INTRODUCTION

TO SPECIAL SECTION ON

2017 Chemical Engineering Faculty Summer School: THE FUTURE IS TODAY

Lisa Bullard
North Carolina State University • Raleigh, NC 27695

David Silverstein
University of Kentucky - Paducah • Paducah, KY 42002

Jason Keith
Mississippi State University • Mississippi State, MS 39762

Marina Miletic
Miletic Consulting • Albuquerque, NM 87112

One could not have asked for better weather or for better participation at the July 29 to August 3, 2017, American Society for Engineering Education (ASEE) Chemical Engineering Faculty Summer School. The 16th Summer School was held at the sprawling and contemporary campus of North Carolina State University in Raleigh, NC. As in previous Summer Schools, there were a plethora of sessions conducted by leaders in chemical engineering education and research posters presented by the newest generation of chemical engineering faculty to share their research and pedagogy.

Lisa Bullard, Kevin Dahm, Jason Keith, David Silverstein, and Don Visco worked for the previous five years preparing for the event, assisted by Matt Cooper, Chuck Coronella, Marina Miletic, and Troy Vogel along with a host of NC State student volunteers, including AIChE student chapter members and graduate students.

HIGHLIGHTS

By all measures, the 2017 Chemical Engineering Summer School was a resounding success. This Summer School had a total of 242 registered attendees (Figure 1), of which 171 were faculty members within the first 5 years of their career. Attendees came from 40 different U.S. states, Ontario, and British Columbia. The rapid growth and turnover of the ChE professoriate in recent years resulted in the largest Summer School to date.

An overview schedule for the summer school is shown in Figure 2. Most participants arrived on Friday night or Saturday and left Thursday afternoon. There was an all-day Teaching Institute on Saturday, conducted by Rich Felder and Rebecca Brent (Figure 3). The kickoffs to the Sunday, Monday, Tuesday, and Wednesday activities were invited plenary lectures by Phil Wankat; Nicholas Peppas; Tony Go and Buddy Lang; and TJ "Lakis" Mountziaris.

Dr. Lisa Bullard *is an Alumni Distinguished Undergraduate Professor and Director of Undergraduate Studies in the Department of Chemical and Biomolecular Engineering at North Carolina State University. She received her BS in Chemical Engineering from NC State and her Ph.D. in Chemical Engineering from Carnegie Mellon University. She served in engineering and management positions within Eastman Chemical Company from 1991-2000. A faculty member at NC State since 2000, Dr. Bullard's research interests lie in the areas of teaching and advising effectiveness, academic integrity, and instruction in material and energy balances and capstone process design.*

David L. Silverstein *is a Professor of Chemical Engineering at the University of Kentucky, and Director of the College of Engineering's Extended Campus Programs in Paducah, Kentucky, where he has taught for19 years. He received his BSChE from the University of Alabama and his MS and PhD in chemical engineering from Vanderbilt University. Silverstein's research interests include conceptual learning tools and training with a special interest in faculty development. He received the following ASEE ChE Division awards: Fahien for young faculty teaching and educational scholarship, Corcoran for best CEE article (twice), and Martin for best ChE Division paper at the ASEE Annual Meeting.*

Jason Keith *is the Dean and Earnest W. and Mary Ann Deavenport, Jr. Chair in the Bagley College of Engineering at Mississippi State University. Keith received his chemical engineering B.S. from The University of Akron and PhD from the University of Notre Dame. He was a faculty member at Michigan Technological University from 2000-2011, became Director of the Dave C. Swalm School of Chemical Engineering and holder of the Earnest W. Deavenport Chair at Mississippi State University in 2011, and became dean in March 2014. Keith, a Fellow of ASEE, received the Fahien Award from the ChE Division of ASEE.*

Dr. Marina Miletic *served as a Lecturer in the Department of Chemical & Biomolecular Engineering at the University of Illinois at Urbana-Champaign for eight years. Her research has focused on promoting concept-based learning in the classroom, developing Chemical Engineering video lectures, studying the efficacy of remote web-controlled Unit Operations experiments, and incorporating Design throughout the Chemical Engineering curriculum. She currently works as a freelance Engineering Education Consultant and Chemical Engineer.*

The majority of the formal Summer School program was comprised of concurrent workshop presentations, listed in Table 1. Thirty-eight unique workshops were offered, almost all of them delivered more than once to allow schedule flexibility. All workshops were interactive, collaboratively developed, and most were presented by more than one person. Sixty-six workshop presenters attended the Summer School representing academia, industry, and government agencies. Presenters from academia came from Canada, Hong Kong, and 24 U.S. states. Overall, there were 10 regular session blocks and two additional industry session blocks (Figure 4), allowing for great depth and breadth of pedagogical and career development instruction.

Figure 1. *The 2017 ASEE Chemical Engineering Summer School class, photographed in NC State's Talley Student Center prior to the final banquet.*

Each participant at the junior faculty rank was asked to present a poster in the evening poster session/mixers. There were also plenty of networking events, social activities, and open blocks to facilitate discussion between junior faculty participants with each other and also with seasoned faculty. The informal networking opportunities resulted in a great deal of camaraderie as shown in Figures 5 and 6. Many informal mentoring relationships on teaching and research resulted from the Summer School.

2017 ASEE Chemical Engineering Summer School Schedule

Time	Saturday (7/29)	Sunday (7/30)	Monday (7/31)	Tuesday (8/01)	Wednesday (8/02)	Thursday (8/03)
8:00		Education Plenary Prof. Phil Wankat	Summer School Lecture Prof. Nicholas Peppas	Industry Plenary Tony Go and Buddy Lang	NSF Plenary TJ "Lakis" Mountziaris	
8:30	Teaching Institute					Reflection Session
9:00						
9:30		Workshops	Workshops	Industry Day Session 1	Workshops	Workshops
10:00						
10:30						
11:00						
11:30						
Noon	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
12:30						
1:00	Teaching Institute	Workshops	Workshops	Industry Day Session 2	Workshops	Departures
1:30						
2:00						
2:30		Workshops	Workshops	Industry Day EXPO	Workshops	
3:00						
3:30						
4:00		Free Time	Networking Events	Networking Events	Free Time	
4:30						
5:00	Dinner	Picnic	Dinner	Dinner	Banquet	
5:30						
6:00						
6:30						
7:00	Welcome Reception	Poster Session/Mixer	Poster Session/Mixer	Poster Session/Mixer		
7:30						
8:00						
8:30						
9:00						

Figure 2. *Summer School Schedule*

SURVEY RESULTS

A post-conference, three-level Likert scale survey was conducted, and the results are shown in Figure 7.

These results show that the Summer School significantly impacted or impacted the teaching of 99% of attendees, the research of 58% attendees, and the professional service of 67% of attendees. The conference committee was happily surprised by these last two results. The junior faculty attendees formed research relationships with each other and with senior faculty (some won grants together or felt that they were more competitive for grants based upon what they learned). They were inspired to increase their level of service to the community and their involvement with ASEE and AIChE.

Figure 3. *The first day was comprised of a Teaching Institute plenary workshop facilitated by Rebecca Brent (President of Education Designs Inc.) and Richard Felder (Distinguished Professor Emeritus of Chemical Engineering at North Carolina State University.) Attendees learned the importance of active learning and its incorporation in courses, effective classroom teaching approaches, and how to balance coursework and research, among other topics.*

The impact of the summer school on the attendees' teaching is illustrated in the Drawn to Engineering comic and in the comments below:

> *Used open educational resources such as screencasts, lectures and polling tools produced through NSF and other granting agencies in my teaching. I would not have known about these*

otherwise.

In the past, I had toyed with the idea of flipping my course, but didn't have the courage to do so. The Summer School gave me great ideas that I could use to flip the class without taking a lot of time to prepare.

Flipped classroom, YouTube videos, simple demonstrations, etc. have made my class more lively.

A sampling of specific attendee comments regarding how the summer school impacted their research is shown below:

I found two collaborators at the summer school and we wrote two proposals to NSF and DOE together. This is not what I expected though since my mentality going there was to learn how to improve my teaching.

Figure 4. *Tuesday's emphasis was on Industry collaborations and featured an Industry plenary lecture, concurrent industry workshop sessions, and an EXPO. Here Jessica Rogers and Dwight Anderson represented International Paper at the EXPO session where faculty mingled with exhibitors.*

Figure 5. *Adam Melvin (Assistant Professor at Louisiana State University) presents his award-winning poster during one of the evening poster sessions. Adam attended the Summer School with his wife, Liz Melvin (Director of Academic Affairs at the College of Engineering at LSU) and three children Abby (6), Charlie (2), and Zach (7 months, pictured here.) They enjoyed family-friendly activities such as the children's museum mixer, barbeque picnic, and outings.*

The summer school deepened my understanding of engineering pedagogy which has led to improved proposals. I was successful in multiple grants last year and what I learned at the summer school helped greatly in achieving these results.

This helped in developing CAREER proposal especially integration of research and education. NSF CAREER proposal was successful.

Began a new collaboration on a side educational project. We are just finalizing the assessment now, and we hope to prepare a manuscript in the fall.

TABLE 1
List of Workshop Presentations

Workshop Title	Presenter(s)
LabVIEW & Data Acquisition as a Problem-Solving and Design Tool in ChE	Heidi Martin & R. Craig Virnelson, Case Western Reserve
Learn Aspen Plus™ in 24 Hours: A Modular Approach to Teaching Process Simulation	Thomas Adams II, McMaster & Mario Eden, Auburn
Methods and Tools to Help Students Learn Core ChE Concepts	Milo Koretsky & Tom Ekstedt, Oregon State & Margot Vigeant, Bucknell
New Faculty Career Development	Tim Anderson, U Mass & Geoff Prentice, NSF
Putting Chemistry in ChE Classes	Phil Westmoreland, NC State
SAFEZONE: Creating an Inclusive and Supportive Environment	Anthony Butterfield & Kyle Branch, Utah
Scale Up: Tools and Tips for Teaching a Large Class	Matthew Liberatore, Toledo, Daniel Burkey, U Conn & Reginald Rogers, RIT
Sustainable Design of Industrial Processes: Integration of Sustainability into the Curriculum	Mario Eden, Auburn, Yinlun Huang, Wayne State & Mahmoud El-Halwagi, Texas A&M
Students Are People Too – Tips on Advising	Taryn Bayles, Pitt & Joshua Enszer, Delaware
Taking it to the Next Level...Game-Based Learning in ChE	Cheryl Bodnar, Rowan, Daniel Burkey, U Conn, Joshua Enszer, Delaware & Daniel Anastasio, Rose-Hulman
Teaching Across the ChE Curriculum with Food!	Polly Piergiovanni, Lafayette & Margot Vigeant, Bucknell
Teaching Modules for Integrating Biological Systems Models into the Undergraduate Curriculum	Ali Cinar, IIT & Michael Henson, U Mass
Teaching Process and Product Design	Warren Seider, Penn, & Ka Ming Ng, Hong Kong Univ. Science & Technology
Unit Operations Laboratory	John Clay, Ohio State
Updating the Process Controls and Dynamics Course for the 21st Century	Wayne Seames, North Dakoka

Workshop Title	Presenter(s)
Using Arduino Microcontrollers in Your Classroom or Laboratory	Anthony Butterfield & Kyle Branch, Utah
Using Interactive Molecular Simulations to Help Students Understand Thermo, Transport, and Kinetics	David Kofke & Andrew Schultz, SUNY Buffalo
What are NSF Broader Impacts? How Does This Fit into Teaching and Outreach?	Caryn Heldt, Michigan Tech
You Too Can Flip! Overcoming Activation Energy Barriers for Active Learning in ChE Courses	Anna Bostwick Flaming & Julie Jessop, Iowa
Navigating the Curriculum and Guiding Student Chapters: Academic and Student Group Advising	Laura Ford, Tulsa
Application of Numerical Problem Solving in ChE Coursework	Robert Hesketh, Rowan & Michael Cutlip, UConn
Application of the Mass and Energy Balance in Preparing Students for Industrial Assignments	Marc Privitera, San Jose State & Paul Tucker, International Paper
Applied Statistics and Data Analytics	Richard Braatz, MIT & Michael Henson, U Mass
Breathing Life and Relevance into ChE Thermodynamics	Richard Spontak, NC State
Developing Successful Collaborative Research with Industry	Dwight Anderson & Shari Brown, International Paper & David Sholl & Krista Walton, Georgia Tech
Digital Tools Inside and Outside the Classroom for Enhanced Student Learning	Matthew Liberatore, Toledo & Daniel Lepek, Cooper Union
Engaging Students in the 21st Century: Using YouTube to Develop Course Content	Matthew Liberatore, Toledo, Margot Vigeant, Bucknell & J. Patrick Abulencia, Manhattan
ChE Course Packages	John Falconer & Katherine McDanel, Colorado
From Sage on the Stage to Guide by the Side: Design of Group Activities that Promote Meaningful, Consequential Learning	Milo Koretsky, Oregon State & Susan Nolen, Univ. Washington
Groups, Teams, and Conflicts	Kelly Cross, Illinois & Troy Vogel, Notre Dame
Hands-on ChE Design Projects for Use in Outreach Programs and Undergraduate Classes	Taryn Bayles, Pitt & Karen High, Clemson
How to Introduce your Students to Problem Solving and Troubleshooting Skills and Help Them Transition to the Workplace	H. Scott Fogler, Michigan & Steven LeBlanc, Toledo
Impactful TA Mentoring/Training for Optimized ChE Learning Experiences	Bihter Padak, South Carolina & Brad Bundy, Brigham Young
Incorporating Active Learning into ChE Courses – Practical Tips and Techniques	Wayne Seames, North Dakota
Incorporating Dynamic Simulation into ChE Curricula	John Hedengren, Brigham Young & Thomas Badgwell, ExxonMobil
Insights from Industry: Vendors Describe Industrial Equipment and Key Engineering Concepts	Leo Avila, EMCOR-Bahnson, Dean Mallon, Endress+Hauser & George Osenga, Thierry Plasma
Integrating Community-, Industry-, Research-, and Entrepreneurial Design Challenges into Core and Early ChE Coursework to Enhance Diversity	Vanessa Svihla & Jamie Gomez, Univ. New Mexico
Integrating Practical Examples in the Classroom	John Clay, Ohio State

A sampling of specific attendee comments regarding how the summer school impacted their professional service is shown below:

Summer school was a great opportunity to get to know others in the AIChE Education Division better. I now serve on a committee and as a session chair for the annual meeting.

Launched a curriculum review committee in our department.

Volunteered to work on committee integrating flipped classroom/online classes into our professional graduate program.

Joined ASEE and volunteered as a session co-chair for AIChE Annual Meeting, Ed Division Sessions.

Seeing so many in the field selflessly donate their time to help shape new faculty has been quite inspiring. I volunteer for committee services now, and once I settle in with my workload, I hope to be able to be more actively involved with ASEE as well.

Additional feedback from the attendees is summarized below:

It is a wonderful experience! I met a lot of people, and it is great to know other people who are going through the same difficulties, issues, and problems.

This was a great event! I met lots of great young faculty in a setting where we actually built some level of camaraderie and recognition even if our research areas don't necessarily overlap, and so it was a great network building opportunity in addition to the educational component.

Thanks so much for putting this on. I love coming together with the community of chemical engineering educators. I met new people, learned from new people, and reinforced professional connections in the arena. The location was great, and I appreciated so much that the committee did to make this event family-friendly. It was a fundamental experience that shaped my teaching. I am so glad I had the opportunity to go right before my first year. I hope this program can be offered more frequently

and help shape other junior faculty..

It was amazing -- hands down the most useful (and enjoyable) thing I've ever done professionally. I can't wait for the next one in four years! Even though I won't be a "new" faculty member anymore, I will do whatever I can to attend -- help plan, create a workshop, etc.

PREVIEW OF SPECIAL ISSUE PAPERS

The Summer School Special Section appearing in this issue of *CEE* features articles written by Summer School participants regarding topics presented at the evening poster sessions.

All attendees were invited and encouraged to present posters during the Sunday, Monday, and Tuesday evening poster sessions at the Summer School. Of all attendees, 136 presented posters during one of these nights. All posters were evaluated by a team of at least two judges, with each judge selecting an Outstanding Poster. Poster judges were selected among all workshop presenters.

Figure 6. *Sanchari Chowdhury (Assistant Professor at New Mexico Tech) chats with Tim Anderson (Distinguished Professor and Dean of the College of Engineering at the University of Massachusetts Amherst, and former CEE editor) on her poster "Teaching basic nanotechnology concepts to different audiences - middle schoolers to grad students."*

The list of awardees for Outstanding Summer School poster included: Samira Azarin, Fani Boukouvala, Janie Brennan, Shannon Ciston, Adam Ekenseair, Derek Englert, Ashlee Ford Versypt, Jamie Gomez, Ryan Robert Hansen, Lucas Landherr, Heather Mayes, Adam Melvin, Jake Nease, Jennifer Pascal, Courtney Pfluger, Thehazhnan Ponnaiyan, Neha Raikar, Rajib Saha, Kelly Schultz, Greg Szeto, Andrew Teixeira, Christy Wheeler West, Jason White, and Sarah Wilson.

All 24 awardees were invited to convert their poster into a *CEE* journal article. Ten papers were submitted to the review process, and eight papers were selected for publication. All papers were subject to the regular *CEE* refereed review process. These eight publications cover a wide breadth of pedagogical topics:

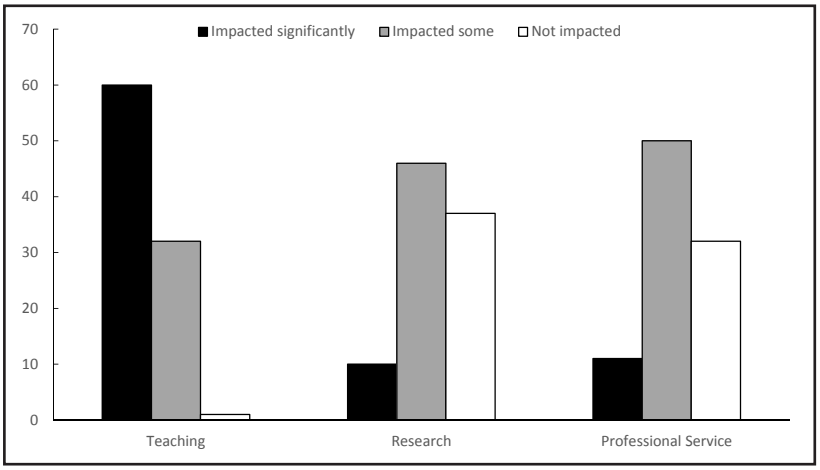

Figure 7. *Summer School Survey Results (n=93 participants). Survey was conducted at the end of the academic year following the event.*

Effect of Unit Operations Laboratory Course Structure on Learning and Self-Efficacy discusses the implementation of open-ended, problem-based projects in a laboratory course with the aim of enhancing student understanding, teamwork, and communication skills. Students are provided real world-based problems and typically asked to characterize systems, optimize performance, validate results, and make engineering recommendations. Results show increased student self-efficacy in communication skills and design, achievement of course learning objectives, and increased in-lab student engagement, regardless of gender or ACT score.

The use of self-reflection assignments as a means for student self-evaluation across 10 non-technical skills is described in *Self-Evaluation and Reflection for Professional Development of Chemical Engineering Students*. The self-evaluation rubric includes assessment for four Basic skills: Persistence, Organization, Connections, and Self-compassion and six Advanced skills: Courage, Mental resourcefulness, Communication, Diligent skepticism, Collaboration, and Reflection. This paper provides a valuable approach to helping students organically develop key non-technical skills in an authentic, progressive manner. Communication and Collaboration were the advanced skills which students felt they developed most across the semester.

The paper *ENGage LSU: How to Organize and Implement an Engineering Outreach Day for Middle Schoolers* discusses the successful engagement of middle school students in STEM activities through a college-sponsored outreach day. Students in grades 6-8 engage in hands-on activities focused

on bioengineering, nanoengineering, clean energy and water, cancer treatment, tissue engineering, and materials. The paper outlines unique activities which enhance desired outcomes, such as ice breakers, passports, a reflection portion, and concluding remarks discussion. This program also implemented a tracking program to see how many students enroll in engineering or STEM programs. The process is effective, as students leave the day more interested in pursuing careers in engineering and knowing much more about a variety of engineering fields.

A workshop and turn-based video game are combined to introduce undergraduate and high school students to types of power generation. *BLACKOUT: Teaching Students about the Power Grid through Experiential Workshops and Video Gaming* describes teaching students about power grids. The workshop introduces students to types of power generation and the advantages and disadvantages of each. The game portion has students compete against each other as electricity providers in an open market. This unique education approach is used to teach chemical engineering students about capital and operating costs, production, demand, and optimizing the sale of power. Students show significant improvements in perceived knowledge about power grids after completing this interactive project.

A classroom environment which combines online and in-class learning was a new approach employed in a Chemical Engineering Computation course to address instructional challenges including a lack of student engagement, difficulty applying active learning, and difficulty applying team approaches to teaching. In *Applying Blended Learning Techniques: Perspectives from Chemical Engineering Computation*, the use of pre-class online videos, concept questions, and in-class peer instruction were implemented to increase students' fundamental understanding as well as student engagement, accountability, and preparedness. The new course design also helped instructors determine students' misconceptions and topical understanding. Students reported favorable improvement in their perceived course learning.

In the paper *Chemical Engineering 'On-a-Chip': Capturing the Integrated Scope of Chemical Engineering in STEM Outreach*, instructors developed a hands-on educational module which integrates fundamental concepts with a laboratory experience of designing and fabricating a 'plant-on-a-chip' microfluidic device. This paper provides ideas on teaching reaction kinetics on a microfluidic scale through the example of scaling down the Landolt iodine clock reaction to the microliter level. Students meet specific mixing design criteria as well as evaluate and test their device. This active learning module approach integrates reaction fundamentals with a real world hand-on example to help students reinforce kinetics principles, understand the effects of scale-down on fluid flow, and better understand mixing, reaction, and residence time through direct data collection from their device.

Leveraging Students to Help Generate Senior Plant Design Project Topics discusses engaging students in the process of selecting capstone senior design projects for the purposes of offering more interesting and unique real-world open ended problems. This activity was also leveraged for improving perceived ABET outcomes achievement. Notable submission examples included "Production of naloxone to be administered to victims of an opioid overdose" and "Conversion of waste carbon dioxide and carbon monoxide into acetic acid and acetic acid derivatives." It appears the assignment was beneficial as the majority of the students felt they achieved targeted ABET outcomes. Underrepresented minority student responders felt they had achieved ABET outcomes (f) and (i) (ethics and lifelong learning) to a greater extent than non-underrepresented minority students. Three new senior design projects per year have been developed as a result of these student proposals.

Please enjoy these special issue papers!

FINAL THOUGHTS

The organizing committee would like to thank workshop presenters, plenary presenters, industry representatives, and attendees for their participation, enthusiasm, and attendance to this largest Summer School in its history. Please help us continue the tradition by offering a workshop at a subsequent Summer School to share the positive changes you have implemented in your courses and career. Based on the success of this event and continuing demand amidst growth in chemical engineering faculties, the next Summer School is planned for Summer 2021.

Those interested in gaining access to workshop, plenary, and other resources from the Summer School are invited to contact Kevin Dahm (dahm@rowan.edu). Access is restricted to faculty members to protect course materials, including solutions.

ACKNOWLEDGMENTS

The Summer School would not have been possible without external support that is gratefully acknowledged. A grant from the National Science Foundation (CBET #1703951), Diamond Sponsors Chevron and ExxonMobil, and Graphite Sponsor International Paper enabled the planning team to pay forward their experiences at past Summer Schools. Additional sponsors included Simulation Solutions, ZyBooks, Thierry Plasma, John Wiley & Sons, EMCOR – Bahnson, Endress+Hauser, Pearson Education, and the Education Division of AIChE. ❐