



THE ATHENS INSTITUTE FOR EDUCATION AND RESEARCH

Abstract Book

4th Annual International Conference on
Engineering Education & Teaching
3-6 June 2019, Athens, Greece

Edited by
Gregory T. Papanikos

2019

Abstracts

4th Annual International Conference on Engineering Education & Teaching

3-6 June 2019, Athens, Greece

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Preface

This book includes the abstracts of all the papers presented at the *4th Annual International Conference on Engineering Education & Teaching (3-6 June 2019)*, organized by the Athens Institute for Education and Research (ATINER).

In total 19 papers were submitted by 21 presenters, coming from 12 different countries (Australia, Canada, China, Croatia, Finland, France, Hong Kong, Poland, Singapore, South Africa, Spain, and USA). The conference was organized into 7 sessions that included a variety of topic areas such as Project-based Learning, Innovative Teaching Methods and Technologies, Experiential Learning, Student Engagement and Service-Learning, Teaching Strategies and other issues. A full conference program can be found before the relevant abstracts. In accordance with ATINER's Publication Policy, the papers presented during this conference will be considered for inclusion in one of ATINER's many publications.

The purpose of this abstract book is to provide members of ATINER and other academics around the world with a resource through which to discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. ATINER was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world could meet to exchange ideas on their research and consider the future developments of their fields of study.

It is our hope that through ATINER's conferences and publications, Athens will become a place where academics and researchers from all over the world regularly meet to discuss the developments of their discipline and present their work. Since 1995, ATINER has organized more than 400 international conferences and has published nearly 200 books. Academically, the institute is organized into 6 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of ATINER for putting this conference and its subsequent publications together. Specific individuals are listed on the following page.

Gregory T. Papanikos
President

**4th Annual International Conference on Engineering
Education & Teaching
3-6 June 2019, Athens, Greece**

Scientific Committee

All ATINER's conferences are organized by the [Academic Council](#). This conference has been organized with the assistance of the following academics, who contributed by a) setting up the program b) chairing the conference sessions, and/or c) reviewing the submitted abstracts and papers:

1. Gregory T. Papanikos, President, ATINER & Honorary Professor, University of Stirling, UK.
2. Nicholas N. Patricios, Vice President of Strategic Planning & Analysis, ATINER and Professor & Dean Emeritus, School of Architecture, University of Miami, USA.
3. Theodore Trafalis, Director, Engineering & Architecture Division, ATINER, Professor of Industrial & Systems Engineering and Director, Optimization & Intelligent Systems Laboratory, The University of Oklahoma, USA.
4. Virginia Sisiopiku, Head, Transportation Engineering Unit, ATINER, & Associate Professor, The University of Alabama at Birmingham, USA.
5. Mike Mavromihales, Academic Member, ATINER & Senior Lecturer and Course Leader, University of Huddersfield, UK.
6. Sergey Dubikovskiy, Associate Professor, Purdue University, USA.
7. Melanie Basantis, Director, Engineering Outreach/Professor, Rowan University, USA.
8. Rosalie Van Baest, Academic Member ATINER & Lecturer, Fontys University of Applied Sciences, The Netherlands.
9. Anneli Kakko, Project Manager & Senior Lecturer, JAMK University of Applied Sciences, Finland.
10. Srdjan Vujicic, Professor, University of Dubrovnik, Croatia.
11. George S. Tsagaris, Associate Professor, Cleveland State University, USA.

FINAL CONFERENCE PROGRAM
**4th Annual International Conference on Engineering Education &
Teaching, 3-6 June 2019, Athens, Greece**
**Conference Venue: Titania Hotel, 52 Panepistimiou Street, 10678 Athens,
Greece**

Monday 3 June 2019

07:50-08:40 Registration and Refreshments

08:50-09:20 (Room B - 10th Floor): Welcome and Opening Address by Gregory T. Papanikos, President, ATINER and David Philip Wick, Director, Arts, Humanities & Education Division, ATINER & Professor of History, Gordon College, USA.

09:30-11:00 Session I (Room A - 10th Floor): Project-based Learning

Chair: Virginia Sisiopiku, Head, Transportation Engineering Unit, ATINER, & Associate Professor, The University of Alabama at Birmingham, USA.

1. Sergey Dubikovsky, Associate Professor, Purdue University, USA, Katherine Minarik, Graduate Student, Purdue University, USA & Peng Hao Wang, Assistant Professor, Purdue University, USA. A Correlation between Operational Status of Equipment and Technical Proficiencies of Aeronautical Engineering Technology Students: A Case Study.
2. Gene Hou, Professor, Old Dominion University, USA. Cross-Departmental Collaboration for a Project Based Senior Class: Intelligent Machines.
3. Kian Jon Ernest Chua, Associate Professor, National University of Singapore, Singapore & Md Raisul Islam, Senior Lecturer, National University of Singapore, Singapore. Studying the Effectiveness of Combining Flipped Classroom to an Engineering Project Based Learning Module.
4. Jing Liang, Professor, China University of Mining and Technology, China & Rongli Jiang, Dean, Department of Applied Chemistry, China University of Mining and Technology, China. Developing Students' Critical Thinking, Problem Solving, and Analysis Skills in a Problem-based Organic Synthesis Course.

11:00-12:30 Session II (Room A - 10th Floor): Innovative Teaching Methods and Technologies

Chair: Sergey Dubikovsky, Associate Professor, Purdue University, USA.

1. Tom Wanyama, Assistant Professor, McMaster University, Canada, Ishwar Singh, Professor, McMaster University, Canada & Omar Danta, Facilities Manager, McMaster University, Canada. A Platform for Teaching PLC System Integration and PLC Systems Data Access.
2. Anneli Kakko, Project Manager & Senior Lecturer, JAMK University of Applied Sciences, Finland. Smart HEI-Business Collaboration for Skills and Competitiveness.
3. Md Raisul Islam, Senior Lecturer, National University of Singapore, Singapore & Kian Jon Ernest Chua, Associate Professor, National University of Singapore, Singapore. The Hybrid Interactive Platform - Blended Learning Pedagogy for Concept-Heavy Engineering Modules to Foster Engagement and Learning.

12:30-14:00 Session III (Room A - 10th Floor): Emerging Technologies

Chair: Srdjan Vujicic, Professor, University of Dubrovnik, Croatia.

1. Grzegorz Sierpinski, Associate Professor, Silesian University of Technology, Poland & Marcin Staniek, Assistant Professor, Silesian University of Technology, Poland. Intelligent Solutions Supporting the Development of Electromobility.
2. Marcin Staniek, Assistant Professor, Silesian University of Technology, Poland &

- Grzegorz Sierpinski, Associate Professor, Silesian University of Technology, Poland. The Potential and Limitations of Transport System as Factors Affecting the Development of Electromobility.
3. Simon Cohen, Senior Researcher, IFSTTAR, France & Zoi Christoforou, Associate Researcher / Associate Professor, IFSTTAR / Ecole des Ponts ParisTech, France. Travel Time Estimation by Bluetooth and FCD Technologies: A Comparison Study on Motorway.
 4. Sheikh Shahriar Ahmed, Graduate Research Assistant, University at Buffalo, The State University of New York, USA, Grigorios Fountas, Lecturer, Edinburgh Napier University, UK, Ugur Eker, Researcher, University at Buffalo, The State University of New York, USA, Stephen E. Still, Professor, University at Buffalo, The State University of New York, USA & Panagiotis Ch. Anastasopoulos, Associate Professor, University at Buffalo, The State University of New York, USA. An Empirical Exploratory Analysis of Potential Residence Relocation Trends from the Future Introduction of Flying Cars.
- This session is jointly offered with the Transportation Engineering Unit.*

14:00-15:00 Lunch

15:00-16:30 Session IV (Room A - 10th Floor): Experiential Learning

- Chair:** George S. Tsagaris, Associate Professor, Cleveland State University, USA.
1. Geok Chin Ivy Tan, Associate Professor, Nanyang Technological University, Singapore. Student-Teachers' Conception and Perception of the Use of the Inquiry-Based Approach in Geography Fieldwork in Singapore.
 2. YM Tang, Teaching Fellow, The Hong Kong Polytechnic University, Hong Kong, To Sum Ho, Assistant Professor, The Hong Kong Polytechnic University, Hong Kong & Chun Ho Wu, Assistant Professor, The Hong Kong Polytechnic University, Hong Kong. Engineering Education with Mixed Reality (MR).
 3. Jose Miguel Alvarez Romero, PhD Student, Instituto Universitario de Microgravedad "Ignacio Da Riva" (IDR/UPM), Spain, Elena Roibas-Millan, Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva" (IDR/UPM), Spain, Santiago Pindado, Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva" (IDR/UPM), Spain, Javier Pérez-Álvarez, Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva" (IDR/UPM), Spain & Ángel Sanz-Andrés, Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva" (IDR/UPM), Spain. UPMSAT-2 Communications System Design, Integration and Testing, within MUSE (Master in Space Systems) Academic Plan.

21:00-23:00 Greek Night and Dinner

Tuesday 4 June 2019

08:00-11:00 Session V: An Educational Urban Walk in Modern and Ancient Athens

Group Discussion on Ancient and Modern Athens.
Visit to the Most Important Historical and Cultural Monuments of the City (be prepared to walk and talk as in the ancient peripatetic school of Aristotle)

11:30-13:00 Session VI (Room A - 10th Floor): Student Engagement and Service-Learning

Chair: Anneli Kakko, Project Manager & Senior Lecturer, JAMK University of Applied Sciences, Finland.

1. Aaron Brown, Professor, Metropolitan State University of Denver, USA & Michael Bauer, Sustainability Director, Naropa University, USA. Merging Engineering Education with Service-Learning: How Humanitarian Engineering Education Can Encourage Socially Conscious Engineers.
2. Melanie Basantis, Director, Engineering Outreach/Professor, Rowan University, USA & Kauser Jahan, Department Head Civil Engineering/Professor, Rowan University, USA. A Model for STEM Success, 20 Years of the Attracting Women into Engineering (AWE) Workshop, Sharing the Pedagogy and Assessing the Impact.

13:00-14:30 Session VII (Room A - 10th Floor): Special Topics /Teaching Strategies

Chair: Melanie Basantis, Director, Engineering Outreach/Professor, Rowan University, USA.

1. Srdjan Vujicic, Professor, University of Dubrovnik, Croatia, Nermin Hasanspahic, PhD Student, University of Dubrovnik, Croatia, Ana Gundic, Professor, University of Zadar, Croatia & Niko Hrdalo, PhD Student, University of Dubrovnik, Croatia. Assessment for Adequately Qualified Instructors in Maritime Education and Training Institutions.
2. Krystle Ontong, Lecturer, Stellenbosch University, South Africa. Exploring Place and Space as 'Fluid Centres' for Preparing Geography Student Teachers in Becoming Curriculum-Makers.
3. Arthur Firipis, PhD Student, Deakin University, Australia, Siva Chandrasekaran, Lecturer, Swinburne University of Technology, Australia & Matthew Joordens, Lecturer, Deakin University, Australia. Nurturing Creativity through Differentiation while using 1:1 Mobile Devices for Learning?

14:30-15:30 Lunch

20:00- 21:30 Dinner

**Wednesday 5 June 2019
Mycenae and Island of Poros Visit
Educational Island Tour**

**Thursday 6 June 2019
Delphi Visit**

**Friday 7 June 2019
Ancient Corinth and Cape Sounion**

Sheikh Shahriar Ahmed

Graduate Research Assistant, University at Buffalo, The State University
of New York, USA

Grigorios Fountas

Lecturer, Edinburgh Napier University, UK

Ugur Eker

Researcher, University at Buffalo, The State University of New York, USA

Stephen E. Still

Professor, University at Buffalo, The State University of New York, USA
&

Panagiotis Ch. Anastasopoulos

Associate Professor, University at Buffalo, The State University of New
York, USA

**An Empirical Exploratory Analysis of Potential Residence
Relocation Trends from the Future Introduction of Flying
Cars**

Flying cars, a new transportation mode capable of operating on both land and air, are expected to be introduced in the existing traffic fleet between 2020 and 2025. Due to their capacity to offer flexible mobility patterns and shorter travel time, flying cars are anticipated to bring forth significant changes in the urban transportation network. Even though the launch of flying cars is expected in the near future, potential effects of this new transportation mode on public perceptions towards residence location based on the improved access to mobility, have not been explored in the existing literature. The focus of this paper is to analyze whether the future introduction of flying cars in urban environments is likely to trigger a residence relocation trend from urban to rural areas, or vice versa. Using data collected from an online survey, individuals' opinions towards potential residence relocation are statistically modeled with correlated grouped random parameters probit modeling techniques. The analysis reveals that various socio-demographic characteristics and individuals' opinions towards the perceived benefits and challenges of flying cars affect public opinion towards considering residence relocation from the future introduction of flying cars. Although detailed information regarding the operation of flying cars is limited, the findings from this study can provide insights into the anticipated challenges likely to be faced by policymakers, urban planners, and manufacturing companies, from the future introduction of flying cars.

Jose Miguel Alvarez Romero

PhD Student, Instituto Universitario de Microgravedad "Ignacio Da Riva"
(IDR/UPM), Spain

Elena Roibas-Millan

Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva"
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Javier Pérez-Álvarez

Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva"
(IDR/UPM), Spain

&

Ángel Sanz-Andrés

Professor, Instituto Universitario de Microgravedad "Ignacio Da Riva"
(IDR/UPM), Spain

**UPMSAT-2 Communications System Design, Integration and
Testing, within MUSE (Master in Space Systems) Academic
Plan**

In recent years, the development of small-size satellites by companies, research institutions and universities have become common practice. This tendency is based on the need for providing an easy and low-cost access to space for those institutions and companies that cannot afford the use of the usual big industrial platforms. In this context, IDR/UPM Institute (*Instituto Universitario de Microgravedad 'Ignacio Da Riva'*) of *Universidad Politécnica de Madrid*, has been developing the UPMSAT-2 microsatellite within the past years. This is one of the most relevant projects in the existing space engineering framework at IDR/UPM, which integrates university professors, research staff of IDR/UPM, and students of the Master in Space Systems (MUSE). Going back to the UPMSAT-2 mission, it should be underlined that this type of small-size satellite requires reliable communication systems able to ensure the quality of the communication link between the satellite and ground control, but they must be also optimized in terms of costs. Therefore, the use of Commercial-Off-The-Shelf (COTS) components, which are normally developed for terrestrial applications, has become a usual practice in such kind of small-size satellite missions. Therefore, these communication subsystems require deep trial campaigns to ensure their proper operation. From this point of view, a proper balance between the limited resources available in this kind of university-satellite missions and the appropriateness of the testing techniques is needed. IDR/UPM professors and MUSE students have performed the full design, manufacture and testing of the UPMSAT-2

communications systems (flight and ground). This paper summarizes the development of the whole UPMSAT-2 communication system, describing the tasks that were required for its implementation, and focusing on how they were harmonized and integrated within the academic plan of the Master in Space Systems (MUSE).

Melanie Basantis

Director, Engineering Outreach/Professor, Rowan University, USA

&

Kausar Jahan

Department Head Civil Engineering/Professor, Rowan University, USA

A Model for STEM Success, 20 Years of the Attracting Women into Engineering (AWE) Workshop, Sharing the Pedagogy and Assessing the Impact

Worldwide, STEM education focuses on bringing creative thinking, problem solving, and STEM career awareness to underrepresented groups and genders that traditionally do not pursue STEM disciplines. This involves engaging young students and allowing them to explore, finding their passion in the creative world of STEM, while also portraying the limitless opportunities of a STEM foundation. STEM skills take students where they never imagined and the world will experience change that cannot be predicted. However, educators must be skilled and trained while also understanding youth and their learning environment. They must be able to relate to and engage these young people through instructional approaches implemented in the classroom, mainly hands-on learning, which is the basis of this study.

A proven model of success for instituting STEM knowledge has been the Henry M. Rowan College of Engineering's Attracting Women to Engineering workshop (AWE). First introduced in 1999, AWE is a summer program that introduces middle school girls to engineering career pathways. Participants have the opportunity to interact with faculty members and undergraduate students, many of whom are female, via hands-on engineering experiments while also learning about various engineering disciplines and fundamental STEM concepts. Our aim is to eliminate preconceived stereotypes within the engineering field and inspire girls.

This paper highlights the AWE model, one that instills excitement in STEM disciplines through hands-on engineering projects. These projects, designed specifically for middle school females, will be identified and what worked, what did not and what needs to be changed based upon the 20-year history of this program will be addressed. Pedagogical approaches for the presentation of this material will also be shared as well as numerous lessons learned. In addition, a compilation assessment, inclusive of the AWE alumnae from 2007-2012, who now have already graduated from high school is a focus of this research.

Aaron Brown

Professor, Metropolitan State University of Denver, USA

&

Michael Bauer

Sustainability Director, Naropa University, USA

Merging Engineering Education with Service-Learning: How Humanitarian Engineering Education Can Encourage Socially Conscious Engineers

Engineers provide essential services to society, solving pressing challenges through technological inventiveness. For students new to engineering, the lure of creative problem-solving is often cited as attracting them to the discipline. However, the structures of traditional engineering curricula are narrowly focused on the application of fundamentals to solve restrained, closed-ended problems. Too often, engineering programs do not encourage inventive expression in problem solving. Not surprisingly, the attrition rate for engineering programs is unusually high. Recently, engineering education has shifted its focus to new, more engaging practices that incorporate hands-on methods, boosting prospects for students to engage in creative problem solving. Because service-learning provides opportunities for applied work, then it is practical to incorporate service-learning into engineering education programs in order to positively engage students and thereby lower attrition rates. Moreover, since engineers are fundamentally involved with social improvement, one could argue that engaging students in activities that expand their understanding of the potential impact of their skills on a community is not only prudent but best practices. This paper explores two case studies of community based service-learning engineering projects. It will discuss various aspects of the projects including community partnerships, analyses and decision making that helped drive the designs and outcomes. It explores how both the communities and students benefitted, focusing notably on the influence these activities had on student understanding of their work, academic and/or professional direction and social consciousness. These are analyzed via longitudinal reporting of students incorporating lessons learned several years post-project. The service-learning projects took place in marginalized communities in Denver and Costa Rica. In the Denver project, engineering students designed, built and installed low cost solar heaters into an area with poor housing stock. In Costa Rica, students built a solar water heater for a local school.

Kian Jon Ernest Chua

Associate Professor, National University of Singapore, Singapore

&

Md Raisul Islam

Senior Lecturer, National University of Singapore, Singapore

Studying the Effectiveness of Combining Flipped Classroom to an Engineering Project Based Learning Module

We evaluate the effectiveness of implementing a combined pedagogy for a group of year-2 Engineering students where fundamental concepts belonging to the flipped classroom (FC) paradigm are applied to a project-based learning (PBL) module. The key aspect of this pedagogy study is to structure most of the engineering basics and mathematical aspects of the subject matter into pre-recorded video lectures, on-line media platforms, learning materials and quizzes. For students exposed to the Project Based Learning - Flipped Classroom (PBL-FC) format, it is essential for them to watch the video lectures and partake in the on-line quizzes before coming to class. The PBL studio sessions are not spent covering theories, instead time is devoted to discussions and small-scale demonstration so that students have better perspectives on the engineering applications. Results from the two classes of students are collected and evaluated – one is subjected to a traditional PBL while the other undergoes a PBL-FC learning format. Key findings have indicated a marked increase in fundamental formative knowledge; enhanced problem-solving abilities; and production of better performing artefacts with regards to the set of design skills for students undergoing hybrid PBL-FC groups. Survey results further highlighted that PBL-FC students were highly positive towards achieving better project outcomes, enjoyed teamwork, and are able to think critically, as a result, became more active in their learning process.

Simon Cohen

Senior Researcher, IFSTTAR, France

&

Zoi Christoforou

Associate Researcher / Associate Professor, IFSTTAR / Ecole des Ponts
ParisTech, France

Travel Time Estimation by Bluetooth and FCD Technologies: A Comparison Study on Motorway

Advanced traveler information systems are being deployed at a large scale. Communications and display technologies now allow for the provision of key travel information to drivers in real time and, thus, introduce a new era in infrastructure management strategies. Real time information can be either prescriptive or descriptive and it may be provided either pre-trip or en-route. Information provision aims to assist drivers in decision making and to enhance travel safety and comfort with additional benefits to the overall system performance. Informed drivers can make more rational choices regarding route choice conditional upon travel time and travel time reliability.

Numerous studies provide evidence on the importance that drivers give to travel time (TT) information under normal traffic conditions as well as in the case of accidents, works, adverse weather, or special events.

In France, several infrastructure management systems using conventional inductive loop detectors are being renewed. New technologies are then progressively introduced such as Bluetooth sensors or Floating Car data (FCD). This modernization requires a good knowledge of the performance of these new sensors to display travel time on Variable Message Signs. This is why comparative studies are first conducted on these new devices.

This paper presents an in-depth comparison between travel time estimates (TT) from Bluetooth detectors (BT) and Floating Car Data (FCD). The test is performed, during summer 2018, on the A31 urban motorway in the region of Metz, North-East France. We first present the data sets and we precise the process used for travel time estimation by each technology. Next, we compare these estimates for variable length trips going from 5 to 40 km. Several indicators, such as the Mean Absolute Percent Error (MAPE), are used to illustrate the deviations between Bluetooth and FCD. Statistical analysis is carried out separately for passenger cars and heavy vehicles. Various settings are also considered in the comparison: peak hours, off-peak hours, working days, holidays, rain, etc. Furthermore, stable linear relationships between the two TT estimates are calibrated.

Finally, results are discussed and recommendations are provided to traffic operators to improve their knowledge of these new technologies for TT display on motorways.

Sergey Dubikovsky

Associate Professor, Purdue University, USA

Katherine Minarik

Graduate Student, Purdue University, USA

&

Peng Hao Wang

Assistant Professor, Purdue University, USA

A Correlation between Operational Status of Equipment and Technical Proficiencies of Aeronautical Engineering Technology Students: A Case Study

In order to graduate, students in the Aeronautical Engineering Technology (AET) program of Purdue University's School of Aviation and Transportation Technology are required to demonstrate knowledge of reciprocating engine overhaul. The same expertise is mandatory for qualifying for an optional Federal Aviation Administration's (FAA) 14 CFR Part 147 "Aviation Maintenance Technician Schools" graduation and Airframe and Powerplant certificates. In this case, students must take and pass written and practical tests based on the Federal Aviation Administration's guidelines. The preparation for this task consists of learning theoretical aspects of inspection, troubleshooting, repair, and overhaul. To reinforce those concepts, all students must perform practical inspection, disassembly, cleaning, inspection, and reassembly of the engine. However, some engines in the laboratory are functioning and some are not. This study examined possible correlations between an operational status of the equipment and students' technical proficiencies. The hypothesis was made that operational engine would lead to higher technical abilities of the students compare to use of the nonoperational equipment. This prediction is based on the difference in mental pressure levels to perform the tasks correctly. There is less pressure if the students are aware about nonfunctioning status of an engine, and more pressure if they know that the engine must run after the overhaul. The abilities were measured utilizing criteria of the Federal Aviation Administration's Aviation Mechanic Powerplant Practical Test Standards (FAA-S-8081-28A).

Arthur Firipis

PhD Student, Deakin University, Australia

Siva Chandrasekaran

Lecturer, Swinburne University of Technology, Australia

&

Matthew Joordens

Lecturer, Deakin University, Australia

Nurturing Creativity through Differentiation while using 1:1 Mobile Devices for Learning?

Differentiation is an important concept for educators, because it attempts to explain the relationship occurring between theory and application. The responsibility to manage this relationship is that of the curriculum designer. Stating the obvious alludes to the need to have a clear understanding about differentiation. With the acceptance of 1:1 mobile devices within the learning space, differentiating to facilitate its use effectively is an important discussion. This paper explores the theoretical and practical considerations when differentiating the curriculum to incorporate 1:1 mobile devices. Also, results from a recent research study are discussed to contextualise and understand learner perceptions when using BYOD (Bring your own device) within the learning space.

Gene Hou

Professor, Old Dominion University, USA

Cross-Departmental Collaboration for a Project Based Senior Class: Intelligent Machines

Intelligent Machine Systems, their developments and applications, have a profound impact on our current culture, daily life and the job market for future engineering graduates. They can be found in entertainment, medicine, communication, military, manufacturing, transportation, security, to name a few. An intelligent machine system such as a factory robot or a military drone is multidisciplinary in nature. Furthermore, the complexity of the intelligent machine system has been expanded in such a pace beyond what traditional engineering education can effectively support, as the latter is usually divided along the disciplinary lines. Such observation led the faculty from three different engineering departments to jointly develop a cross-departmental, senior elective course to address in an integrated matter the overall design and application of an intelligent machine. The course is called, Intelligent Machine Systems: Technologies and Applications, which is a three-credit hour course, cross-listed among three departments with emphasis on hands-on, team-oriented lab experience.

The objectives of this class are two folds: (1) address the overall design and application of an intelligent machine in an integrated and systematic matter, and (2) prepare students to work in a team with engineers from different majors. Most importantly, this new course is intended to serve as a platform for instructional innovation in teaching an interdisciplinary, emerging subject to cross-departmental students by cross-departmental faculty.

The class is made of three different projects with a mix of lectures and laboratories. Two students from different departments will form a team. Students will work as a team to assemble, construct and program a robot for pick and place and an autonomous vehicle for path tracking and mapping. Every lecture/lab module is designed gearing toward the related class project. Lecture/lab topics include sensors and actuators, hardware/software interface, communication protocols, microcontroller embedded systems, programming, machine design, computer vision, navigation, inverse kinematics and feedback control.

Since its onset in Fall 2013, the format and the technical content of this course have been undergone through several revisions to deal with the cost of consumable parts, balance of skill sets, the distribution of teaching load, TA training and the frequently updated software and hardware. The paper will address the challenges encountered and the resolutions put in

place during the development phases of this course and the outcomes of these efforts.

Md Raisul Islam

Senior Lecturer, National University of Singapore, Singapore

&

Kian Jon Ernest Chua

Associate Professor, National University of Singapore, Singapore

The Hybrid Interactive Platform – Blended Learning Pedagogy for Concept-Heavy Engineering Modules to Foster Engagement and Learning

A concept-heavy engineering module “Optimization of Energy Systems” was developed in 2015 to bring the full-scale real-world problems into the classroom and prepare the final year Mechanical Engineering students professionally ready for the industries. The proactive traditional classroom lectures and tutorials approach were adopted in 2015 and 2016 to teach the working principles, evaluation of energy performance, cause-and-effect, energy saving opportunities, design and operational considerations, control strategies, technical and economic feasibilities for the real-world systems. The actual performance data of two full-scale major energy-consuming systems were provided to students as the take-home open-ended group assignments to evaluate the performance of existing systems and develop the energy-smart solutions. It was evident from students’ feedback and the developed solutions that our verbal explanation was not enough for the students. In 2017, an innovative interactive platform was developed. The platform allows students to revisit recorded lectures on critical concepts, practice well-thought-out real life multi-part problems as well as cause-and-effect questions and simulate the effects of different design and operating variables at their own pace. In addition to the benefits of the conventional flipped classroom approach, the platform provides immediate feedback to students on their mistakes and forwards the students to specific teaching materials before reattempting the problem. The platform creates a report book on the performance of students. Educators can identify students’ conceptual difficulties from the report book and prepare for the reactive blended teaching in an interactive environment for the next class. The platform has changed the entire dynamics of teaching of the technical module, which is evident from the marked improvement in the quality of the solutions produced by the students. A survey was conducted to understand students’ view on the teaching pedagogies adopted in 2016 and 2017. The survey results distinctly show that the intervention has enhanced students’ motivation and level of confidence in applying the multidisciplinary engineering knowledge for developing the energy efficient practical solutions.

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**Smart HEI-Business Collaboration for Skills and
Competitiveness**

Smart HEI-Business collaboration for skills and competitiveness (HEIBus) is Erasmus + Knowledge Alliances 2 (KA2) project. Its duration is 36 months (1 January 2017 – 31 December 2019) and it aims to develop smart and innovative new methods for High Education Institution (HEI)-company cooperation. With a budget of about one million euros, the project brings together universities and companies from five European countries with strong expertise and experience in different fields.

The project focuses on strengthening the collaboration between HEIs and companies by creating new innovative cooperation models and teaching methods. These models and methods facilitate the involvement of students and staff from HEIs in international Research & Development & Innovation (R&D&I) projects proposed by companies.

In HEIBus project, there are eight workpackages, which are Management (WP1), Best practices of HEI-company cooperation (WP2), Multidisciplinary student level real life problem solving (WP3), Expert level real life problem solving (WP4), Flexible student mentoring by companies (WP5), Quality assurance (WP6), Evaluation (WP7) and Dissemination & exploitation (WP8). WP2, WP3, WP4 and WP5 are implementation workpackages.

HEIBus project takes the collaboration process to high level by adding multidisciplinary aspects, virtual elements and experts of High Education Institutes (HEI) in its activities. In my presentation I will explain how companies will get wide perspective to the solutions of their problems, promote new innovations and mentor student groups. I will also explain how HEI staff can use their expertise and cooperate with other HEI and company partners during HEIBus project. I do not forget to explain how students will benefit from activities of this project. One good example of the benefits for students is increasing study motivation.

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&

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Developing Students' Critical Thinking, Problem Solving, and Analysis Skills in a Problem-based Organic Synthesis Course

Organic synthesis involves many modern organic reactions whose elusive charm will frustrate ordinary students if the course is taught in a classical format. Problem-based learning can not only enhance the engagement of each student in the classroom but also be helpful for students to digesting and absorbing knowledge. And according to Ausuel and Novak's theory of meaningful learning, the learner must possess prerequisite knowledge with which to anchor the new knowledge. Furthermore, the learner must consciously choose to relate the new knowledge to previous knowledge in some nontrivial way. With this in mind, at the first stage we presented students with their familiar structure and encouraged them to solve the synthetic problem. Although students discussed and tried every possible method they have learned but they soon discovered if focused on traditional reaction this synthetic problem couldn't be solved successfully, which stimulated students to think and analyze the limitations of traditional reactions. How to solve the problem? The strong desire for problem-solving was greatly evoked.

Then we introduced new modern reactions, explicated the characteristics, the mechanisms, the application scope of the modern reactions and made students familiar with this reaction.

At the third stage, the modern reaction was applied in the synthesis of the unresolved molecule and gained success, Which made students realize the distinction between traditional reactions and modern ones. Then we further apply this reaction into synthesis of new target molecules and deepen students' understanding of this reaction.

Herein, PBL not only develops skills such as group work, communication, but also the skills of critical thinking, problem solving, and analysis skills which are more valued than the reaction itself.

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Exploring Place and Space as 'Fluid Centres' for Preparing Geography Student Teachers in Becoming Curriculum-Makers

Since the establishment of the national curriculum in South Africa the 'disjuncture' between university and school geography has become commonplace. The nature of change in geographical knowledge in the academy is therefore important in helping student teachers to understand and 'cope' with a rather 'fragmented' geography curriculum awaiting them in schools. One of the many challenges experienced by teacher educators is gaining a precise conceptual grasp of what geographical knowledge is and how it can best be mediated across the spatialized tension between the academy and school geography. Adding to the complexity of the knowledge agenda are the current pressing environmental and social issues. This poses several questions for teacher educators to reflect upon such as: *What is school geography really for? Secondly, what type of knowledge and skills are needed in the 21st century that would equip student teachers with an adequate intellectual toolkit to respond to these challenges in practice?*

In this paper I argue that some of the answers to the aforementioned questions can be found at the conceptual and pedagogical intersections of the notions of place and space, that is, at the 'fluid centre'. I shall address these questions by discussing how organising pedagogy around the 'fluid' centre could: provide a different lens for rethinking the purpose of geography education; illuminate an intellectual toolkit for student teachers to become curriculum-makers amidst a 'fragmented' school geography curriculum; and utilise student teachers' *sense of place* and *sense of planet* as key components in strengthening the relationship between university and school-based geographies.

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Intelligent Solutions Supporting the Development of Electromobility

Transport brings with it numerous problems, especially with regard to congestion in city centers and has a negative impact on the environment. Institutions that influence the shaping of transport systems are constantly looking for solutions that can change the choices of travelers, and thus the modal split of traffic towards pro-ecological solutions. Electromobility is a relatively new trend towards reducing the negative impact of transport on the environment. However, in many cases the development of electromobility is too slow. Among the solutions that can accelerate the increase in the number of electric vehicles in cities, you can indicate the use of modern information technologies. Among other things, this issue devoted to research carried out in the framework of the international project "Electric travelling - platform to support the implementation of electromobility in Smart Cities based on ICT applications" in the ERANET CoFund EMEurope financed among others from the means of the National Centre for Research and Development.

The term smart refers to the use of many solutions in the field of advanced technologies. The flow of information is one of the basic conditions for the functioning of such solutions. The use of intelligent technologies can accelerate the development of electromobility in cities. In accordance with the principles of sustainable development, it is the combination of rational use of energy and technological development that is the key to success in this field. The information transfer in modern and intelligent cities is a necessary element for their efficient and effective functioning. This flow should guarantee proper identification of the needs of travelers (in accordance with the definition of sustainable development), as well as support for travelers in deciding on the course and manner of travel. In the case of electric vehicles, a significant limitation is the range that a car can achieve on a single full battery charge. Smart solutions can support a traveler in several ways. First of all, they can break the barrier of traveling by electric car over longer distances, through support planning stopovers on charging. The dynamic search of optimal routes and booking of the charging station can minimize the inconvenience resulting from the limited range of the electric vehicle. Looking at the problem on the other hand, smart devices in vehicles and their communication with the infrastructure can extend the distance that

can be traveled on one charge, dynamically choosing routes to the current traffic flows distribution of the transport network.

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The Potential and Limitations of Transport System as Factors Affecting the Development of Electromobility

The term electromobility means the possibility of moving users of the existing transport system, taking into account its potential and limitations, using alternative-fueled vehicles (vehicles powered by electricity). Electromobility does not only directed to means of transport, but also technical infrastructure allowing travelling with vehicles requiring the availability of charging stations in a specific spatial and appropriate technological solutions. It also includes public transport that uses the potential of newly created electrical solutions in addition to being environmentally friendly. Electromobility is struggling with legal and economic problems related to the creation, purchase and use of electric vehicles, as well as the implementation and use of charging infrastructure.

The development of electromobility in the economic, infrastructural and social aspect is the result of the implemented policy of sustainable development of transport, according to the White Paper, which includes conceptual proposals referring to specific areas within the EU. The key factors affecting the development of electromobility are the potential and limitations of the transport system as well as legal and economic aspects in the area of electromobility services. The specificity of a specific region, including the potential and limitations of the transport system, determine the possibilities of developing electromobility services. By identifying the weak points of the transport system and key transport solutions in the field of travelling persons and transport of goods, the aim is to use existing solutions and changes existing in direction to solutions favoring the use of electromobility, taking into account the need to minimize the negative impact on the natural environment.

The indication of elements of the transport infrastructure description as input to the planning algorithms of the charging station localization is one of the tasks carried out within the framework of the international project "Electric traveling - platform to support the implementation of electromobility in Smart Cities based on ICT applications" in the ERANET CoFund EMEurope program, financed among others from the means of the National Centre for Research and Development. The main objective of the project is to develop support tools for the development of electromobility services in urban and suburban areas, directly for users of the transport system, as well as local authorities managing this system.

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Student-Teachers' Conception and Perception of the Use of the Inquiry-Based Approach in Geography Fieldwork in Singapore

The secondary and junior college geography syllabuses in Singapore recommend the inquiry-based approach for the teaching and learning of Geography. One salient feature of the syllabuses is the introduction of geographical investigation in fieldwork as a component in the examinations for both lower and upper secondary. Therefore, it is now necessary and essential for geography teachers to conduct geography fieldwork for students to enable them to actively make meaningful connections of what they learn in their classrooms with the realities in the field.

This present qualitatively study seeks to explore 36 student teachers' conception and perception of applying the inquiry-based approach in fieldwork within a 39-hour "Field-based Teaching in Geography" course at the National Institute of Education, Singapore. The key objective of the field-based teaching course is to enable student teachers to construct and deepen their understanding collaboratively of how to plan and conduct field-based lessons in Geography. It is an experiential course where student teachers will experience field inquiries themselves. Student teachers are required to complete three sets of reflections as part of their portfolio for assessment. The guiding questions for each reflection are:

1. What have I learnt about the nature and role of sparking curiosity in field inquiry? How might I spark curiosity in my students about a field inquiry topic?
2. What have I learnt about the data collection and data representation in field inquiry? What implications does this understanding have on designing field inquiry for my students?
3. What are my key understandings and takeaways about field inquiry from this course? How do these guide me when designing field inquiry for my students?

These reflection pieces from the 36 student teachers were analysed to surface themes and issues for further discussion. This paper will provide some insights from the student teachers' reflections so as to understand how they themselves construct their understanding of fieldwork and their conception of the inquiry-based approach in fieldwork.

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Engineering Education with Mixed Reality (MR)

Nowadays, virtual reality (VR) is widely used in different applications such as healthcare, fashion, sports, education, commercial and entertainment, etc. Education and training is one of the leading area which is expected to grow to US\$2.2 billion in revenue by 2023. For the education and training in various disciplines, VR gives an opportunity to connect with learners and teachers in a novel and meaningful way. VR enables experiential learning by simulating virtual environments. It not only increases students' levels of engagement. Hands-on VR learning approaches can also contribute to increase cognitive and memory abilities. It is suggested that games, simulations, and virtual worlds in VR were effective in improving learning outcome gains of the students in higher education.

Mixed Reality (MR) is the most reason reality teahnology which encompassing both virtual reality (VR) and augmented reality (AR). MR further enhances the effects of VR technology in teaching and education. It not only allows digital model combined with real world, but also enable users to interact with the digital content dynamically in real time. MR allows interaction and feedback from the students which is particularly important for enhancing experience in teaching and learning. The benefits of incorporating MR technology into educational experiences include better engagement and the opportunity for students to experience and better remember what they have learned.

Despite various approaches have been developed to help students in understanding engineering subjects with the aids of VR, not much work has been conducted to investigate the effects of MR in teaching engineering subjects in tertiary education. Therefore in this project, an MR application is proposed and developed for the teaching and learning of Enigneering subject in tertiary education. The application is developed on the HoloLens system. A practicable application has been designed that allows students to visualize the geometry of 3D objects, as well as the exploded diagrams of selected components. The students can command the system through the command manual, or signal the system through gazing, gesturing and voice to implement instructions. We have organized two MR workshops for the teachers and students in the university to

collect their feedbacks and comments. The teachers and students are allowed to experience and develop their MR application in the workshops. It was found that the MR application can help students in understanding the learning outcome of the engineering subject in university, the workshops can also enhance the skills of teachers in teaching university subjects with the support of MR. The outcomes and recommendations for future work of the proposed MR application are discussed and explained.

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Assessment for Adequately Qualified Instructors in Maritime Education and Training Institutions

Introducing new technologies, knowledge, understanding and proficiency for seafarers is a challenging task for maritime instructors since it affects maritime safety. Effective teaching strategies depends on qualified instructors with STCW Convention requirements and adequate arrangement of teaching. According to STCW Convention every party shall ensure that all instructors of the Maritime Education and Training (MET) institutions are appropriately qualified for the particular type and levels of training. This article presents a review of factors that are not included in STCW Convention requirements and are very important for development of instructor's competences and the strategies for teaching and learning.

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A Platform for Teaching PLC System Integration and PLC Systems Data Access

The Programmable Logic Controllers (PLCs) are the industrial controllers of choice among control, automation, and design engineers. Therefore, automation and mechatronics engineering and technology programs to focus on teaching PLC programming. However, in real industrial systems PLCs are usually not installed or integrated alone on automated machines. Instead, third party products such as servomotors, variable frequency drives, vision systems, testing equipment, or robotics are often used to complement PLCs. In this paper we present a platform for teaching PLC system integration. To match the training needs of industry, our platform is a fusion of the following components that are based on different technologies: vision system, programmable logic controller (PLC), Human machine interface (HMI), and a gantry robot that is equipped with sensors, as well as vacuum suction and open-close gripper units. This has created a realistic system for teaching the principles and practices of integrating various technologies in a PLC based systems. In addition, this paper describes how we strategically deploy our platform to enhance student's skills in PLC machine integration. Finally, the paper presents examples of students' work to demonstrate the educational effectiveness of our platform.