

REFLECTIONS AND ASSESSMENT OF THE 2022 CHEMICAL ENGINEERING SUMMER SCHOOL

MARGOT A. VIGEANT¹, DANIEL ANASTASIO², DANIEL D. BURKEY³, MICHAEL BARANKIN⁴, TARYN M. BAYLES⁵, LAURA P. FORD⁶, TRACY Q. GARDNER⁷, MILO D. KORETSKY⁸, DANIEL LEPEK⁹, AND MATTHEW W. LIBERATORE¹⁰

1. *Bucknell University • Lewisburg, PA 17837*

2. *Rose-Hulman Institute of Technology • Terre Haute, IN 47803*

3. *University of Connecticut • Storrs, CT 06269*

4. *Colorado School of Mines • Golden, CO 80401*

5. *University of Pittsburgh • Pittsburgh, PA 15261*

6. *University of Tulsa • Tulsa, OK 74104*

7. *Colorado School of Mines • Golden, CO 80401*

8. *Tufts University • Medford, MA 02155*

9. *Cooper Union • New York, NY 10003*

10. *University of Toledo • Toledo, OH 43606*

INTRODUCTION

The Chemical Engineering Summer School (ChESS) has a rich history within the chemical engineering education community.^[1,2] This week-long workshop began in 1931 and has been held every five years since 1962.^[1] Summer Schools in engineering were originally conceived of by William Wickenden under the auspices of the Society for the Promotion of Engineering Education (SPEE) and workshops were delivered in Mechanics (1927), Electrical Engineering (1928), Mechanical Engineering (1929), and Civil Engineering (1930) before the inaugural ChESS in 1931. However, only chemical engineers have consistently maintained a Summer School into the 21st century. Since its origins, ChESS has been primarily associated with the American Society for Engineering Education (ASEE), and more recently obtained joint affiliation with the American Institute of Chemical Engineers (AIChE), where it was formally retitled the ASEE/AIChE Summer School for Chemical Engineering Faculty as of 2021. We report here on the delivery of the 17th ChESS that took place at the Colorado School of Mines in Golden, Colorado from July 25-29, 2022.

The focus of ChESS is on the development of new faculty, typically within the first five years of their appointment, including both tenure-track faculty and fixed-term instructional faculty. ChESS also has been a nexus for more senior faculty to share emergent pedagogical practices, technology innovations, and strategies for social support.^[3] Specifically, the Organizing Committee for the 17th delivery of ChESS in 2022 identified two explicit goals:^[4]

1. To build community nationwide (and further!) within the newest cohort of ChE faculty and between the newer faculty members and the faculty who return to the Summer School as workshop presenters
2. To help newer faculty develop their toolbox for teaching, scholarship, and service

ChESS offers financial support for at least one new faculty member from every BS-granting chemical engineering program in the United States to attend the week-long workshop by soliciting grants from government agencies, industry, and education foundations. Most workshops are delivered by volunteer presenters from the chemical engineering education community, and several are offered by industry and funding agency partners. As technology has evolved, there have been corresponding efforts to archive ChESS workshop materials and related resources on CD-ROM, thumb drives, and the cloud.

One manifestation of the persistence of ChESS relative to Summer Schools in other engineering disciplines is the close connection to the discipline's education journal, *Chemical Engineering Education (CEE)*. Indeed, *CEE*'s very first issue promoted the 5th ChESS, advertising 49 workshop presenters. While sessions were mostly content-focused, they showed emerging signs of pedagogical practice (the purpose of the undergraduate laboratory) and workforce development (industry's opinion of the chemical engineering graduate).^[5] *CEE* has referenced the Summer School over the

years, evolving from advertising the upcoming 7th ChESS [6] to Final Reports from the 9th [7] and 10th ChESS.[8] Recently, *CEE* special issues have asked new participants from ChESS to expand their poster presentations into scholarly papers, leading to nine papers from the 13th ChESS [9] and eight papers from the 16th ChESS.[10] Calls expanded to also include workshop presenters from the 17th ChESS, leading to such a response that 25 papers will be included over three issues of *CEE*, including this one.[11]

While the persistence of ChESS and its inclusion into *CEE* implicitly suggest the goals are being achieved, there has been little evidence provided about the experience from the participants themselves, such as for the National Effective Teaching Institute.[12] There have been anecdotal reports of the positive impact of this event,[1,3] but it was not until the 16th ChESS that any data were provided where participants were surveyed about their experience and the potential impact.[10] Here we attempt to provide a systematic archival report of perceptions of benefits of the 17th ChESS in 2022 through a longitudinal survey strategy where participants provided responses immediately at the conclusion of the event and then again towards the end of the following academic year. This article builds upon a report initially presented at the 2023 ASEE Annual Meeting.[4]

In this study we ask the following research questions:

- Based on the perceptions of new attendees and workshop presenters, did the 17th ChESS achieve the organizing team's goals?
- What are the opportunities and challenges for future Summer Schools?

PROGRAM

The Program for the 2022 ChESS leveraged structures of previous Summer Schools.[1, 3, 5-10] More details on formal and informal programming and on funding and administration for the 17th ChESS in 2022 are reported in Ref. [4]. Figure 1 shows the overall program schedule, and Figure 2 shows a montage of photographs from the 2022 ChESS.

Reflecting a value for work-life balance, the Programming Committee chose not to start the 2022 ChESS on the weekend, leaving it one day shorter in length. The team also decided to reduce the number of parallel sessions to ensure that all the workshops had enough participants to promote interactive engagement. Taken together, these changes resulted in fewer repeated workshop sessions than at previous

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
8:00 AM		Welcome Reception	Outside ChE Plenary	Industry Panel	Diversity Plenary	
9:00 AM		Teaching Institute	Break	Break	Break	Reflection
10:00 AM		Teaching Institute	Session 3 (Pedagogy)	Industry Panels, Workshops, and Expo	Session 6 (Pedagogy)	Session 9 (Pedagogy)
11:00 AM		Teaching Institute	Session 3 (Pedagogy)	Industry Panels, Workshops, and Expo	Session 6 (Pedagogy)	Session 9 (Pedagogy)
12:00 PM		Lunch	Lunch	Lunch	Lunch	Lunch
1:00 PM		Session 1 (Content)	Session 4 (Content)		Session 7 (Diversity / Inclusivity)	
2:00 PM		Break	Break		Break	
3:00 PM		Session 2 (Content)	Session 5 (Pedagogy)	Social / Recreation Events	Session 8 (Content)	
4:00 PM		Networking Events	Session 5 (Pedagogy)		Networking Events	
5:00 PM						
6:00 PM		Dinner	Dinner	Dinner	Banquet	
7:00 PM	Informal Gatherings and Social Activities					
8:00 PM		Poster Session 1	Poster Session 2			
9:00 PM						

Figure 1. Overall Program Grid.

Summer Schools and in reducing the traditional teaching institute from a full day to a half day in the program. An additional driver for these changes was the growing pedagogical understanding within the community. Collectively, newer faculty are coming to the profession with more skills in teaching than in the past. Many graduate programs now feature formal opportunities for students pursuing academic careers to be involved in course development and teaching, and many universities have centers of excellence in teaching and learning where faculty and students can obtain professional development in their teaching skills. Simultaneously, as the field of engineering education research has emerged, many more presenters are doing scholarship on instruction, student learning, and diversity, equity, and inclusion (DEI).

Overall, 39 different sessions were offered, eight of which were offered twice. The volunteer-led workshops formed the core of the programming and were typically attended by 20-50 faculty. To ensure high-quality workshops and provide professional development to workshop presenters who may not have participated in Summer School previously, a virtual *Workshop on Workshops* was delivered approximately two months before ChESS in May 2022, facilitated by esteemed engineering education community members Rich Felder and Rebecca Brent. As in some prior Summer Schools, and in the spirit of inclusivity, proposers of similarly themed workshops were put in contact with each other by the Programming Committee, resulting in several presenters combining to deliver a joint workshop.

In addition to the workshops proposed by volunteer faculty, the 2022 ChESS included the half-day *Teaching Institute*, facilitated by Prof. Mike Prince from Bucknell University, as well as two morning plenary sessions. Then-AIChE President and Professor at North Carolina State University, Christine Grant, led a plenary focused on DEI Initiatives (“Unscripted... an IDEAL Chemical Engineering Journey”). Another plenary was an out-of-discipline perspective on STEM pedagogical practice by Prof. Mark Windschitl, a Learning Scientist from the University of Washington

(“Teaching Moves to Foster Student Engagement, Dialog, and Deeper Learning”). Finally, on Wednesday there was an Industry Expo, which allowed participants to interact with corporate and academic partners and sponsors, starting with the Gold Sponsor Plenary with 3M, Chevron, and Dow and followed by four vendor-sponsored workshops shown in Table 1.

A more significant shift from previous Summer Schools was the solicitation and organization of the workshops according to three major themes:



Figure 2. Clockwise from top left: (1) The 2022 Summer School Group Photo; (2) Dr. Taryn Bayles (Pitt) introducing Dr. Christine Grant (NC State and AIChE Past President) as a keynote speaker; (3) One of the evening Poster Sessions for New Attendees; (4) A live recording of the ChemE podcast “In the Fume Hood” hosted by Dr. Matt Cooper (NC State) with guests Dr. Michael Barankin and Dr. Tracy Gardner (Colorado School of Mines).

TABLE 1 Industry Day Workshops	
Title	Workshop Presenters
CHEMCAD™ Process Simulation Software and Support Material for Educators	Whitney Garcia
ChemE-Sports™ Overview: Dynamic Simulation Competition with <i>Petroskills Simulation Solutions Inc.</i>	Matt Garvey
Making the Most of Elsevier Engineering Products	Walter Coto
Teaching Chemical Engineering with MATLAB, Simulink®, and Hardware	Aycan Hacıoglu

1. Table 2 shows the titles and presenters for the 18 **Content** workshops, 90-minute sessions mainly focused on sharing materials and techniques that faculty could adopt directly into specific classes (e.g., transport phenomena) or on teaching them a specific skill (e.g., Python® programming).
2. Table 3 shows the titles and presenters for the 16 **Pedagogical** workshops, 150-minute sessions focused on higher-level learning and different frameworks and ideas for teaching and learning (e.g., active learning, flipped classrooms).
3. Table 4 shows the titles and presenters for the five **Diversity, Equity, Inclusion, and Justice** workshops, 90-minute sessions focusing on issues of social justice in teaching and learning.

In switching to dedicated mid-week plenaries on pedagogy and DEI, the Programming Committee wanted to ensure there was an interactive follow-up with workshops related to the ideas in each. The committee acknowledges putting workshops into themes meant that it was difficult or impossible to attend multiple workshops in a single theme. The trade-off that the Programming Committee chose was that the thematic approach encouraged all attendees to attend *at least* one workshop focused on each of the critical themes as well as giving them a mental model to think about their practice (i.e., that DEI stands alongside content and pedagogy as an essential area).

Feedback from previous ChESS participants highlighted the value and importance of building in time for networking, both structured and unstructured. To facilitate this, we drew

Title	Workshop Presenters
Advisor: Your Most Impactful Role	Lisa Bullard; Susan Montgomery
Applied Statistics and Data Analytics	Richard Braatz; Victor M. Zavala
* Becoming an Agent of Change: Theory and Strategy for Effective Change Planning and Implementation for New and Early Career Faculty	Donald Visco; Charles Henderson; Lisa Bullard; Jason Keith; David Silverstein
Brewing Beer and the Relation to Chemical Engineering	Kevin Cash
Chemical Engineering Laboratories: What Should We Be Teaching and How Should We Teach It?	Tracy Carter; Samira Azarin; Chris Barr; Janie Brennan; Amy Karlsson; Sarah Wilson
Creating a Culture of Academic Integrity Through Prevention, Detection, Reflection, and Accountability	Adam Melvin; Lisa Bullard
Entrepreneurially-Minded Learning for ChemEs (sponsored by KEEN)	Cheryl Bodnar; Matt Liberatore; Margot Vigeant
Grading: Easier, Better, Faster, Stronger	Joshua Enszer
Incorporating Dynamic Simulation into Chemical Engineering Curricula	Martha Grover; John Hedengren; Thomas Badgwell
* Incorporating Hands-on, Inquiry-based Learning Modules into the Chemical Engineering Classroom	Jennifer Weiser; Kristine Horvat; Courtney Pfluger.
Learn Aspen Plus® in 24 Hours – A Modular Approach to Teaching Process Simulation	Thomas Adams; Mario Eden
NSF Workshop: Grant Writing Tips with NSF CBET Division Director, CBET Program Director, and MCB Division Director	Jeanne VanBriesen; Raymond Adomatis; Theresa Good
Numerical Problem Solving across the Curriculum with Python and MATLAB® Using Interactive Coding Templates	Ashlee Ford-Versypt; Matthew Stuber; Robert Hesketh
Principles of Leadership for Engineers	Dennis Hess; John Flake
* Publishing Your Research on Education	Milo Koretsky; Allison Godwin; Donald Visco
Resources to Facilitate Active Learning	John Falconer
Teaching Engineering Ethics through Highly Interactive, Team-based, Playful Games	Beth Rundlett; Jennifer Fiegel; Daniel Burkey
Teaching Process Control Using Dynamic Simulations	Martha Grover; John Hedengren; Thomas Badgwell
* Workshop article in the three volume <i>CEE</i> Special Sections on ChESS	

TABLE 3 Pedagogy Workshops	
Title	Workshop Presenters
Art to Teaching: Using Comics to Improve Student Learning in Engineering	Lucas Landherr; Jennifer Pascal
* Development of Learning Assistants (LAs) to Improve Student Success	Sandy Pettit; Clifford Henderson
Effective and Equitable Team Learning	Victoria Goodrich; Troy Vogel
Enhancing Critical Thinking and Professional and Graduate School Readiness with Connected Teams, Analytics and Experimental Design in a Unit Operations Laboratory	Zenaida Gephardt
From Syllabus to Final Grades: Outcomes-Based Course Design, Delivery, and Assessment	Joseph A. Shaeiwitz; Daniel Lepek
Game-Based Learning for Challenging Topics in Chemical Engineering	Daniel Anastasio; Matthew Cooper; Cheryl Bodnar; Daniel Burkey
Hands-On Engineering Design Projects	Taryn Bayles; Joshua Enszer
Hands-On Interactive Learning in Fluid Mechanics & Heat Transfer with Virtual Options	David Thiessen; Zeynep Durak
* High Structure Course Design: What, Why, and How	Justin Schaffer
“How Do I Get My Students to Talk?” A Primer on Classroom Discourse That Helps Engage Students and Raises the Effectiveness of Working with Peers	Mark Windschitl
Methods and Tools to Help Students Learn Core ChE Concepts	Milo Koretsky
* Process Safety in Chemical Engineering: Frameworks and Approaches	Tom Meadowcroft; Tracy Carter; Cheryl Bodnar; Elif Miskioğlu; Dan Crowl; Hunter Flodma
Student-Centered Approaches to Textbooks	Matthew Liberatore; Daniel Lepek
The Applied Neuroscience of How We Learn	Dendy Sloan; Fernando Giráldez; Cynthia Norrgran
* Undergraduate Research: Benefits and Best Practices	Christy Wheeler West; Joseph Holles
Visual, Creative, Student-Written Problems for Any Course: Developing Unique Problems that Reverse Engineer YouTube™ Videos	Matthew Liberatore; Amanda Malefyt
* Workshop article in the three volume CEE Special Sections on ChESS	

TABLE 4 Diversity, Equity, Inclusion, and Justice Workshops	
Title	Workshop Presenters
Best Teaching Practices for Collaborative and Inclusive Environments in Teams	Sindia Rivera-Jiménez; Courtney Pfluger
* Building Effective Teams	Sandy Pettit; Clifford Henderson
Incorporating Anti-Racism and Social Justice into Class Examples and Homework Problems	Jennifer Cole; Alex Prybutok; Chloé Archuleta
* Promoting Mental Health and Wellness in Undergraduate Engineers	Sarah Wilson; Karin Jensen; Andrew Danowitz; Melanie Miller
University Citizenship	Laura Ford
* Workshop article in the three volume CEE Special Sections on ChESS	

from successful events from previous Chemical Engineering Summer Schools. There were informal but topically structured networking events on Monday and Thursday, after the last regular session of the day and before dinner. There were also two poster session events for new attendees on Monday and Tuesday evenings to allow participants to share their work, current or planned, as well as interact with more senior members of the community. Wednesday afternoon included a variety of social events, ranging from a Colorado Rockies baseball game to whitewater rafting, a guided bike tour, and tours of local points of interest.

A challenge in programming is the tension between the desire to maximize the content of this unique opportunity and the need or desire to have non-program time to attend to other work or personal matters as well as for informal interactions. Two program decisions were made to shift the balance a little more towards the latter. First, the program was limited to Monday morning through Friday lunchtime in a single week. Second, the time between nearly all program blocks was at least 15 minutes.

Finally, to promote informal interactions, facilitate community-building, and help connect new and established chemical engineering educators, a week-long networking game was used. This game involved seeking others who fulfilled specific prompts (e.g., someone who is attending their first ChESS, someone who teaches a specific class, someone from a specific region, etc.). The game served as a springboard to start conversations with new people during designated networking events or other interactions during mealtimes. For more detail, see Refs. [4] and [13].

METHODS

Participants and Setting

We divide ChESS participants into two groups: new attendees and workshop presenters. New attendees included 142 attendees from 88 institutions, primarily from the United States but including faculty from five Canadian universities and one other international university. The number of Chemical Engineering faculty who are on contracts other than tenure-track has been growing as in other sectors of higher education,^[14] and this is reflected in the attendees who were 22% professional / teaching track and 75% tenure-track, with the remainder being graduate students or post-doctoral researchers. The modal teaching load of all attendees was two courses per year, with a range from zero to over six. Of the attendees who shared demographic information, 38% identified themselves as women, 61% as men, and 1% as non-binary or another gender. Fifty-three percent (53%) described themselves as white, 34% as Asian, 10% as Black / African American, and 3% as another racial group. Nine percent (9%) of attendees reported they were of Hispanic origin.

The workshop presenters included 69 faculty, four of whom were also first-time attendees, as well as over 30 additional representatives sponsors and professional societies who attended the Expo on Wednesday of the program. Most presenters stayed several days and attended workshops other than their own. Several registered faculty were unable to attend for a variety of reasons, including the ongoing COVID-19 crisis. Two workshops also needed to be shifted to remote delivery due to COVID.

Survey Design, Administration, and Analysis

At the conclusion of the 2022 Summer School, participants were informed they would be asked to complete two anonymous surveys, both administered in Qualtrics®. Survey 1 was sent to all participants on the final day of the ChESS and asked for their immediate reflections and takeaways from the week. Questions centered on the achievement of the two core goals of the Summer School as articulated in the Introduction – building community and learning valuable tools.

Survey 2 was sent to all participants in March 2023, eight months after the workshop, to provide the opportunity for participants to further reflect on the experience and report how they actualized or implemented some of what they had learned in practice during the school year. The items focused on the longer-term impacts of the Summer School on participants' professional practice — what did they actually implement in their teaching or scholarship? Did they maintain connections with people they had met at the Summer School? Had new scholarly connections resulted from the connections made?

One-hundred fourteen (114) respondents completed this first survey. Of these 114, we report only the 111 who fully completed the survey, with 74 completed by new attendees and 37 completed by workshop presenters. Of the 74 new attendees, 19 were teaching/professional/fixed-contract track, 51 were tenure-track, and 3 were “other instructional staff” and 1 was “other.” For the 37 presenters, 13 were teaching/professional/fixed-contract track, 16 were tenure-track, 2 were “other instructional staff,” 3 were professional society members, and 3 were “other.”

Sixty-six (66) respondents completed at least part of this second survey. Of these 66, we report only the 52 who fully completed all of the questions in the survey, with 29 completed by new attendees and 23 completed by workshop presenters. Of the 29 new attendees, 10 were teaching/professional/fixed-contract track, 18 were tenure-track, and 1 was “other instructional staff.” For the 23 presenters, 7 were teaching/professional/fixed-contract track, 14 were tenure-track, and 2 were “other.”

Each survey had several open-ended items. Both surveys asked the question, “What are your top three takeaways from the Summer School?” Responses were coded by two

authors looking for confirming or disconfirming evidence of how the ChESS achieved its stated goals. Survey 2 asked “You answered ‘yes’ or ‘not yet, but I’m still planning to do so’ to the question ‘I’ve used at least one thing I learned at ChESS22.’ Please tell us what you learned that you’ve applied already / are planning to apply.” The results were coded using an emergent coding process to look for the most common or popular themes that participants put into practice.

Both surveys were reviewed and approved as exempt by Bucknell University’s Institutional Review Board, and only results from those who consented are reported here.

RESULTS

Survey 1 (July 2022)

Table 5 shows the responses to Survey 1 administered at the immediate conclusion of the 2022 Summer School, separated by new attendees and workshop presenters. The first two items were only provided to new attendees. Responses were overwhelmingly positive, with 78% of all of the selections corresponding to strongly agree (5) and 95% corresponding to either agree (4) or strongly agree (5). The only item with even a marginally equivocal response related to the connections with industry and professional societies, which accounted for 23 of the 47 total neutral responses and 9 of the 18 responses rated disagree or strongly disagree. Overall, like the 2017 ChESS findings,^[10] these survey responses indicate that both the new attendees and the workshop presenters believed the 2022 ChESS achieved the Organizing Committee’s goals of connecting with faculty and attending interesting and useful workshops facilitated by knowledgeable presenters.

In a free-response question participants were asked for their top three takeaways from their time at the ChESS. The most common takeaways aligned with the two stated goals of the 2022 ChESS. The most common response participants cited was that active learning is effective and related ideas on how to use active learning (54 responses). The next most frequently mentioned theme related to networking and community (51 responses) including the benefits of meeting and connecting with other faculty in similar areas or experiencing similar situations. For example, one new attendee wrote that it was “*reassuring to see my colleagues have similar struggles as junior faculty - I am not alone.*” One workshop presenter commented on the impact of “*seeing the overall strength of the chemical engineering education community and taking pride in the degree to which our field is striving.*”

Survey 2 (March 2023)

Results of Survey 2, administered towards the end of the following academic year, are presented in Tables 6 and 7, and the code counts from the qualitative coding are presented in Table 8. The vast majority of both attendees and presenters responding to the survey (49/52) “used at least one thing that I learned about or used a resource that was shared” at the Summer School in their professional practice. Respondents were asked to elaborate on this question in a follow-up free response item, which was then coded by two authors to identify the main themes. The most common themes are presented in Table 8 and include: Active Learning; Team Building; Lab Support; Online Resources (e.g., AIChE Concept Warehouse,^[16] LearnChemE^[17]); Coding Support (e.g., MATLAB, Python); Mental Health; DEI Integration; Project-Based Learning; and Rubrics). Most of these themes were also identified in the three “take-aways”

TABLE 5
Survey responses collected at the conclusion of the 2022 CHESS. Likert scale responses from strongly disagree (1) to strongly agree (5) and the average (\bar{x}) are reported

Item	New Attendees (n = 74)						Workshop Presenters (n = 37)					
	1	2	3	4	5	\bar{x}	1	2	3	4	5	\bar{x}
ChESS '22 was good for forming connections with newer faculty (Goal 1)	1	0	2	6	65	4.8						
ChESS '22 was good for forming connections with more experienced faculty (Goal 1)	1	0	1	7	65	4.8						
ChESS '22 was good for forming connections with other ChemE faculty (Goal 1)	1	0	3	7	63	4.8	0	0	0	0	37	5.0
ChESS '22 was good for forming connections with industry/prof. societies (Goal 1)	2	5	19	31	17	3.8	1	1	4	19	12	4.1
Presenters were knowledgeable (Goal 2)	1	0	0	13	60	4.8	0	0	0	1	36	5.0
Workshops were interesting (Goal 2)	1	0	3	22	48	4.6	0	0	0	5	32	4.9
Workshops were useful (Goal 2)	1	0	2	16	55	4.7	0	0	1	4	32	4.8
I would recommend ChESS to a colleague	1	0	3	3	67	4.8	0	0	0	0	37	5.0

TABLE 6
Responses From Follow-up Survey Conducted Eight Months After the 2022 ChESS

Item	New Attendees (n=29)			Workshop Presenters (n=23)		
	Yes	No	Planning To	Yes	No	Planning To
Since the conclusion of ChESS22, I've used at least one thing that I learned about or used a resource that was shared at ChESS22.	29	0	0	20	1	2
Since the conclusion of ChESS22, I've gotten in touch or stayed in contact with someone I met there.	18	5	6	17	6	0
I've started a new collaboration / project as a result of my participation in ChESS22.	5	13	11	5	13	5
ChESS22 had an impact on my teaching.*	28	1	0	19	1	1
ChESS22 had an impact on my service.*	16	13	0	15	6	0
ChESS22 had an impact on my scholarship.*	22	7	0	17	2	2

* Two workshop presenters did not complete the entire survey, resulting in 21 responses for those three items.

TABLE 7
Summative responses from participants 8 months after ChESS

Item	New Attendees (n = 29)						Workshop Presenters (n = 23)					
	1	2	3	4	5	\bar{x}	1	2	3	4	5	\bar{x}
Summer School was conducive for me to meet other Chemical Engineering faculty members.	0	1	0	2	26	4.8	0	0	0	2	21	4.9
Summer School was conducive for me to meet Industry and Professional Society representatives.	3	3	12	9	2	3.1	0	3	6	13	1	3.5
I would recommend the Chemical Engineering Summer School to a colleague.	0	0	2	0	27	4.9	0	0	0	0	23	5.0

in the free response question in Survey 1. In addition, several other themes were identified. Each theme was mentioned by one to three respondents (Advising Support; Societal Impacts of Engineering; Safety Education; Leadership Development; Research Development; Proposal Development; Ethics). This broad spectrum of participant-identified topics indicates the inclusive strategy of accepting many workshops with fewer repeats might be fruitful.

Connections formed at the Summer School also appeared to be durable, with 35 of 52 respondents noting that they had kept in touch with a colleague they met there, leading to 10 new collaborations and 16 planned collaborations. Attendees also reported that ChESS generally impacted teaching (47/50), service (31/50), and scholarship (39/50). Taken collectively, we conclude that the ChESS was an effective professional development experience for *both* new attendees and workshop presenters.

Table 7 shows responses for items similar to items asked in the immediate post-conference survey (Table 5). Like that survey, there was near-unanimous agreement that the Summer School is an excellent venue for meeting and in-

teracting with other chemical engineering faculty (47/52 rated strongly agree) and also near-unanimous agreement on recommending the Summer School attendance to colleagues (50/52 rated strongly agree). Despite the mid-week focus on industry and professional societies, however, again many attendees reported that the Summer School was not as useful a venue for interacting with those groups, with averages around neutral for new attendees (3.1) and only slightly higher for workshop presenters (3.5). The next Programming Committee should consider if they want to re-structure programming to focus more on industry and professional society partners.

While not all respondents chose to elaborate on their experiences in the free response portion of Survey 2, several themes arose highlighting what some participants saw as especially valuable and should be continued in the future, as well as things they felt were missing and should be added or included in future Summer Schools.

For the “yes, keep this” feedback, many respondents praised the breadth of workshops offered. While it did come at the expense of offering some workshops multiple times as

TABLE 8
Emergent Codes Identifying What Participants Implemented

Code	New Attendees (#)	Workshop Presenters (#)	Total
Active Learning	16	6	22
Team Building	9	6	15
Lab Support	3	4	7
Online Resources (e.g., Concept Warehouse, LearnChemE)	5	1	6
Coding Support (e.g., MATLAB, Python)	2	2	4
Mental Health Awareness	2	2	4
DEI Integration	2	2	4
Project Based Learning	2	2	4
Rubrics	2	2	4

in past Summer Schools, the breadth of programming was an intentional choice by the Programming Committee to try to cover as many topics as possible for as many diverse interests as possible. There was also praise for the social events. Striking a balance between programming time, free time, and “structured free time” such as organized social events was something the Programming Committee strove for in response to feedback from previous Summer Schools. The venue at Colorado School of Mines and the proximity to activities in and around Golden helped facilitate some of this activity, and that may be a consideration as future venues are chosen. Clearly, many respondents felt that the mix of workshops and social time was an important aspect of their experience as it allowed informal interactions and conversations to occur throughout the week.

For the “you should consider adding this” feedback, aside from some specific requests for certain social activities, a common theme was increased programming on both research development as well as graduate student mentoring. This feedback suggests that additional workshops on research development and proposal development outside of the National Science Foundation (NSF) sessions would be valuable, as would additional workshops specifically on graduate mentoring. Much of the Summer School programming was geared toward teaching-focused topics for faculty who will be new to the classroom. Programming that helps develop faculty also as mentors not just to undergraduates but also to their graduate students is a topic for future committees to consider for inclusion in the program.

CHALLENGES AND FINAL THOUGHTS

Evaluation of data collected in two surveys, one at the end of the workshop and a second well into the academic

year, indicates participants highly valued their experiences at the 17th ChESS in 2022. Participants indicated that the ChESS met its stated goals, with faculty taking away useful resources that they used in the classroom (and professional practice) and connecting with an enthusiastic, knowledgeable chemical engineering education community. One participant shared the following summative reflection, touching on how the two goals relate:

“I believe every new/newer faculty should attend ChemE Summer School. It was incredible to carve out time dedicated to teaching excellence and hear about a variety of related topics from other chemical engineers practicing those methods. I am grateful for the network of chemical engineering faculty ChESS helped cultivate, and I look forward to rooting my peers on in the upcoming career milestones. 10/10 would recommend Summer School!”

However, this assessment also provided insights both for future ChESS organizers to consider and for the greater chemical engineering education community. First, we should consider the extent of our reach within chemical engineering – who chooses to participate and who does not. As one workshop presenter summarized:

“All faculty members need to attend this workshop; we, as Faculty, get limited training on education and available resources. This is particularly true at research-focused universities.”

This sentiment aligns with the following poignant response from a new attendee:

“Very few faculty from peer institutions (places where I will go for tenure letters) were in attendance (either junior or senior faculty). This communicated to me that the content of the Summer School was not valued by the faculty at these institutions and as a result I don’t think it is the best use of my effort to pursue further professional development in this area.”

When reconciled with respect to otherwise very positive indications of this participant’s ChESS experience (e.g., “There are a number of small things that are possible to do to become a better instructor and create a more inclusive classroom;” “There is a passionate community of educators in chemical engineering who are doing great work to help us teach students better”), such a choice appears cultural. This “culture of disengagement” is antithetical to that of faculty at prestigious research universities from earlier periods in our history, such as when William Wickenden conceived of the Summer Schools in 1925, when Warren Lewis presented in 1931, and when Jud King was co-chair of the 1977 ChESS.^[1]

This affects the quality of undergraduate education in those highly ranked research institutions. Importantly, many PhD graduates from those institutions go on to teaching positions thereby multiplying the effect.¹¹⁵ We advocate for our community to disrupt these cultural norms generally, and, as a start, the Organizing Committee for the 18th ChESS should consider targeting recruitment of new attendees and even workshop presenters from these institutions.

To this end, we encourage future organizers to identify some areas, such as PhD student advising and post-doc mentoring, where they invite presenters who might otherwise miss the open call because they are not ASEE Chemical Engineering Division or AIChE Education Division members. To help support attendees, if possible, it would be good to offer onsite support for those faculty who have a caregiving role while they attend workshops; while the organizers found and shared information about local daycare and elder care centers, none of the local centers were offering drop-in hours due to decreased staffing. This is not easy to remedy but would be of tremendous help to some members of the community. The survey showed that ChESS did not facilitate interactions with industry and professional societies at the same level as new faculty with one another and with more experienced colleagues. However, that may be reasonable given all the other activity of the week. In this regard, future organizing committees should visit the length and scope of Industry Day. Finally, the organizers are aware of significant interest among mid-career faculty (and perhaps graduate students) to be able to attend ChESS itself or something similar. Currently, this is possible as a presenter, but that pathway could be made more widely available, perhaps through a separate event.

The ASEE/AIChE Summer School for Chemical Engineering Faculty is a special event that supports faculty development and connections to the chemical engineering education community. As we approach the centennial ChESS, we encourage continued participation, feedback, and growth that can sustain Summer School for another 100 years.

IN MEMORIAM

We dedicate this article to co-author Daniel Lepek, who sadly passed away during its writing. We miss you, Daniel!

ACKNOWLEDGMENTS

Providing the opportunity for each chemical engineering department in the United States to send one faculty member to attend the Summer School with all local expenses paid and to cover support for the volunteer and plenary workshop presenters is no small endeavor, and the authors are grateful for the financial and logistical support to deliver this workshop.

The 17th ChESS in 2022 would not have been possible without support from the National Science Foundation under Grant CBET-2204362, and generous sponsorship from Chevron, 3M, Dow, Kern Entrepreneurial Engineering Network (KEEN), AbbVie, Amgen, Bristol-Myers Squibb, Eli Lilly, the AIChE Foundation, ABET, Chemstations, Elsevier, Mathworks, Pearson, Petroskills, and Wiley/zyBooks. We are also grateful to the many faculty members who volunteered their time and provided expertise and to the support of the Conference Services at Colorado School of Mines. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

REFERENCES

1. Hanesian D, Buonopane R, and Perna A (2012) History of the ChE Summer Schools. *Chem. Eng. Ed.* 46(3): 196-203. <https://journals.flvc.org/cee/article/view/121964>.
2. Wankat P (2009) The history of chemical engineering and pedagogy: The paradox of tradition and innovation. *Chem. Eng. Ed.* 43(3): 216-224. <https://journals.flvc.org/cee/article/view/122315>.
3. Cutlip M, Fogler H, and Slater C (2003) The ASEE Chemical Engineering Summer School for New Faculty. *Proceedings of the ASEE Annual Conference*.
4. Vigeant, M, Anastasio D, Barankin M, Bayles T, Burkey D, Ford L, Gardner T, Koretsky M, Lepek D, and Liberatore M (2023, June) Preliminary reflections and assessment of the 2022 Chemical Engineering Summer School. *Proceedings of the ASEE Annual Conference*.
5. Cooper A (1962) A.S.E.E. Summer School for Chemical Engineering Teachers, *Chem. Eng. Ed.* June 1962: 34. <https://journals.flvc.org/cee/article/view/127370>.
6. Staff CEE (1972) Chemical Engineering Division activities. *Chem. Eng. Ed.* 6(1): 51. <https://journals.flvc.org/cee/article/view/126395>.
7. Staff CEE (1984) Division activities: Final report: 1982 ASEE Summer School for ChE Faculty. *Chem. Eng. Ed.* 18(2): 53-55. <https://journals.flvc.org/cee/article/view/124754>.
8. Schrader G and Larson M (1987). 1987 Summer School. *Chem. Eng. Ed.* 21(4): 168-169. <https://journals.flvc.org/cee/article/view/124386>.
9. Barabino G (2003) Introduction: Strategies for effective teaching in chemical engineering. *Chem. Eng. Ed.* 37(3): 168-169. <https://journals.flvc.org/cee/article/view/122725>.
10. Bullard L, Silverstein D, Keith J, and Miletic M. (2019) Introduction to special section on 2017 Chemical Engineering Faculty Summer School: The future is today. *Chem. Eng. Ed.* 53(3): 139-144. <https://journals.flvc.org/cee/article/view/114402>.
11. Koretsky M, Burkey, D, Godwin, A. (2023) Introduction to a special section on the ASEE/AIChE Chemical Engineering Summer School. *Chem. Eng. Ed.* 57(4): 166-168. <https://doi.org/10.18260/2-1-370.660-134568>.
12. Felder R and Brent R (2010) The National Effective Teaching Institute: Assessment of impact and implications for faculty development. *J. Eng. Educ.* 99(2): 121-134.
13. Anastasio D (2023) Promoting networking and engagement using a scavenger hunt app. *Chem. Eng. Ed.* 57(4): 200. <https://doi.org/10.18260/2-1-370.660-132214>.
14. Kezar A, DePaola T, and Scott D (2019) *The Gig Academy: Mapping Labor in the Neoliberal University*. Johns Hopkins University. Press, Baltimore, MD.
15. Mathieu R, Austin AE, Barnicle K, Campa III H, and McLinn C (2020) The center for the integration of research, teaching, and learning: A national-scale network to prepare stem future faculty. *New Dir. Teach. Learn.* 2020(163): 45-53
16. AIChE Education Division Concept Warehouse. <https://concept-warehouse.tufts.edu/cw/CW.php>. Accessed Dec. 26, 2023.
17. LearnChemE. <https://learncheme.com/> Accessed Dec. 26, 2023. □