanics research projects performed over the summer by pre-physical therapy majors. One project involved assessing medial knee displacement (MKD), a situation where the subject’s knee becomes misaligned during a squatting motion and is a contributing factor in ACL and other knee injuries. The other project looks at the difference in landing forces experienced by gymnasts and cheer-leaders while performing on foam mats versus spring floors. The goal of this talk is to demonstrate how easy it can be to engage life science majors through the use of video analysis and topics like biomechanics and encourage others to try it for themselves.

11:39AM S7.00003 Development of a Hands-On Survey Course in the Physics of Living Systems, MEGAN MATTHEWS, DANIEL I. GOLDMAN, Georgia Institute of Technology — Due to the widespread availability and technological capabilities of modern smartphones, many biophysical systems can be investigated using easily accessible, low-cost, and/or “homemade” equipment. Our survey course is structured to provide students with an overview of research in the physics of living systems, emphasizing the interplay between measurement, mechanism, and modeling required to understand principles at the intersection of physics and biology. The course proceeds through seven modules each consisting of one week of lectures and one week of hands-on experiments, called “microlabs”. Using smartphones, Arduinos, and 3D printed materials students create their own laboratory equipment, including a 150X van Leeuwenhoek microscope, a shaking incubator, and an oscilloscope, and then use them to study biological systems ranging in length scales from nanometers to meters. These systems include population dynamics of rotifer/algae cultures, experimental evolution of multicellularity in budding yeast, and the bio- & neuromechanics involved in animal locomotion, among others. In each module, students are introduced to fundamental biological and physical concepts as well as theoretical and computational tools (nonlinear dynamics, molecular dynamics simulation, and statistical mechanics). At the end of the course, students apply these concepts and tools to the creation of their own microlab that integrates hands-on experimentation and modeling in the study of their chosen biophysical system.

11:51AM S7.00004 Physics of Health Sciences, MILLARD BAUBLITZ, BENNETT GOLDBERG, Boston University — A one-semester algebra-based physics course is being offered to Boston University students whose major fields of study are in allied health sciences: physical therapy, athletic training, and speech, language, and hearing sciences. The classroom instruction incorporates high-engagement learning techniques including worksheets, student response devices, small group discussions, and physics demonstrations instead of traditional lectures. The use of pre-session exercises and quizzes has been implemented. The course also requires weekly laboratory experiments in mechanics or electricity. We are using standard pre- and post-course concept inventories to compare this one-semester introductory physics course to ten years of pre- and post-course data collected on students in the same majors but who completed a two-semester course.

12:03PM S7.00005 Promoting Active Learning: The Use of Computational Software Programs, TOM DICKINSON, Washington State University — The increased emphasis on active learning in essentially all disciplines is proving beneficial in terms of a student’s depth of learning, retention, and completion of challenging courses. Formats labeled flipped, hybrid and blended facilitate face-to-face active learning. To be effective, students need to absorb a significant fraction of the course material prior to class, e.g., using online lectures and reading assignments. Getting students to assimilate and at least partially understand this material prior to class can be extremely difficult. As an aid to achieving this preparation as well as enhancing depth of understanding, we find the use of software programs such as Mathematica® or MatLab®, very helpful. We have written several Mathematica® applications and student exercises for use in a blended format two semester E&M course. Formats include tutorials, simulations, graded and non-graded quizzes, walk-through problems, exploration and interpretation exercises, and numerical solutions of complex problems. A good portion of this activity involves student-written code. We will discuss the efficacy of these applications, their role in promoting active learning, and the range of possible uses of this basic scheme in other classes.

12:15PM S7.00006 Student Responses to a Flipped Introductory Physics Class with built-in Post-Video Feedback Quizzes, ROBERTO RAMOS, University of the Sciences — We present and analyze student responses to multiple introductory physics classes in a university setting, taught in a “flipped” class format. The classes included algebra- and calculus-based introductory physics. Outside class, students viewed over 100 online video lectures on Classical Mechanics, Electricity and Magnetism, and Modern Physics prepared by this author and in some cases, by a third-party lecture package available over YouTube. Inside the class, students solved and discussed problems and conceptual issues in greater detail. A pre-class online quiz was deployed as an important source of feedback. I will report on the student reactions to the feedback mechanism, student responses using data based on anonymous surveys, as well as on learning gains from pre-/post- physics diagnostic tests. The results indicate a broad mixture of responses to different lecture video packages that depend on learning styles and perceptions. Students preferred the online quizzes as a mechanism to validate their understanding. The learning gains based on FCI and CSEM surveys were significant.

12:27PM S7.00007 Teaching Electrostatics and Entropy in Introductory Physics, MARK REEVES, George Washington University — Entropy changes underlie the physics that dominates biological interactions. Indeed, introductory biology courses often begin with an exploration of the qualities of water that are important to living systems. However, one idea that is not explicitly addressed in most introductory physics or biology courses is important contribution of the entropy in driving fundamental biological processes towards equilibrium. I will present material developed to teach electrostatic screening in solutions and the function of nerve cells where entropic effects act to counterbalance electrostatic attraction. These ideas are taught in an introductory, calculus-based physics course to biomedical engineers using SCALEUP pedagogy. Results of student mastering of complex problems that cross disciplinary boundaries between biology and physics, as well as the challenges that they face in learning this material will be presented.

12:39PM S7.00008 ABSTRACT WITHDRAWN —

12:51PM S7.00009 High speed video analysis study of elastic and inelastic collisions, ANDREW BAKER, JACOB BECKEY, VASUDEVA ARAVIND, Clarion University, ČLARION TEAM — We study inelastic and elastic collisions with a high frame rate video capture to study the process of deformation and other energy transformations during collision. Snapshots are acquired before and after collision and the dynamics of collision are analyzed using Tracker software. By observing the rapid changes (over few milliseconds) and slower changes (over few seconds) in momentum and kinetic energy during the process of collision, we study the loss of momentum and kinetic energy over time. Using this data, it could be possible to design experiments that reduce error involved in these experiments, helping students build better and more robust models to understand the physical world.

We thank Clarion University undergraduate student grant for financial support involving this project.
1:03PM S7.00010 Hurricane Balls: A rigid-body-motion student project. DAVID JACKSON, DAVID MERTENS, BRETT PEARSON, Dickinson College — Hurricane Balls is a spinning-top toy that consists of two metal spheres that are welded (or glued) together. The motion of Hurricane Balls provides a beautiful example of rotational motion in which the angular velocity and angular momentum point in different directions. Because the motion is both captivating to students and extremely reproducible, this system is an ideal example to include in a mechanics course. Moreover, the excellent agreement between theory and experiment makes a detailed analysis of Hurricane Balls a perfect topic for an independent student project. This talk will give an overview of the system and will provide some tips on how to make such a project a successful student experience.

1:15PM S7.00011 First order error corrections in common introductory physics experiments1. JACOB BECKEY, ANDREW BAKER, VASUDEVA ARAVIND, Clarion University, CLARION TEAM — As a part of introductory physics courses, students perform different standard lab experiments. Almost all of these experiments are prone to errors owing to factors like friction, misalignment of equipment, air drag, etc. Usually these types of errors are ignored by students and not much thought is paid to the source of these errors. However, paying attention to these factors that give rise to errors helps students make better physics models and understand physical phenomena behind experiments in more detail. In this work, we explore common causes of errors in introductory physics experiment and suggest changes that will mitigate the errors, or suggest models that take the sources of these errors into consideration. This work helps students build better and refined physical models and understand physics concepts in greater detail.

1:27PM S7.00012 Are our textbooks too good to be good? Let students own their textbooks to own the skills. XIUPING TAO, Winston-Salem State University — The two new yearlong high school courses, AP Physics 1 and 2, are equivalent to the two-semester algebra-based introductory physics college course. The AP courses have more than 300 instruction hours, while the college course less than 100. This partially explains why college instructors always struggle to cover the important topics to not necessarily prepared students. To make it worse, many college students are not buying or reading textbooks and rely on instructors to get the course content. The fragmented reception is preventing students from getting a complete picture of the course. Not that there is a shortage of textbooks. There are many 1000-page tomes costing $200 or more, too good to be good. All the struggles contribute to U.S. students' relatively low STEM skills. I propose to let students own their books to own the skills. Students need much shorter (thus manageable) and much more affordable books, and they need to own it for good. Cross-culture comparison reveals that students learn better when they truly own their books (without planning to resell).

1:39PM S7.00013 Physics and Physics Education at Clarion University. VASUDEVA ARAVIND, Clarion University — Clarion University is located in the rolling hills of western Pennsylvania. We are a primarily undergraduate public institution serving about 6000 students. We graduate students who take different career paths, one of them being teaching physics at high schools. Since educating teachers of tomorrow requires us to introduce currently trending, research proven pedagogical methods, we incorporate several aspects of physics pedagogies such as peer instruction, flipped classroom and hands on experimentation in a studio physics lab format. In this talk, I discuss some of our projects on physics education, and seek to find potential collaborators interested in working along similar lines.

1:51PM S7.00014 Learning Through Doing: Teaching Advanced Physics Concepts Through Freshmen Research Immersion. MATTHEW WAHILA, LOUIS PIPER, Dept. of Physics, Binghamton University, JENNIFER AMEY, WAYNE JONES, Dept. of Chemistry, Binghamton University, MEGAN FEGLEY, NANCY STAMP, Freshmen Research Immersion Program, Binghamton University — Often undergraduates have difficulty grasping advanced concepts in physics due to the seemingly abstract and foreign nature of the time and length scales involved. The Smart Energy Freshmen Research Immersion (FRI) program at Binghamton University was created as a way to address this issue and, in turn, improve undergraduate performance and retention in physics and chemistry. Using real-world research problems as a wider context to frame their understanding, we have developed a course sequence providing a more intuitive and comprehensive understanding of core physics and chemistry concepts over the course of the program. Advanced condensed matter topics, such as optical band gaps, crystal and electronic structure, and electron/hole conduction are introduced to students through hands-on, authentic research activities incorporating materials for real-world device applications. I will discuss how employing p-n junctions as a model device can allow for a natural and intuitive progression from basic to advanced physics and chemistry concepts. This approach illustrates how shifting exotic concepts into a more relatable form through the use of analogy is important for fostering a more intuitive understanding of physical phenomena.

2:03PM S7.00015 Transferring a Flipped Class in Algebra-based Physics to New Faculty. LEIGH SMITH, ALEXANDRE SOUSA, Department of Physics, University of Cincinnati — Transferring existing active classroom educational efforts to new faculty is a challenge that must be met to ensure sustainability of changes. We describe a flipped class approach to teaching algebra-based Physics being transferred to a new faculty member. This flipped class includes extensive video and reading-based preparation materials outside of class, and the use of Learning Catalytics for in-class work is developed and tested by one of the authors. These materials are of course idiosyncratic to the style of the developer. Student results using the new materials are compared with students in more standard classes which suggest significant positive benefit over several years. A faculty member decided to use these materials in his own section of the same course. Our experience shows that it takes some time for the new faculty member to use and adapt the materials in a way which matches his own style, which in the end results in equivalently enhanced results. Lessons learned from this transfer process will be discussed.

2:30PM V14.00001 Using the TA to Prepare Graduate Students for Research and Employment. KENNETH HELLER, School of Physics & Astronomy, University of Minnesota — One of the most underused components of the physics graduate program is the time spent being a teaching assistant (TA). Often the TA duties consist of grading and trying to help undergraduates survive a physics course. How those duties are accomplished is left to each TA. The most common TA preparation, if it exists, has a narrow focus on the class being taught. Preparation consists of describing, or perhaps practicing, specific teaching skills and gaining familiarity with the equipment used in the laboratory portion of the class. Instead TAs can be integrated into the entire course in which they function so that they learn the course as a system. This means treating a course in the same way one approaches a research project with the TAs as members of the research team headed by a faculty advisor. TA preparation is broadened and support includes the management, teamwork, and communication skills necessary. This makes the TAs more efficient and effective teachers while explicitly connecting the TA experience to the “soft” skills they need in their own research careers whether in industry, national laboratories, or academia. This talk describes such a program, functioning for over 20 years at the University of Minnesota, that takes no more time than the usual TA but results in graduate students that are more satisfied with their TA experience, are better prepared to function in research groups, and provide a better classroom experience for their undergraduate students.

Thursday, March 17, 2016 2:30PM - 4:54PM
Session V14 FEd: TA Professional Development: Excellent TA's Making Excellent Researchers

2:30PM V14.00001 Using the TA to Prepare Graduate Students for Research and Employment. KENNETH HELLER, School of Physics & Astronomy, University of Minnesota — One of the most underused components of the physics graduate program is the time spent being a teaching assistant (TA). Often the TA duties consist of grading and trying to help undergraduates survive a physics course. How those duties are accomplished is left to each TA. The most common TA preparation, if it exists, has a narrow focus on the class being taught. Preparation consists of describing, or perhaps practicing, specific teaching skills and gaining familiarity with the equipment used in the laboratory portion of the class. Instead TAs can be integrated into the entire course in which they function so that they learn the course as a system. This means treating a course in the same way one approaches a research project with the TAs as members of the research team headed by a faculty advisor. TA preparation is broadened and support includes the management, teamwork, and communication skills necessary. This makes the TAs more efficient and effective teachers while explicitly connecting the TA experience to the “soft” skills they need in their own research careers whether in industry, national laboratories, or academia. This talk describes such a program, functioning for over 20 years at the University of Minnesota, that takes no more time than the usual TA but results in graduate students that are more satisfied with their TA experience, are better prepared to function in research groups, and provide a better classroom experience for their undergraduate students.

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Mobilizing the Forgotten Army: Improving Undergraduate Math and Science Education through Professional Development of Graduate Teaching Assistants

Here, we present a novel framework to increase nationwide uptake of STEM-education best practices through grassroots propagation of Professional Development programs for Graduate Teaching Assistants (GTA-PD). Our model pays special attention to overcoming resistance to change by soliciting, from the very start, critical buy-in from departmental chairs, faculty, and GTAs who have direct control over and responsibility for instruction. A key component of our approach involves an annual National GTA Workshop where faculty-GTA leadership teams from many different Physics and Chemistry departments come together to develop best-practices-based GTA-PD improvement plans for their own departments while guided by a core group of nationally recognized expert practitioners in GTA-PD and STEM education. As a pre-condition for participation, each department chair must pledge to facilitate implementation of their leadership teams plan; additional and ongoing support is provided by the core group of experts, together with other teams from the workshop cohort. Our initial pilot efforts point to success via enthusiastic buy-in within each STEM department due to the potential for immediate positive impacts on both undergraduate instruction and the long term research productivity of GTAs. In the future, longitudinal data on the progress of the GTA-PD programs will be gathered and analyzed to provide guidance for improving the success of future GTA-PD programs.

TA Professional Development: A Graduate Student's Perspective

Graduate Teaching Assistants (GTAs) are essential for teaching large introductory physics classes. In such courses, undergraduates spend approximately half of their in-class contact time in instructional environments (e.g., labs and recitations) supervised by GTAs, which means GTAs can have a large impact on student learning. Therefore it is crucial to adequately prepare GTAs before they first enter the classroom, and to offer them continued support throughout. Since many of the skills required to become effective teachers will also be relevant to their future research careers, it is useful for a GTA preparation program to also include professional development strategies. But what exactly do GTAs get out of these programs? The School of Physics at Georgia Tech runs a preparation and mentoring program for GTAs that focuses on pedagogical knowledge, physics content, and professional development, as well as their intersections. Nearly seventy graduate students have gone through this program in the three years since it was established. Here we discuss the impact this program has had on our GTAs, from their own point of view: the program’s effect on their teaching abilities, how it has influenced their attitudes towards teaching, what elements they have found useful, and what changes they have suggested to its curriculum. We find that, in general, GTAs are more receptive when the curriculum is more hands-on and they are presented with frequent opportunities for practice and feedback.

A Joint Pedagogy Course for Learning Assistants and Teaching Assistants

No abstract available.