

## **Baseline Data on CHE Teaching Focused Faculty in the U.S.**

### **Dr. Stephanie Butler Velegol, Penn State University**

Stephanie Butler Velegol is a Teaching Professor in Chemical Engineering at Penn State University. She pioneered the use of Flipped classes to increase active learning in the classroom and works on water treatment.

### **Dr. Katie Cadwell, Syracuse University**

Katie Cadwell is an Associate Teaching Professor in the Department of Biomedical and Chemical Engineering at Syracuse University, where she has taught Chemical Engineering core courses since 2011. After receiving Chemical Engineering degrees from the Missouri University of Science and Technology (BS) and University of Wisconsin-Madison (PhD) she pursued an engineering education and outreach post-doc and taught at Madison College for several years.

### **Dr. Taryn Melkus Bayles, University of Pittsburgh**

Taryn Melkus Bayles is a Professor, Teaching Track, in the Chemical & Petroleum Engineering Department at the University of Pittsburgh, and serves as the Undergraduate Program Director. She has spent part of her career working in industry with Exxon, Westinghouse, Phillips Petroleum and Pittsburgh Energy Technology Center (now NETL). Her industrial experience has included process engineering, computer modeling and control, process design and testing, and engineering management. She has also spent 25 years teaching Chemical Engineering at the University of Nevada Reno, University of Pittsburgh, University of Maryland College Park and the University of Maryland Baltimore County. Her current research focuses on Engineering Education and Outreach. The goal of this research is to increase awareness of and interest in pursuing engineering as a career, as well as to understand what factors help students be successful once they have chosen engineering as a major.

### **Dr. Lisa G. Bullard P.E., North Carolina State University**

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 St

### **Dr. Mechteld Veltman Hillsley, Penn State University**

Dr. Hillsley is a Teaching Professor in the Department of Chemical Engineering at Pennsylvania State University. She received a BS in Chemical Engineering from Virginia Tech in 1988 and an MS and PhD from Penn State in 1990 and 1994, respective

## Introduction

Teaching-track faculty serve important roles in Chemical Engineering departments around the country, but historically these roles have been overlooked and understudied. For this paper, we will refer to these faculty as “Teaching-Focused Faculty” (TFF). Part of the reason for the opaqueness of this is that these faculty are hired to serve a variety of roles. Some come from years of experience in industry and are hired to teach the design course while others chose to enter a teaching-focused job right out of their PhD or post-doc position. For many years, most departments did not have a way of promoting these faculty and sometimes did not even have the appropriate titles. However, in recent years numerous institutions have developed clear guidelines for promotion for these faculty.<sup>1</sup>

It has also been difficult to find data on these TFF. Nationally, faculty who are not on the tenure-track or tenured make up almost half of all faculty. National data from Institution of Educational Services (IES) reports that out of 728,013 total faculty at Title IV granting universities, 57% are tenured/tenure-track (T/TT) while 39% are nontenured. Of those who are nontenured, 56% are on a one-year contract, 28% are on a multiyear contract, and 16% are on a contract that is indefinite.<sup>2</sup> Focusing on engineering, the latest ASEE report in 2018 found that there are 5026 non-tenure track faculty who make up 14.4% of the total faculty in engineering. Also, in 2018, Bayles reported that 8% of all 2323 chemical engineering faculty in the US were on the teaching track<sup>3</sup>.

The Education Division of the American Institute of Chemical Engineers (AIChE) started a peer group for TFF in 2022. This group has met monthly on Zoom as well as in person at the AIChE and ASEE national conferences. The goal of this group is to create community and provide professional support to TFF in chemical engineering. Meetings include teaching tips for the classroom, ways to get involved in ASEE and AIChE, ways to get involved in engineering educational scholarship, and how to get promoted and/or recognized for their work. This group started with 45 members, but we realized that many more TFF were in the US, so we sought to find them and invite them to the group. We also decided to use this group to identify trends in TFF. Last year at ASEE, we surveyed 41 members of the group who represented 30 institutions. We found that most of them have a documented process for promotion. We also found that 63% teach lab courses and 39% teach design. In terms of service, we found that 66% act as academic advisors, and almost 50% oversee ABET. Finally, we found that just under half of these faculty participate in engineering education scholarship and that 76% have funding to attend at least one conference per year. However, we quickly realized that we were not including all the TFF in chemical engineering in the US.

The purpose of this paper is to more broadly report on the state of Teaching-Focused Faculty (TFF) in chemical engineering (ChE) in the United States. This includes the number of TFF and the percentage of TFF in various departments, as well as typical workloads, compensation, and professional development opportunities. This information will allow faculty to make informed decisions when considering a TFF position and will also help department heads in hiring and supporting TFF.

## Methods

The approach to obtaining this information about TFF in ChE required that we first determine the total number of TFF in ChE departments in the US. First, the number and name of all the ChE departments were obtained from the ABET website.<sup>4</sup> There were 165 departments listed in the search. Then an email was sent out to all the ChE department heads with a survey that asked for their name, the name of their institution, the number of full-time faculty (including TFF), and the number of TFF. We also asked them to list the names of the TFF and to list options for how they currently support these faculty.<sup>5</sup> This initial survey resulted in 51 respondents.

Another survey was then sent to the individual Teaching-Focused Faculty (TFF) in the AIChE group if their department did not respond. That resulted in the names of TFF in 23 more departments. The authors then looked up the emails for all the TFF listed. For the remainder of the departments, the authors went to the website of the department and did their best to count the total number of faculty and TFF and to record the names and emails of the TFF. There are errors implicit in this technique, as it was not always clear from the website if faculty were full-time or part-time, and titles are not consistent across departments and universities. Detailed information about six departments could not be found, and those departments were not included in the data below. The total number of departments recorded was 159.

We were also interested in the experiences of the TFF in each department, including the salary, courses taught, service, research, demographics, etc. To ascertain this information, we prepared an anonymous Qualtrics survey that was emailed to all 279 identified TFF with IRB permission. A complete list of questions can be found in the Appendix and is summarized in Table 1.

**Table 1: Questions from the survey sent to TFF.**

Teaching and service	Professional development	Department and personal demographics
How long have you been a TFF?	What is your current title?	R1, R2, M1, M2, M3, PUI, HBCU?
Contract length?	Have you been promoted?	Ranking of dept?
How many courses/sections in academic year?	Does your institution have a policy for promotion of TFF?	Class size in core courses?
How many students in each course/section?	How did you get your current TFF position?	How many students graduate per year?
How many courses for TTF?	What is your base salary?	How many TFF? How many full-time faculty?
What courses have you taught?	What is the length of your appointment?	Age
What service do you do?	Do you receive summer salary? For what?	Highest degree
Did you work in industry after your BS? How many years?	Can you take sabbatical?	Race, ethnicity
Are you working on: engineering education scholarship? technical engineering scholarship?	Do you receive funding: To attend national meetings? For scholarship? For professional development?	Did you attend college in the US?
<p>In addition, we asked some open-ended questions such as:</p> <p>What is most rewarding about your TFF position?</p> <p>What changes would you like to see in terms of support for TFF at your institution?</p> <p>How do you feel your department perceives the role of TFF?</p> <p>Do you feel you have the support you need to function well in your role as a TFF?</p>		

## Results and Discussion

### ***Summary of Total ChE Faculty and TFF***

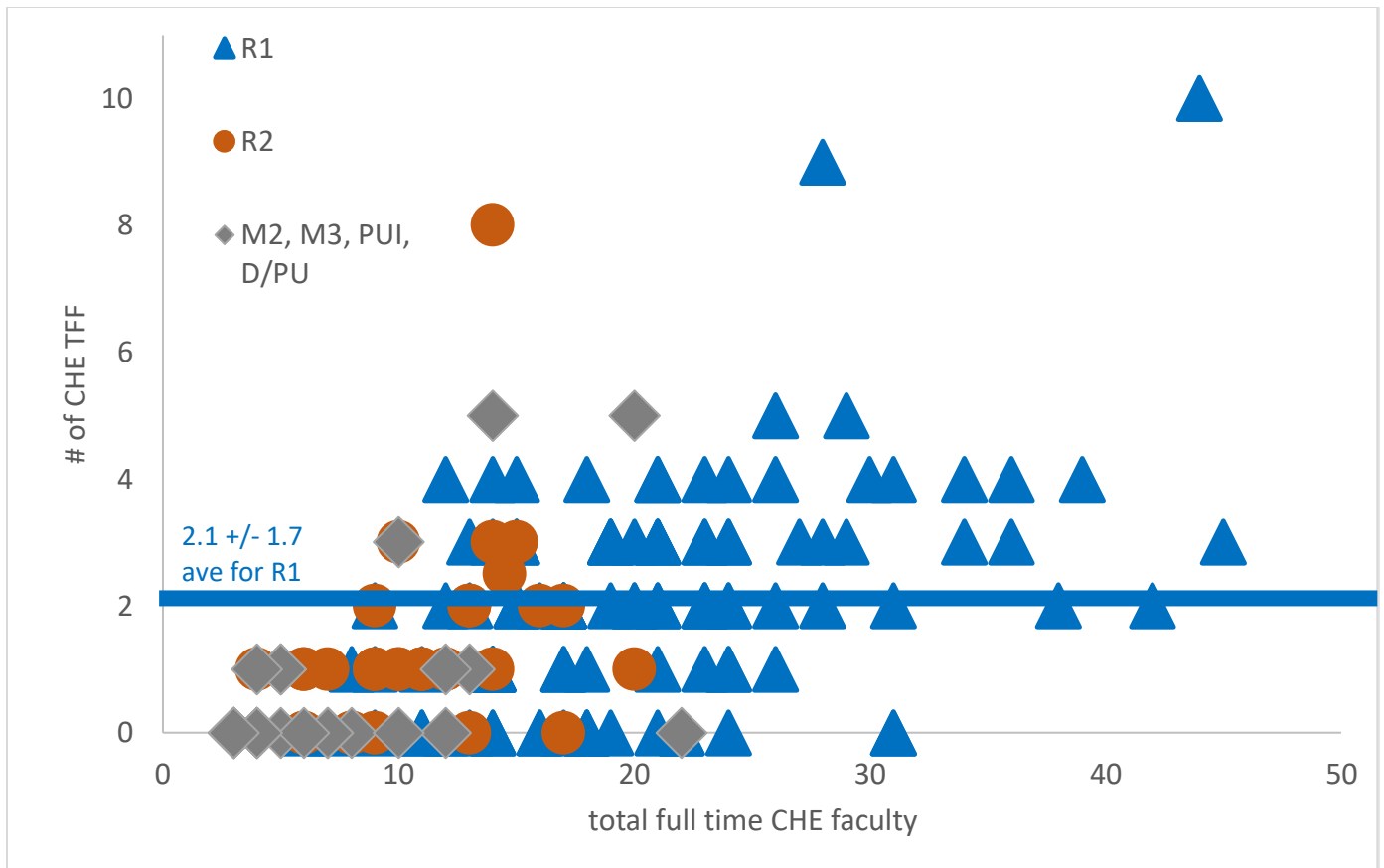
A summary of the total ChE faculty and TFF is found in Table 2. Overall, we found 2706 total ChE faculty in the US with 279 of those being TFF at the 159 universities that we considered. This means that approximately 10% of all current CHE faculty are teaching-focused faculty (TFF). Most of the total faculty (80%) and TFF (78%) are teaching at R1 institutions. The bottom of Table 2 shows the data from 2018 and indicates a 16% increase in total faculty and a 50% increase in TFF in chemical engineering. The data from 2018 were estimated by using data from publicly available departmental websites. The data in this paper comes from survey data for 74 departments and from websites for the other 85 departments. Thus, it is unclear if the difference reflects only changes in numbers or differences in available data on websites. For example, some departments do not differentiate teaching non-tenure track faculty from tenure-track faculty on their website's title designations. This underscores the need to more formally track numbers of TFF in chemical engineering.

**Table 2: Number of total ChE faculty and Teaching Focused Faculty (TFF) in R1, R2, M2, M1, PUI and D/PU Universities.**

	Total # of departments	Total faculty in ChE (% total)	TFF in ChE (% total)	% TFF in department
R1: Doctoral – Very high research activity	103 (103)*	2161 (80%)	217 (78%)	10%
R2: Doctoral – High research activity	32 (31)	354 (13%)	44 (16%)	12%
M2: Masters medium programs	8 (8)	72 (2.7%)	6 (2.2%)	8.3%
M1: Masters larger programs	7 (6)	49 (1.8%)	10 (3.6%)	20%
PUI: Predominantly undergraduate institutions	11 (8)	53 (2.0%)	2 (0.7%)	3.8%
D/PU: Doctoral/ Professional Universities	4 (3)	17 (0.60%)	0 (0%)	0%
<b>Total</b>	<b>165 (159)</b>	<b>2706<sup>6</sup></b>	<b>279</b>	<b>10%</b>
<b>Total from 2018**</b>		<b>2323</b>	<b>185</b>	<b>8%</b>

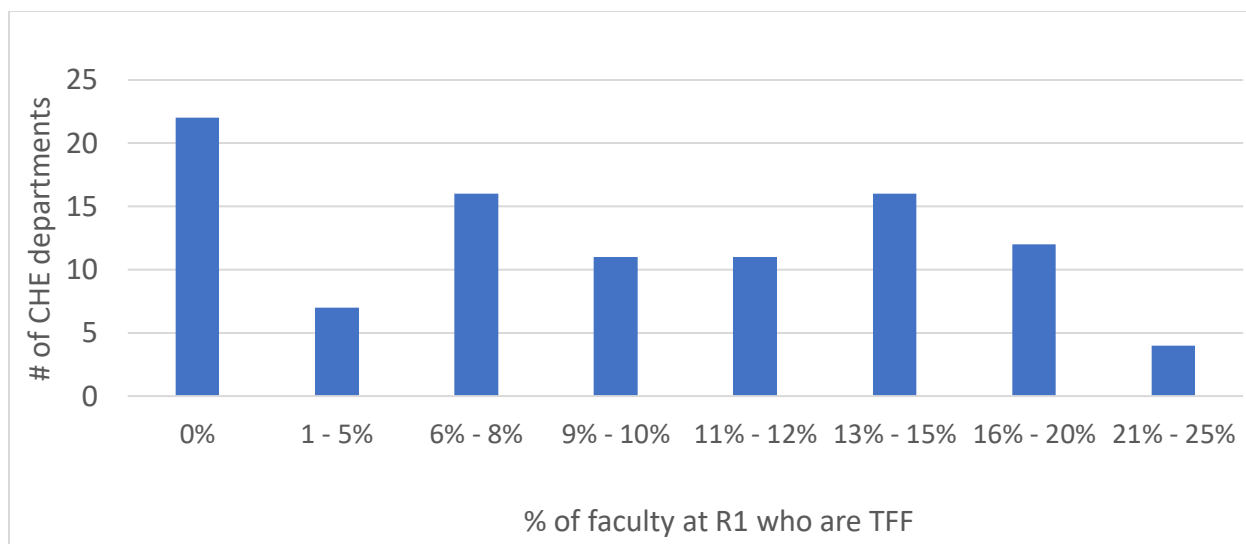
\* Some departments did not have faculty on their website so we could not count them. The number in the parentheses is the number of departments that we used for faculty numbers.

\*\* These data were from Bayles, Taryn Melkus (2020) Alternatives to the tenure track. *Chemical Engineering Education*. 54(1): 14-21.



**Figure 1: The number of CHE Teaching-Focused Faculty (TFF) in each department do not follow a clear trend based on total number of faculty for R1 (blue triangles), R2 (orange circles), and PUI/M2/M3 (gray diamonds).**

It is also interesting to look at the average number of TFF at an institution. At R1 institutions, there are 2.1 +/- 1.7 TFF. There is much more variability for the R2 institutions and PUI/M2/M3, with an average of 1.4 +/- 3.8 and 0.69 +/- 5.3, respectively. This can also be seen in Figure 1 as a function of the size of the faculty. This high standard deviation indicates a broad distribution so we further broke down the percent faculty who are TFF at R1 Universities as shown in the distribution in Figure 2. This shows a distribution from 0% to 25% with an average of 10%.



**Figure 2: Histogram of the percent of the faculty who are TFF at R1 institutions. The average is 10% but ranges from 0 – 25%.**

### ***Demographics of TFF Who Responded to the Survey and Institutions That are Represented***

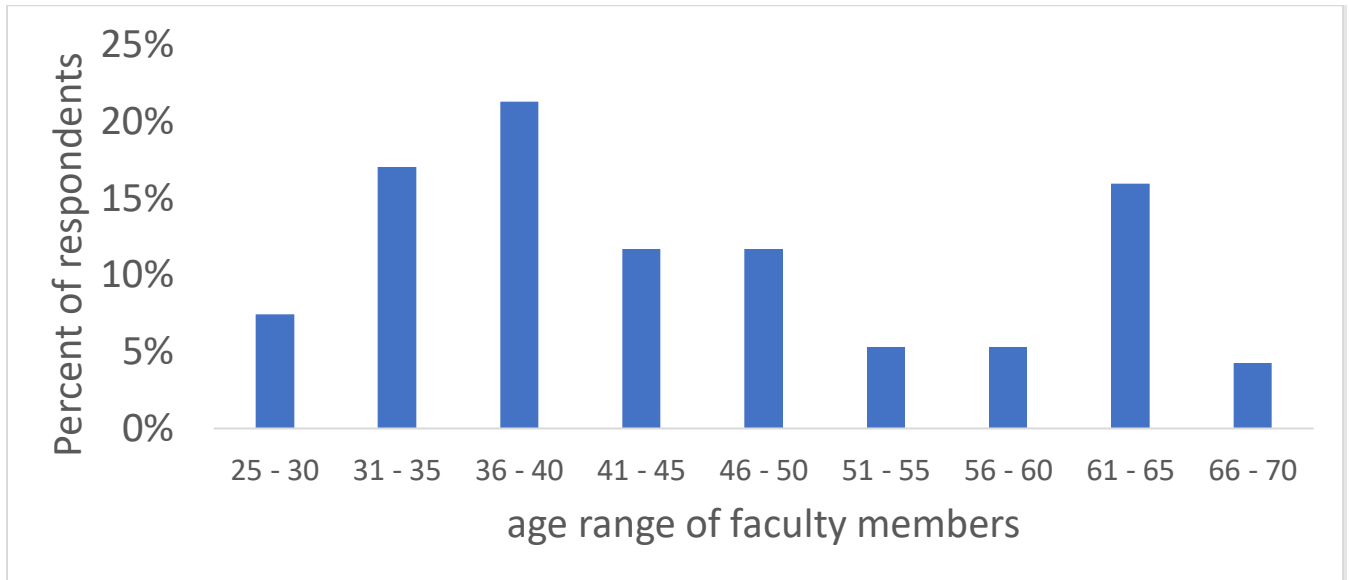
The survey was sent out to further explore the experience of the TFF in chemical engineering. Out of the 104 people who responded to the survey, 96 people completed the survey and 8 completed part of the survey. This means that 44% of the ChE TFF in the US completed the survey. We were interested in the demographics of the respondents to ensure that we were capturing an appropriate sample of faculty. As seen in Table 3, 81% of the respondents identified as white/Caucasian with 8.9% Asian, 2.2% Black or African American, and 7.8% Hispanic. The teaching focused faculty surveyed here are comprised of a lower percent of faculty who identify as Asian (8.9%) than the tenure/tenure-track faculty in CHE (T/TT ChE) (23.9%) and the teaching focused faculty in all engineering disciplines (28%).<sup>6</sup>

In addition, we found that the majority (84%) of the faculty were trained in the US for both undergraduate and graduate school, with 13% doing only graduate school in the US and 2.1% having no education in the US (1% responded with “other”).

**Table 3. Demographics of survey respondents (TFF in ChE) compared to tenure (T) and tenure-track (TT) ChE faculty and TFF in engineering.**

	% in TFF ChE (our survey)	% in T/TT ChE (From ASEE 2018)	% TFF in engineering (From ASEE 2018)
White or Caucasian	81%	69%	55.9%
Asian	8.9%	23.9%	28%
Black or African American	2.2%	2.6%	2.4%
Hispanic	7.8%	4.7%	3.7%

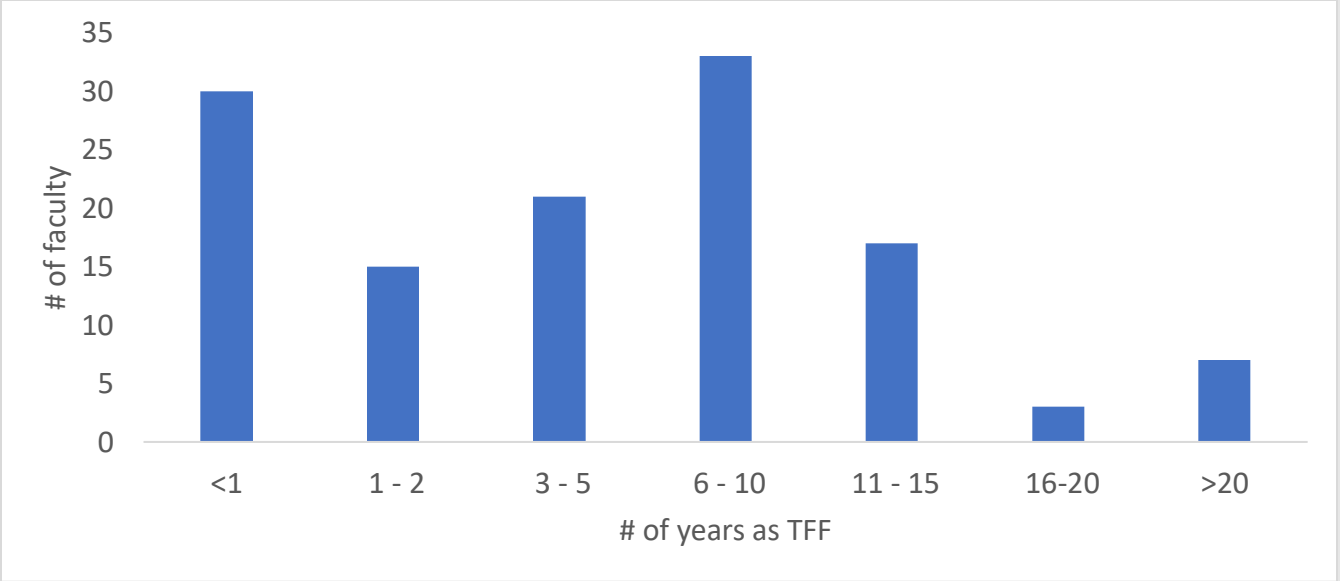
Figure 3 provides the age range of the participants. This is a relatively young group, with 46% being under the age of 45. The highest number of participants is 36 – 41 followed by 31 – 35 and then 61 – 65 and there is representation across all ages.



**Figure 3: Age range of survey respondents.**

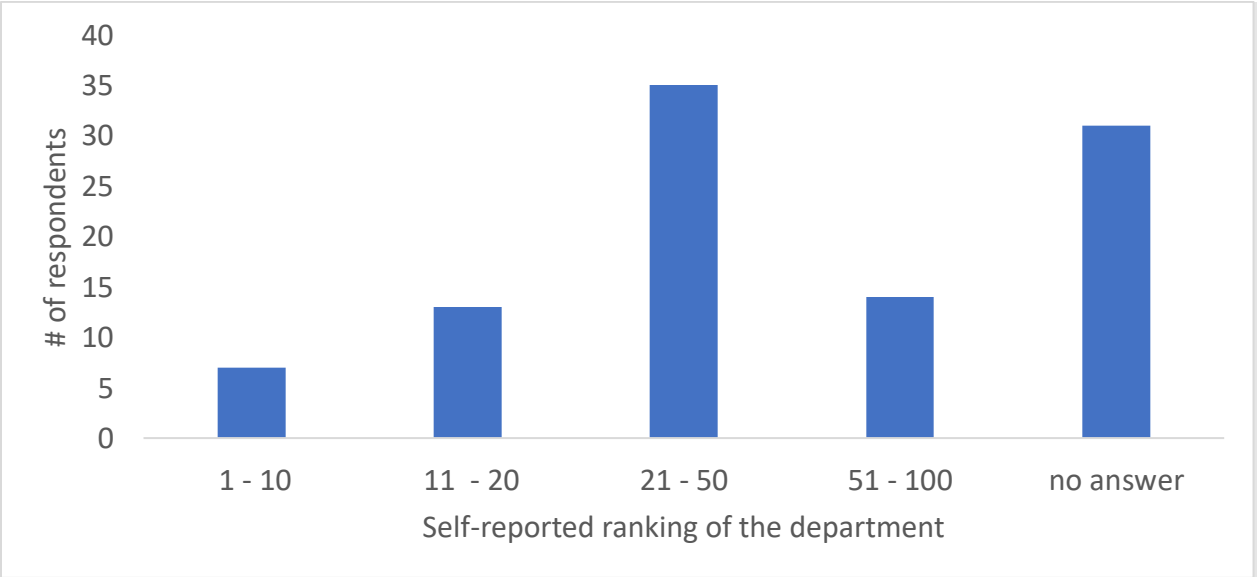
In addition to their age, we wanted to make sure that we had a representation of faculty with a range of experience as a TFF. Figure 4 shows a broad range of years of experience, especially below 15 years. Almost a quarter (24%) of the respondents have been working as a TFF for less than one year, and just over a quarter (26%) have been working as a TFF for 6 – 10 years. Thus, half of these faculty have been working in this role for less than 10 years. This may indicate substantial recent growth in this career path or it may indicate that people leave these positions and pursue other avenues or become a TFF coming from an industrial job. Further work will investigate this.





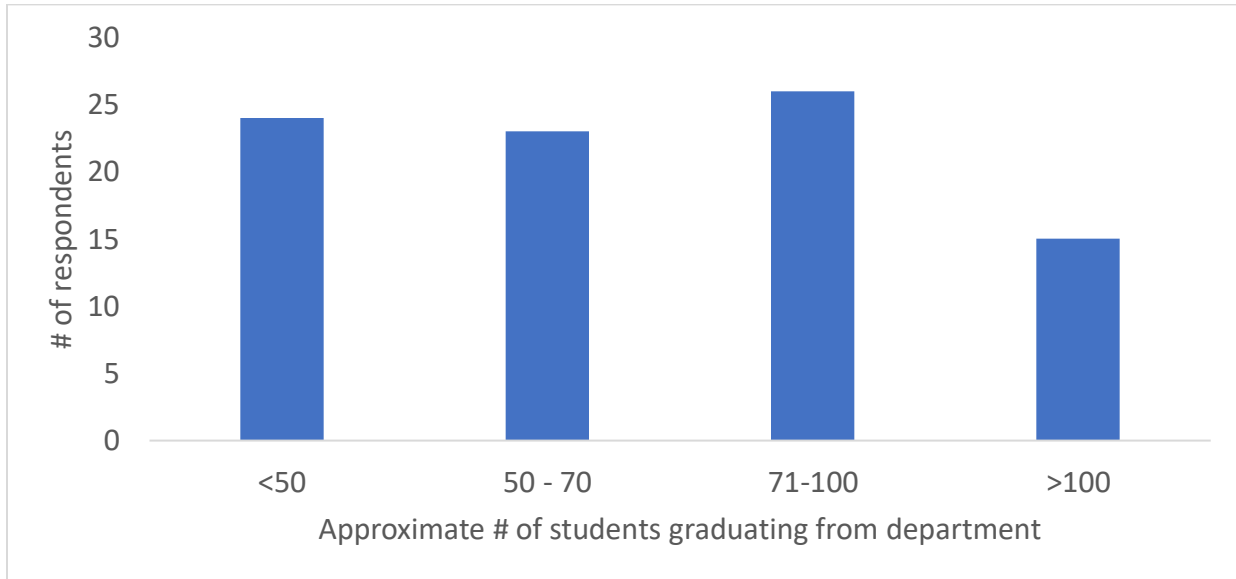
**Figure 4: Distribution of years of work experience TFF in ChE.**

We were also interested in the types of departments represented in the survey. Not surprisingly, most departments are from R1 institutions (81%). This is representative of the entire population. In Table 2, we showed that 13% of the faculty are at R2 institutions. Here we found that 9% of the respondents were from R2. Similarly, we showed that 7% of the TFF are from PUI/M2/M3, but only 3% of the respondents were from M2 or M3 institutions. None of the respondents were from a PUI institution. We also asked the respondents to report on the ranking of their department as shown in Figure 5. Note that seven respondents noted that their department was in the top 10, while 13 reported that their department was in the next tier. Similarly, 35 responded that their department was in the 3<sup>rd</sup> tier. Note that many respondents did not answer this question. Nevertheless, this shows that TFF from a broad representation of departments responded to this survey.



**Figure 5: Number of respondents in various departmental rankings.**

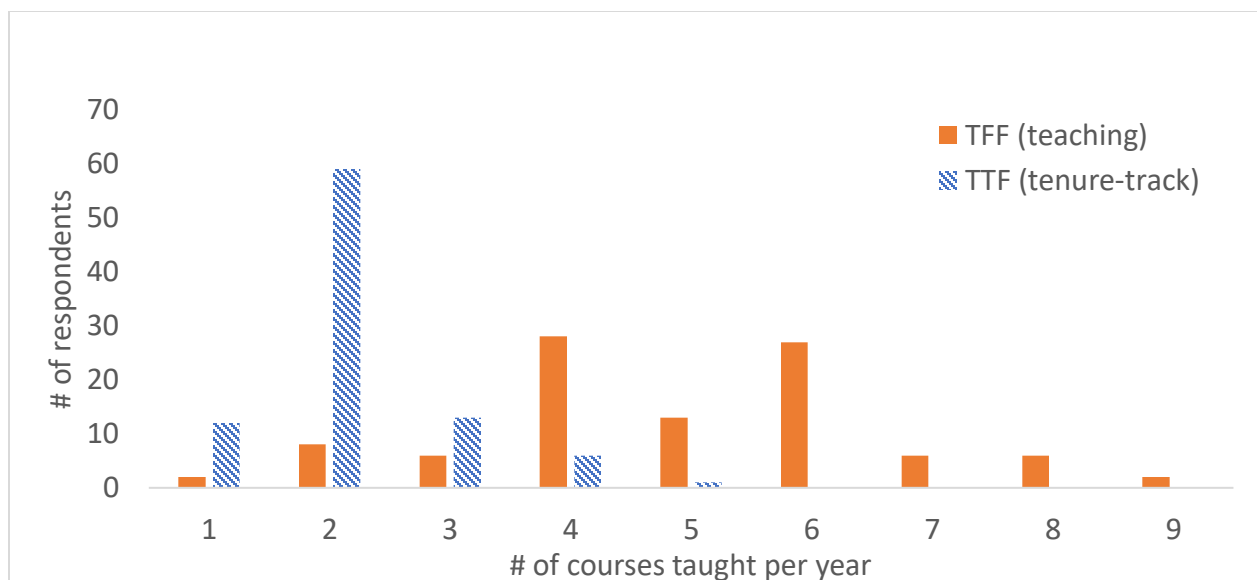
We asked the faculty to approximate how many students graduate each year from their department. We found a range from 15 – 200 with an average of 76. Figure 6 shows an even breakdown of small and large programs represented in survey respondents.



**Figure 6: Undergraduate graduation size for respondents.**

***Professional Responsibilities of TFF from Survey Respondents***

So far, we have shown that the survey respondents represent various demographics, ages, years of experience and types of departments (size and ranking). Now we want to identify the work that they are expected to do. Since these faculty are primarily focused on teaching, we asked them how many courses/sections they are expected to teach and how many courses/sections tenure-track or tenured professors teach in their department. The results show that TFF teach 4.9 +/- 1.9 courses on average per year compared to 2.2 +/- 0.78 per year for tenure-track faculty. Figure 7 provides the breakdown by numbers of respondents. There is a larger variability for TFF, and this probably depends on other service responsibilities.



**Figure 7: Number of courses/sections taught per year for both TFF and T/TT faculty.**

We were also interested in what courses these faculty teach. Table 4 provides the number of respondents who have taught the course listed in descending order. The majority of the TFF teach a lab course (78%) or design (52%) in ChE. This is a bit higher than the smaller survey where we found 63% teach lab and 39% teach design.<sup>1</sup> When looking at the non-lab and non-design courses, it is interesting that the courses that are typically taught in the later years (e.g. heat and mass transfer and kinetics) are less likely to be taught by TFF.

**Table 4: # of respondents that taught CHE courses.**

CHE Course	# of respondents
Lab	75
Design	50
Material balances or material & energy balances	44
Other required courses	43
ChE electives	42
Thermodynamics	37
Fluids	26
Process control	26
Separations	25
Heat transfer	16
Mass transfer	16
Kinetics	15

Since the lab course and design are often taught using multiple instructors, we further broke this down to see if the faculty teach alone or with other TFF or tenure-track faculty. Note that not all faculty who responded that they teach design and/or lab answered this question.

Specifically, 47 faculty responded to the Design question (out of 50 for Table 4) and 69 responded to the lab question (out of 75 in Table 4). Nevertheless, this shows that only 26% and 35% of the TFF who teach design and lab, respectively, teach with only tenure-track faculty. This shows even more strongly that the lab and design courses are primarily taught by teaching-focused faculty.

**Table 5: Instructors who teach design and/or lab were asked if they teach alone or with other faculty in their department. Both the total number and percentage of respondents are noted below.**

	Design		Lab	
	#	percent	#	percent
Teach alone	11	23%	14	20%
Teach with other TFF	12	26%	20	29%
Teach with TT and TFF	12	26%	24	16%
Teach with TT only	12	26%	11	35%
<b>Total</b>	<b>47</b>		<b>69</b>	

TFF typically serve the department in many other ways besides teaching. Table 6 provides the number of respondents who are currently or who have led ABET, advised the AIChE student chapter, led the undergraduate program, and/or serve as a student advisor. It is important to note that more than half of the respondents have been in TFF positions for less than five years. These data are similar to the smaller survey in 2023.<sup>1</sup>

**Table 6: Faculty were asked what service roles they currently hold or have held.**

	Led ABET in dept	Advise AIChE student chapter	Led UG program	Serve as student advisor
Never	54%	58%	75%	41%
Am currently doing	27%	28%	15%	47%
Have done but not now	10%	7%	4%	10%
Blank	9%	7%	6%	2%

Understanding the state of TFF faculty in ChE further requires a look at contract lengths, salary, and professional development support. Table 7 shows the typical length of contract for TFF. The majority of faculty have less than a one-year contract followed by a three-year contract. Some of this variation may be due to differences in level (e.g., Teaching Professor versus Assistant Teaching Professor), while other variations may be university dependent. This will be explored further in future work.

**Table 7: TFF were asked about the length of their contract.**

<b>Length of contact</b>	<b># of respondents</b>
<1 year	35
2 years	9
3 years	31
5 years	20
Other	9

We were interested in how TFF got their position. Most TFF applied for a posted job (Table 8) with just over 1/3 only applying for one position. It is also interesting that 27% of the respondents stated that a position was created for them. Future work will be explored to see if this relates to the age or experience of the faculty member. Some people might think that TFF really want to be T/TT faculty, but this was not supported by our data, with only one person saying they applied for a tenure-track position before accepting a TFF position.

**Table 8: Faculty were asked how they obtained their job.**

<b>How did you get this TFF job?</b>	<b># of respondents</b>	<b>% of respondents</b>
I applied for a posted position, and this was the only one I applied for	30	35%
I applied for many teaching track positions and chose this one	24	28%
The position was created for me	23	27%
I was a spousal hire	7	8.2%
I applied for tenure-track positions and got this instead	1	1.1%

Table 9 details the number of TFF who participate in engineering education scholarship as part of their role. Only 39% of respondents participate in engineering education scholarship, with most of them presenting at ASEE. About a quarter of the respondents present at AIChE and publish in engineering education journals. One goal of the AIChE TFF group is to encourage more TFF faculty to participate in engineering education scholarship and present at conferences, and to further provide participants with developmental resources.

**Table 9: Faculty were asked if and how they participate in engineering education scholarship.**

<b>Do you participate in engineering education scholarship</b>	<b>#</b>	<b>% (out of 85)</b>
no	52	61%
Yes and I present at ASEE	32	38%
Yes and I present at AICHE	23	27%
Yes and I publish in engineering education journals	21	25%
Yes and I advise UG students on engineering educational scholarship	14	16%
Yes and I have received internal funding for scholarship	14	16%
Yes and I have received external funding for scholarship	6	7%
Yes and I advise graduate students on engineering educational scholarship	5	6%

Table 10 summarizes how TFF describe themselves as teachers and if they see themselves as scholars of learning and teaching and learning (SoTL). Almost half see themselves as a scholarly teacher who assesses performance and makes improvements and almost one third engage in education experimentation. The AICHE TFF group hopes to provide support to members toward increasing the scholarship of teaching and learning.

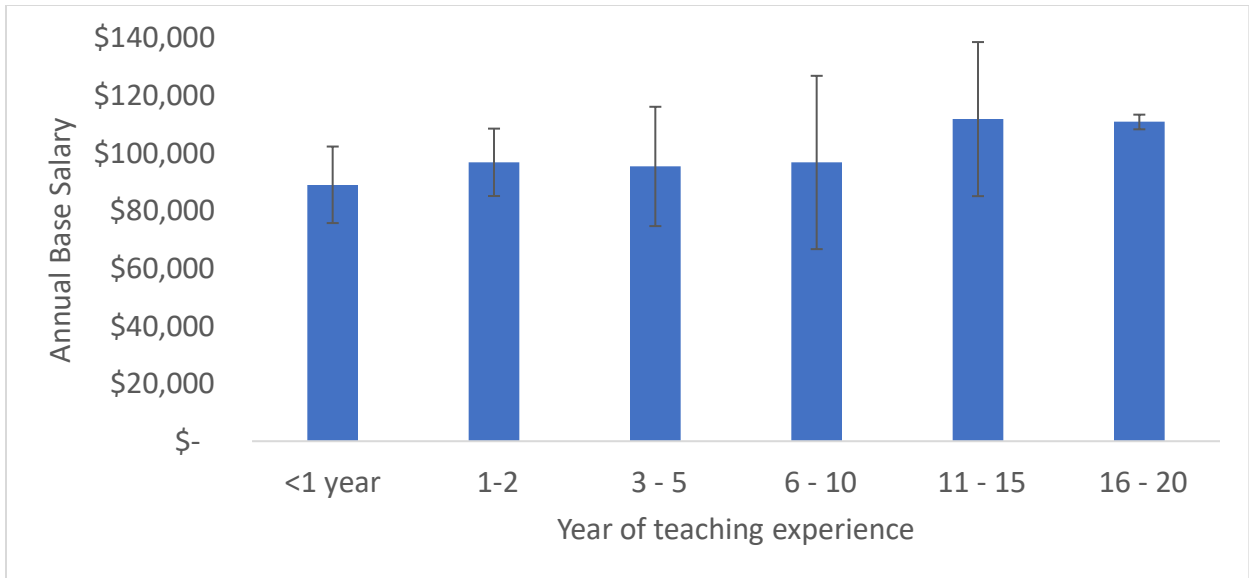
**Table 10: Faculty were asked how they would describe themselves.<sup>7</sup>**

	<b>#</b>	<b>% (out of 85)</b>
Effective teacher: Teaches using accepted pedagogical theories and practices	18	21%
Scholarly teacher: Assess performance and makes improvements	40	47%
Scholar of teaching and learning: Engages in education experimentation	27	32%

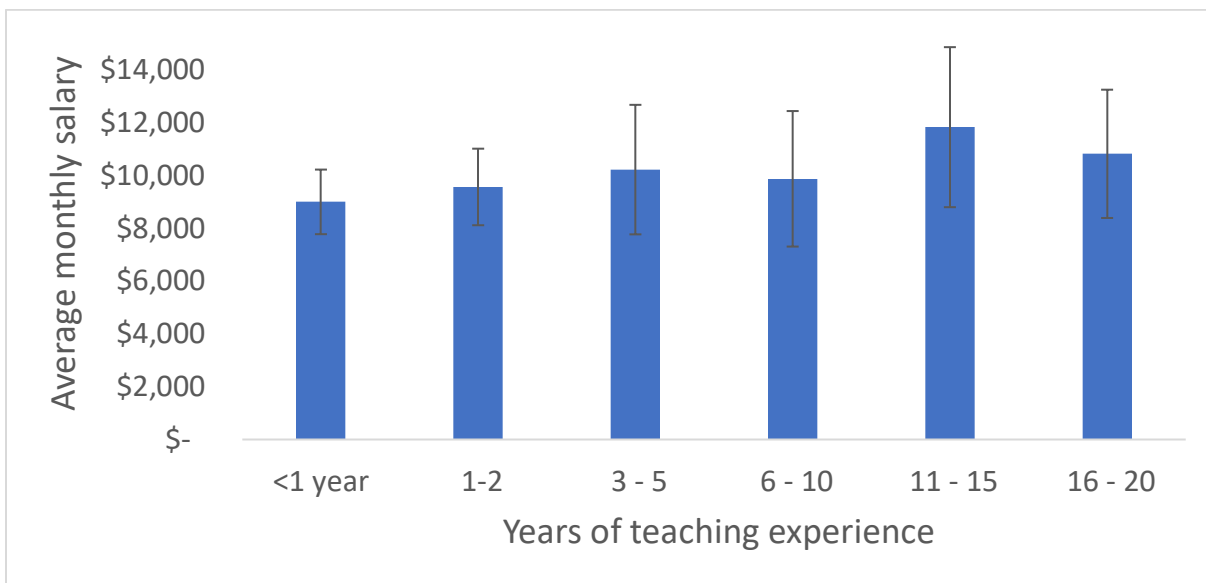
### ***Reported Salaries of TFF from Survey Respondents***

We were very interested in the salary ranges of TFF in ChE and how they compare with years of experience and ranking of school. We asked the faculty to share their yearly salary and then separately asked them if they are on a 9-month or 12-month contract. To obtain the monthly salary, we divided the reported annual salary by 9 or 12 months. Figures 8 and 9 show the annual base salary and monthly salary for the TFF based on the years of experience. Also included is the monthly salary versus the ranking of the school (Figure 10). This provides a range of salaries expected for TFF applying for jobs. The mean annual salary is \$100,300 (median is \$100,000) with a standard deviation of \$24,600, while the average monthly salary is \$10,200 (median is \$9800) with a standard deviation of \$2300. With the error bars included, there does not seem to be a correlation with years of experience or ranking of the school.

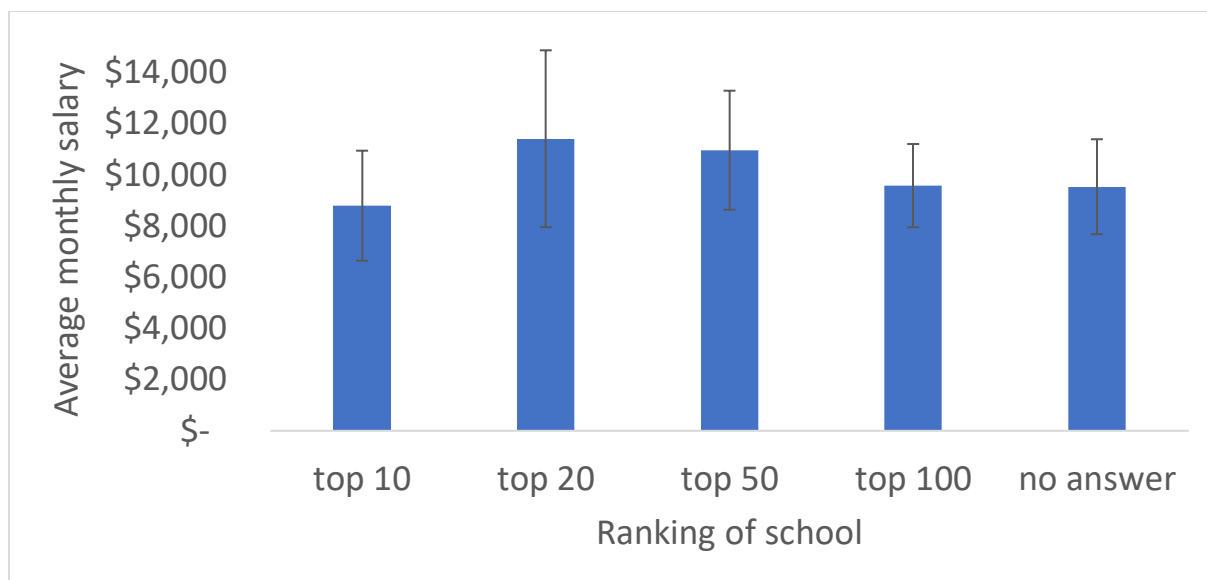
There are several things that we will consider moving forward, including our question about receiving summer salary, level of prior industrial experience, and age of the TFF. We did not ask about location or cost of living, so we cannot make that comparison.



**Figure 8: Average annual salary versus years of experience. Error bars are standard deviation.**



**Figure 9: Average monthly salary vs. years of experience. (Faculty were asked about the length of the contract – either 9 months or 12 months -- and their yearly salary was divided by the length of the contract.) Error bars are standard deviation.**



**Figure 10: Average monthly salary vs. ranking of school. (Faculty were asked about the length of the contract – either 9 months or 12 months -- and their yearly salary was divided by the length of the contract.) Error bars are standard deviation.**

## Conclusions

Here we report that approximately 10% of all 2706 CHE faculty are TFF. This represents 159 departments in the US. Most of these faculty teach at R1 institutions. A survey was sent to all the TFF in ChE in the US, and we received approximately 100 respondents who are a good representation of all TFF based on age, years of service, and department size and rank. Most respondents (63%) applied for a posted TFF job. Future work will explore if this is more representative for younger TFF.

We found that TFF teach 4.9 +/- 1.9 courses on average per year compared to 2.2 +/- 0.78 for T/TT faculty. They tend to teach lab courses (78%) or design (52%) in ChE and are less likely to teach kinetics or mass or heat transfer. These faculty serve important roles outside of teaching too. Almost half the TFF surveyed have or do currently lead ABET and currently serve as a student advisor. 25% have or currently lead the UG program in their department, and 42% have or currently advise the AIChE student chapter. Many of these faculty (39%) also participate in engineering education scholarship, with most of them presenting at ASEE. Almost half of them consider themselves scholarly teachers who assess performance and make improvements.

Interestingly, our work shows that years of experience do not correlate with annual or monthly salary for these faculty. The mean annual salary is \$100,300, while the average monthly salary is \$10,200. With the error bars included, there does not seem to be a correlation with years of experience or ranking of the school. Future publications will explore correlations between salary and other variables such as summer salary, promotion, and industrial experience.



One outcome of this work is that all 279 TFF in ChE were invited to join our AIChE group, and 133 responded that they would like to join! We have also expanded our leadership team to accommodate these larger numbers. Our hope is that these results give voice to hundreds of ChE faculty who have historically been overlooked and understudied. Future work could include the evaluation of if and how this group provides community and professional support to these faculty. In addition, we will report on various titles and the results of the open-ended survey questions.

---

<sup>1</sup> REDATED for blind reference...

<sup>2</sup> <https://nces.ed.gov/ipeds/TrendGenerator/app/build-table/5/51?rid=163&cid=165> accessed March 30, 2024.

<sup>3</sup> Bayles, Taryn Melkus. "Alternatives to the tenure track." *Chemical Engineering Education* 54, no. 1 (2020): 14-21.

<sup>4</sup> <https://amspub.abet.org/aps/name-search?searchType=institution>

<sup>5</sup> <https://forms.gle/XFj3SPrD6z9m3HiYA> assessed March 30, 2024

<sup>6</sup> <https://ira.asee.org/wp-content/uploads/2020/09/E-ET-by-the-Numbers-2019.pdf> accessed March 30, 2024.

<sup>7</sup> Streveler, R. A., Borrego, M., and Smith, K. A. (2007). 9: Moving from the scholarship of teaching and learning to educational research: An example from engineering. *To improve the academy*. 25(1): 139-149.