Continuing Engineering Education Practices and Preferences

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Abstract

This paper presents the results of a survey of 65 working engineers in the energy sector on their formal continuing engineering education (CEE) practices and preferences. The purpose of the survey was to determine what type of continuing education is currently being done in a particular industry and what engineers would prefer if they had their choice. Demographic data such as gender, age range, and ethnicity were collected. Current CEE practices such as number and type of courses taken each year were surveyed. Participants were also asked for their CEE preferences such as which types of courses (technical, management, EH&S, legal, other) they would prefer more of and what was their preferred delivery format (face to face, hybrid, online). This information should be invaluable to those developing curricula and designing and delivering continuing professional development for engineers.

Introduction

The need for CEE has been well-documented [1]. Continuing education is critical for working engineers because of the breadth of processes and equipment they design and use and because of rapid changes in technology [2]. For example, plant engineers take courses to learn how to operate different types of equipment specific to their operations [3].

Calls continue to be made for improving engineering education. The U.S. National Academy of Engineering established a Committee on Engineering Education to answer the question, *What will or should engineering be like in 2020*? [4]. The Phase 2 report from that committee titled *Educating the Engineer of 2020* (National Academy of Engineering, 2005) called for the reinvention of engineering education [5].

While much research has been done on educating engineering *university students*, very little is available in the literature on the continuing education of *working* engineers. This is not surprising as engineering disciplines have received relatively little attention from learning sciences researchers [6].

There are many types of CEE ranging from informal to formal. This paper does not consider informal training such as reading journals and trade magazines, attending conferences, and mentoring. It does consider different types of formal training, some leading to credits and some not. It considers not only technical training, but also management, EH&S (environmental, health, and safety), legal, and other types.

No previous research was found that described the continuing professional development practices and preferences of working engineers. This information is especially important to those development curricula for this type of training. It is also important for those designing and delivering this type of training. This paper reports the results of a survey of working engineers to determine their CEE preferences and practices.

Methodology

A survey (shown in Appendix A) was given to students attending John Zink Institute (www.johnzinkinstitute.edu) continuing professional development courses in Tulsa, Oklahoma in September through November 2017 and to a handful of participants attending a seminar given by the author at a conference in New Orleans in September 2017. The results reported here only include those 65 survey participants who identified their position as "engineer" or listed an engineering degree as their highest degree. The survey was anonymous. Some of the data collected on learning style and verbal-visual preferences are not reported here and are part of an ongoing study of learning preferences for working engineers [7].

Demographics

The survey consisted of 20% females and 80% males. The age group distribution is shown in Figure 1. Approximately two-thirds of the participants were under 35 years old.
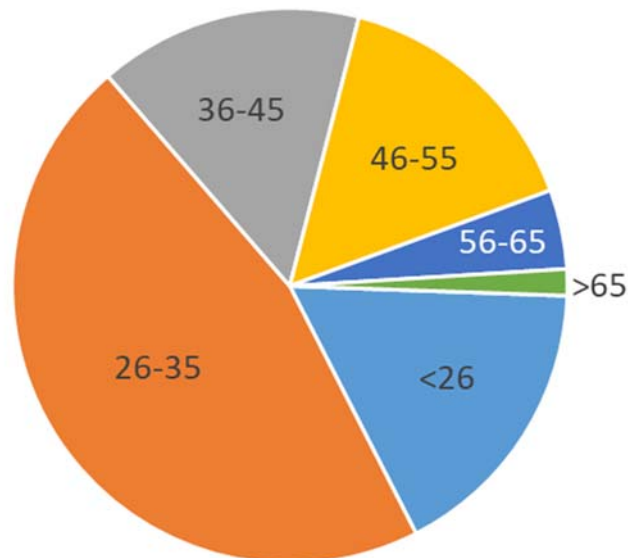

Figure 1. Age distribution for the survey participants.

The ethnicity distribution shown in Figure 2 shows the participants were a little over half Caucasian/White. Most of the participants' native country was the United States.
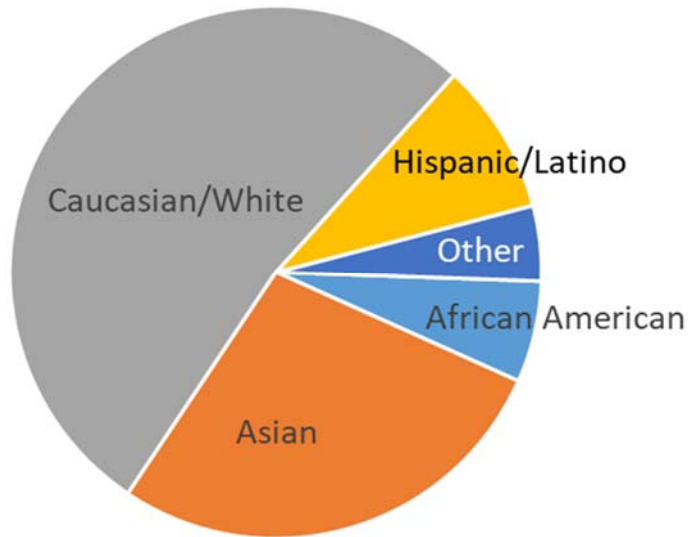
Figure 2. Ethnicity distribution for the survey participants.

Figure 3 shows that the native country of most of the participants was the United States although there were a significant number of countries from outside the U.S. including Brazil, Canada, Chile, China, Dominic Republic, Egypt, India, Italy, Korea, Malaysia, Nigeria, Pakistan, Saudi Arabia, South Korea, Sweden, and the UAE.
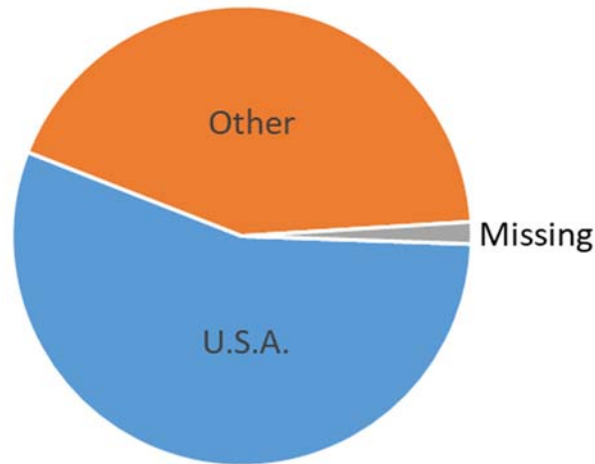

Figure 3. Native country of the survey participants.

Figure 4 shows the native language of about two-thirds of the participants was English. Other native languages included Arabic, Chinese, Hindi, Italian, Korean, Mandarin, Portuguese, Spanish, Swedish, Tamil, Urdu, and Yoruba.
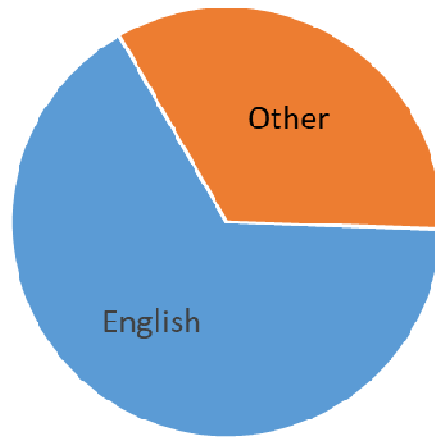
Figure 4. Native language of the survey participants.

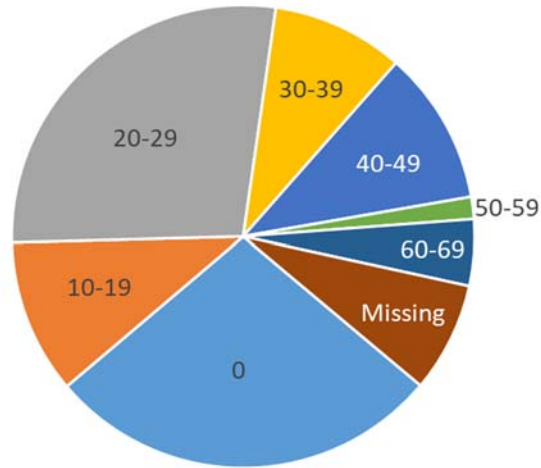According to Figure 5, most of the participants had lived in the U.S. for more than 20 years.

Figure 5. Participants' years living in the U.S.

Most survey participants had a B.S. degree in engineering as shown in Figure 6 with a significant number having some type of graduate degree.
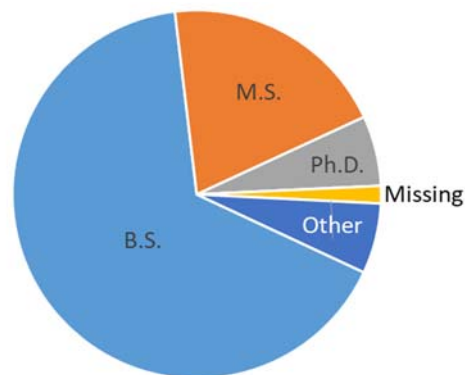

Figure 6. Participants' highest degree.

Figure 7 shows nearly half of the participants were chemical engineers with a large number of mechanical engineers as well. Other majors included civil/environmental, general engineering, engineering management, industrial technology, and nuclear engineering.
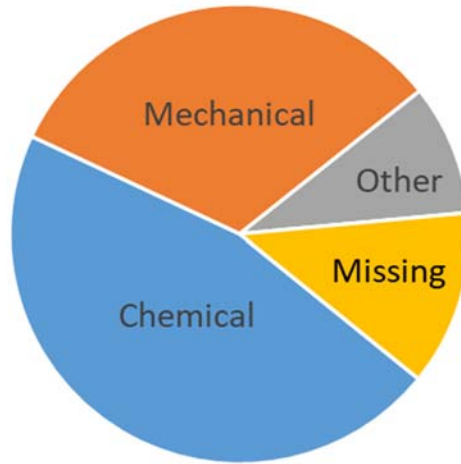

Figure 7.   Participants' degree major.

Approximately 23% of the participants had a Professional Engineering license. According to Figure 8, most of the participants had less than 10 years of total work experience.
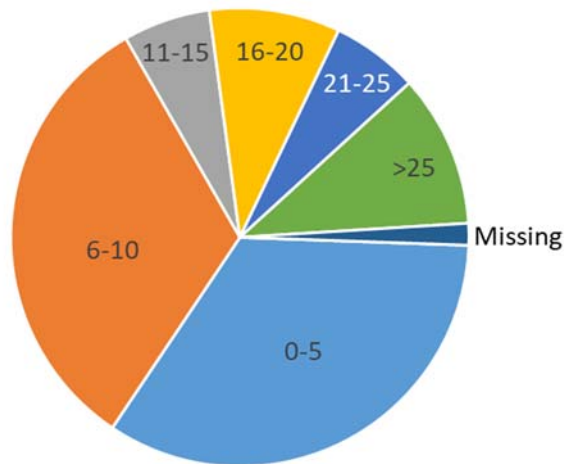

Figure 8.   Participants' total work experience.

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Most participants took up to 5 courses of all types each year as shown in Figure 9.
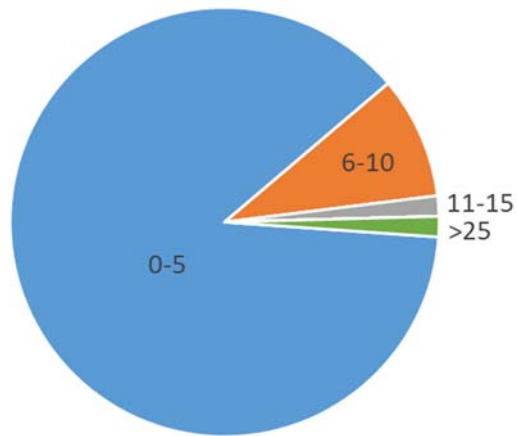
Figure 9. Number of training courses of all types taken per year by the participants.

Figure 10 shows what fraction of the survey participants took various types of courses. Far fewer of them took management, EH&S, legal, and other types of courses.
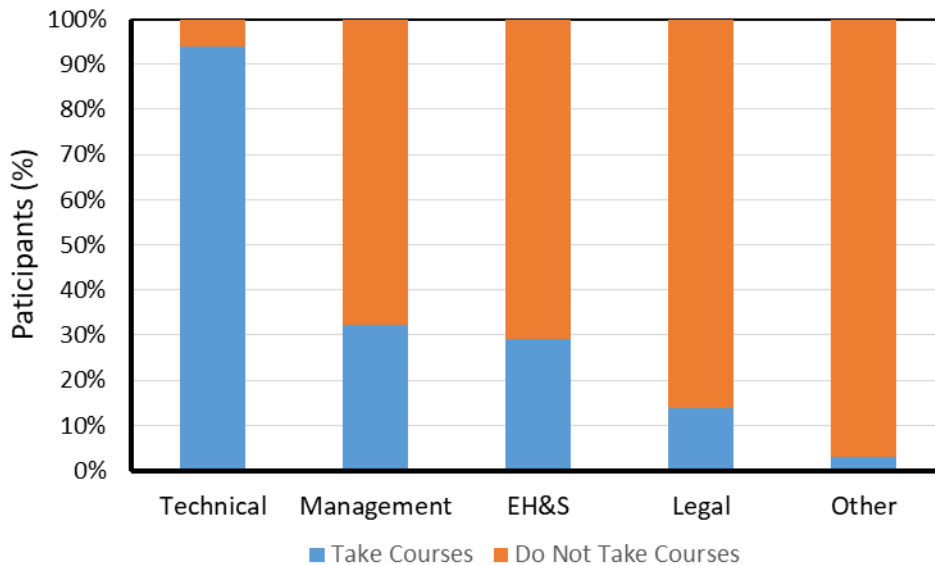

Figure 10. Types of courses taken (shown in blue) by the participants.

Figure 11 shows the fraction of the training taken that was mandatory. It shows approximately a linear relationship for the fraction of participants compared to what fraction of their training was mandatory. A little over 20% of the participants did not take any mandatory training.
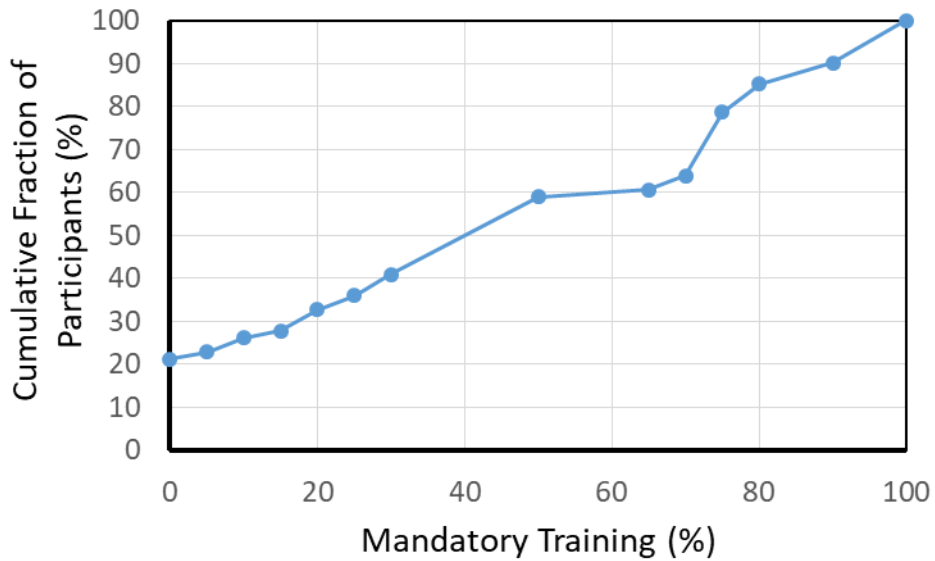
Figure 11. Fraction of the training taken that was mandatory vs. cumulative fraction of the participants.

Figure 12 shows the fraction of training taken by the participants that was required by others besides their employer. An example would be safety training required by clients to enter their facilities. The graph shows that 60% of the participants were not required to take any training by non-employers.

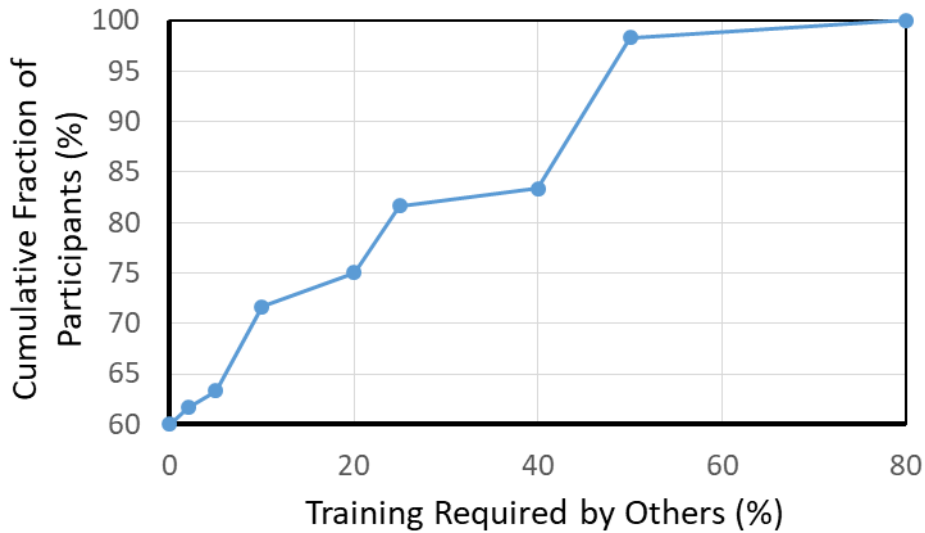Figure 12. Fraction of training required by others besides participants' employer.

Figure 13 shows what fraction of participants' training was taught by their employers. For less than 10% of the participants, their employer did not teach any of their training. For about 8% of the participants, their employer taught all of their training. For the rest it was approximately a linear relationship.

Figure 13. Fraction of participants' training taught by their employer.

Figure 14 shows how much of the participants' training was for credit. For a little over half of them, none of their training was for credit. For approximately 5% of the participants, all of their training was for credit.
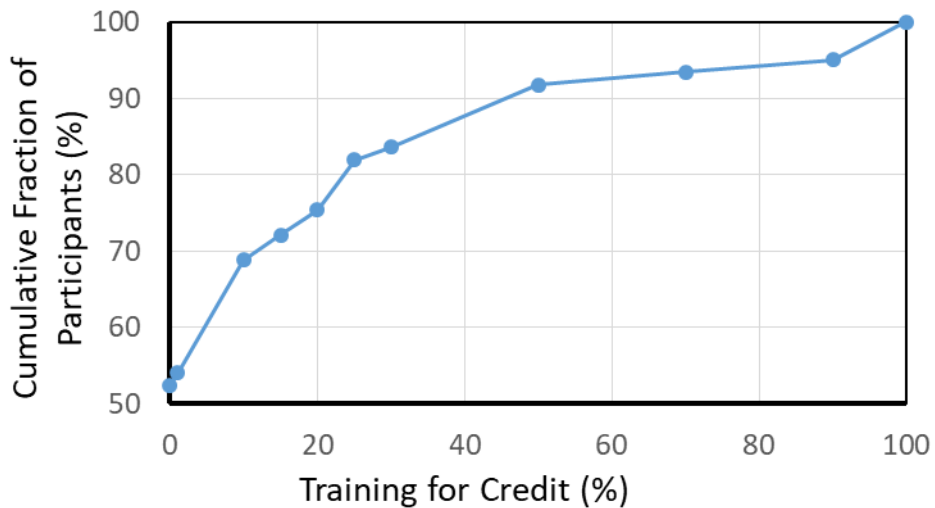

Figure 14. Fraction of training taken by participants for credit.

Figure 15 shows less than half of the participants were required to take training outside of normal working hours with about 10% having to take half or more of their training outside normal working hours.
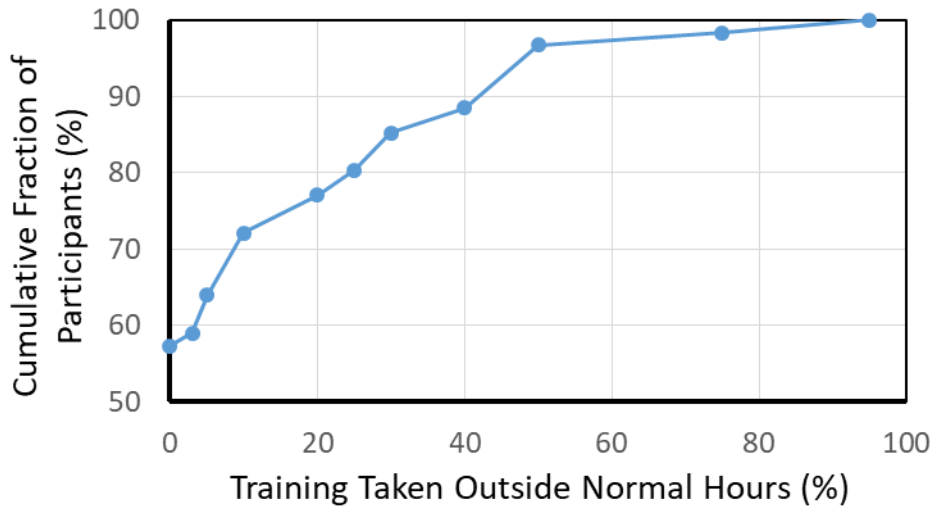
Figure 15. Training taken by participants outside normal working hours.

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Figure 16 shows which types of courses participants would like to take more of. A large majority would like to take more technical courses and about half would like to take more management courses. Relatively few would like to take more legal, EH&S, or other courses. The two "other" courses identified were financial and self-improvement.

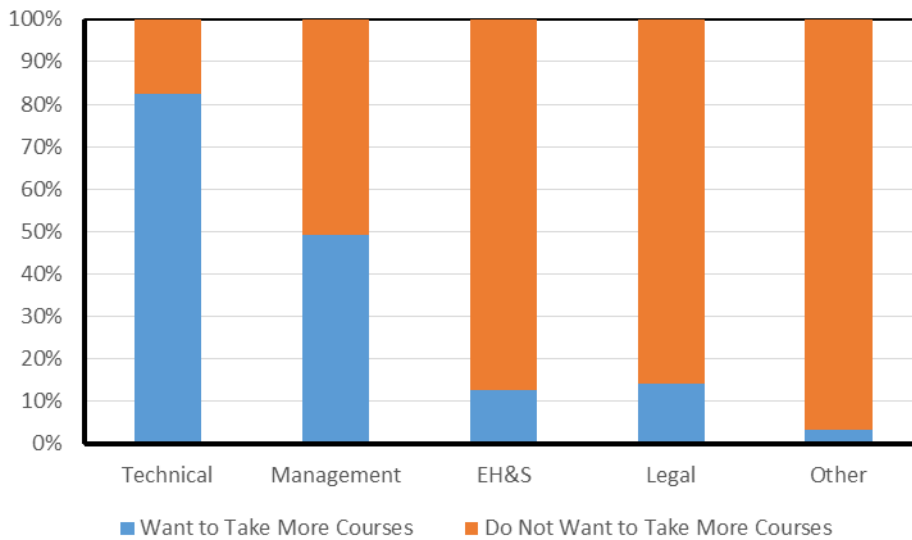Figure 16. What types of training participants would like to take more of.

Figure 17 shows participants' preferences for how they prefer their training to be delivered. Over 90% preferred face to face training as their first choice, 84% selected hybrid as their second choice, and 73% chose online as their third choice. Some of the participants only listed one method (almost always face to face).
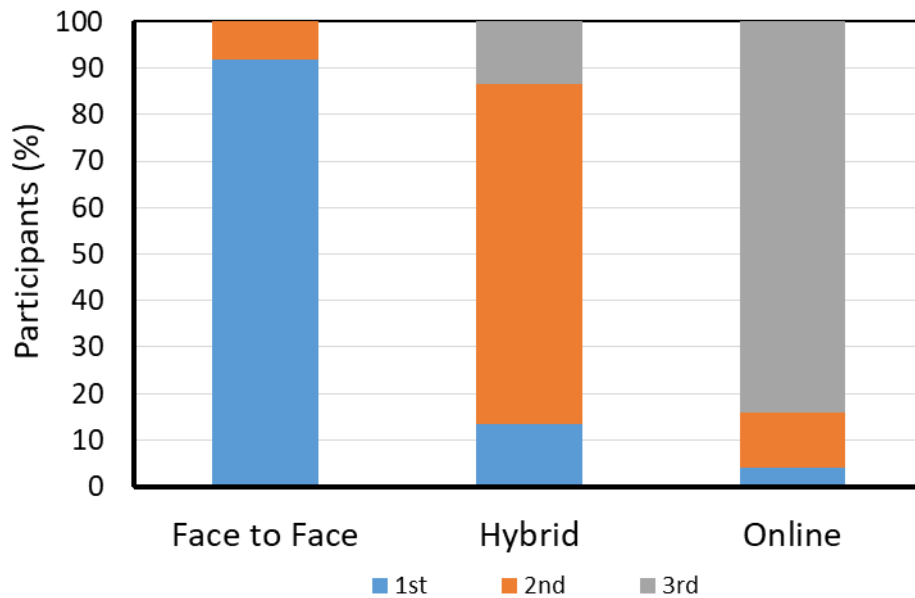
Figure 17. Participants' preferences for training course format.

Conclusions

While the results reported here are based on a relatively small sample, some trends in the data are evident. One somewhat surprising result is that the majority of those sampled took 5 or fewer courses per year. Many at least larger companies typically have more than that number just for their EH&S and legal training courses required to be taken by their engineers. The vast majority of courses taken by the working engineers were technical as might be expected. The legal courses are likely tailored to the specific company and probably need to be developed and taught internally. Depending on the content, the technical and management courses could be taught by either internal or external experts. While the survey did not ask which courses were mandatory, it is expected these would be mostly EH&S and legal. Most participants were not required to take any training courses by non-employers such as clients. The amount of training taught by the employer varied widely. Most of the training taken was not for credit. A significant amount of training was taken outside of normal working hours.

The preferences for more training were very similar to current practices where the vast majority of participants would like to take more technical classes. Nearly half would also have liked to take more management classes. Less than 15% would like to take more EH&S, legal, or other classes. The overwhelming majority preferred their classes to be delivered face to face, their second choice as hybrid, and online as their last choice.

Recommendations

Clearly much more research is needed in this area. A larger and more diverse sample is required to make generalizable conclusions. For example, the present survey consisted mostly of those under 35 years old so some more older participants are recommended. More participants from engineering disciplines besides chemical and mechanical engineering are needed to see if there is any dependence on that variable. The participants in this survey were from the energy industry so it would be important to consider other industries to see if there are any similarities and

differences. It would be useful to understand the size of the organizations where the participants work to see if that impacts how many courses are required to be taken by working engineers, especially non-technical courses such as EH&S and legal. It would be interesting to know if the number of courses taught by the employer varied by employer size where it might be expected larger companies have more resources for such training. It would be interesting to know if the training taken for credit was primarily of any particular type (e.g., technical). It would be useful to know what type of training is taken outside of normal working hours and how it is delivered. It might be expected a significant portion of that is online but there is currently no data to validate that assumption.

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2. C.E. Baukal, Strategy for delivering continuing engineering education. *International Journal of Training and Development*, *16*(4), 284-299, 2012.
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7. C.E. Baukal, *Learner Preferences for Continuing Engineering Education*, Lambert, Mauritius, 2017

Appendix

Verbal-Visual & Learning Strategy Preferences Survey

Question	Circle Your Choice / Fill in the Blank
Gender	1 = Female 2 = Male 3 = Other
Age	1 = <25 2 = 26 – 35 3 = 36 – 45 4 = 46 – 55 5 = 56 – 65 6 = >65
Ethnicity	1 = African American 2 = Asian 3 = Caucasian / White 4 = Hispanic/Latino 5 = Other _____
Native Country	1 = U.S.A. 2 = Other _____
Native Language	1 = English 2 = Other _____
Length of time lived in the U.S.	_____ years
Highest earned degree and major (e.g., high school diploma, B.S. in Mechanical Engineering, etc.)	_____
Do you have a professional engineering license?	1 = Yes 2 = No
Primary Position / Function / Role	1 = Engineer 2 = Operator / Technician 3 = Management / Administration 4 = Teacher / Educator / Professor 5 = Full-Time Student 6 = Other _____
Employer	1 = Industry 2 = Academia / Education 3 = Government 4 = Non-Profit 5 = Other _____

Question	Circle Your Choice / Fill in the Blank
Management Level	1 = Non-supervisory (do not supervise anyone) 2 = Middle Management (supervise at least 1 person) 3 = Senior Management (VP, President, etc.)
Total work experience (including teaching if applicable)	1 = 0 – 5 2 = 6 – 10 3 = 11 – 15 4 = 16 – 20 5 = 21 – 25 6 = >25

Verbal-Visual Preference

In a learning situation, sometimes information is presented verbally (e.g., with printed or spoken words) and sometimes information is presented visually (e.g., with labeled illustrations, graphs, or narrated animations). Please place a check mark indicating your learning preference.

○	○	○	○	○	○	○
Strongly more verbal than visual	Moderately more verbal than visual	Slightly more verbal than visual	Equally verbal and visual	Slightly more visual than verbal	Moderately more visual than verbal	Strongly more visual than verbal

Learning Strategy Preference

Please read the ATLAS assessment (blue sheet) and then mark the result here (Place ONE check mark next to your learning strategy preference):

○ **Navigator**	○ **Problem Solver**	○ **Engager**

The description of your learning strategy group in the ATLAS "Groups of Learners (page 2 of the ATLAS instrument) is reasonably accurate in describing you as a learner.

○	○	○	○	○	○	○
Strongly agree	Moderately agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Moderately disagree	Strongly disagree

Question	Circle Your Choice / Fill in the Blank
Average number of training courses you take each year (circle one)	1 = 0 – 5 2 = 6 – 10 3 = 11 – 15 4 = 16 – 20 5 = 21 – 25 6 = >25
Typical types of training courses you take each year (circle all that apply)	1 = technical 2 = management 3 = environmental, health, & safety 4 = legal / compliance 5 = other: _____
Approximately what percentage of the training courses you take each year are mandatory (where the rest are at your option)	_____%
Approximately what percentage of the training courses you take each year are required by someone other you're your employer (e.g., customers, licensing boards, government, etc.)?	_____%
Approximately what percentage of the training courses you take each year are taught by your employer (where the rest are taught by those outside your organization)?	_____%
Approximately what percentage of the training courses you take each year are for credit (e.g., college credit, Continuing Education Units or CEUs, Professional Development Hours or PDHs, etc.)	_____%
Approximately what percentage of the training courses you take each year are taken outside of normal working hours (e.g., nights, weekends, holidays, etc.)	_____%
If you could take more training each year, what type would it be (circle all that apply)?	1 = technical 2 = management 3 = environmental, health, & safety 4 = legal / compliance 5 = other: _____
Rank your preferences for the following methods of instruction for training courses (1 = most preferred, 2 = 2nd most preferred, 3 = least preferred)?	____ face-to-face (classroom) ____ online (computer-based training) ____ hybrid (classroom + online)