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### Dr. Anne M Lucietto, Purdue Polytechnic Institute

Dr. Lucietto has focused her research in engineering technology education and the understanding of engineering technology students. She teaches in an active learning style which engages and develops practical skills in the students. Currently she is exploring the performance and attributes of engineering technology students often focusing on women and underrepresented minorities, utilizing that knowledge to engage them in their studies.

### Dr. Diane L Peters P.E., Kettering University

Dr. Peters is an Associate Professor of Mechanical Engineering at Kettering University. Her engineering education research focuses on the interactions between industry and academia in various settings and forms.

### Liza Ann Russell, Purdue University

Liza Russell is an Undergraduate Researcher working under Dr. Lucietto. She is a student at Purdue University, pursuing a Bachelors of Science in Mechanical Engineering. She began working under Dr. Lucietto in the summer of 2017 as a part of Purdue's Summer Stay Scholars program and has thus far continued her work. In addition to her Mechanical Engineering coursework, Liza is pursuing minors in Physics and Anthropology. Outside of class, she serves as an Executive Board Member of Convocations Volunteer Network (CVN) and is a Tau Beta Pi member.

### Miss Meher Rusi Taleyarkhan, Purdue University

Meher R. Taleyarkhan is a graduate student earning her Master's in Engineering Technology degree from Purdue University, West Lafayette Indiana. She received her Bachelor of Science degree from Purdue University and majored in Mechanical Engineering Technology. During her undergraduate she was an undergraduate research assistant studying renewable energy with an emphasis on solar energy for residential and utility use. Current research as a Master's student is in curriculum development for engineering technology programs, notably at Purdue University. Her thesis is on conducting an engineering and financial analysis for a local wastewater plant facility.

### Ms. Shelly Tan

Shelly Tan is an undergraduate researcher working with Dr. Lucietto. She is currently pursuing a Bachelors of Science in Health and Disease at Purdue University, and began working with Dr. Lucietto in the summer of 2019 as part of the Summer Stay Scholars program. In addition to her biology coursework, Shelly is pursuing minors in Studio Arts and Chemistry. Outside the classroom, she enjoys writing creative fiction, making art both physical and digital, and moderating for her favorite online communities.

# **Professional Women Identify Their Professional and Personal Needs**

## **Abstract**

Professional women in various fields often express issues they encounter in being able to access quality materials to support professional and personal needs, as well as work-life balance. By studying a variety of modes through which these materials are generally obtained, including conference participation, informal communication via social media, and utilization of networking opportunities, several gaps were identified in available support for professionals. Professionals from various backgrounds were also surveyed in order to better identify their needs in terms of career development. Distributed through a variety of social networks including Facebook, Twitter, and LinkedIn, as well as the Indiana Secretary for Career Connections and Talent Office newsletter, the survey collected demographic information and requested input on respondents' preferred method of material delivery, as well as asking additional questions regarding currently-available materials and the specific needs of each respondent. This paper seeks to present findings from the survey, in order to encourage the future development and improve the availability of materials to support professional development for women in engineering.

**Keywords:** professional women, professional development, personal development, work-life balance, preferred delivery

## **Introduction**

When designing professional development opportunities, it is important to consider the needs of under-represented minorities. This survey focused on women in engineering as the population is growing, though still under-represented. There is increasing pressure on women to fulfill family responsibilities while succeeding in their career. Professional development opportunities are important for everyone to achieve career success, but may not be as accessible to women due to their traditional commitments. To gauge women's participation in professional development opportunities, what development opportunities they are participating in and how often, and what types of opportunities they would prefer, the researchers distributed a survey through professional networks targeted at females in engineering as well as general networks. This paper will present the results of this survey. The results may be useful to researchers and others as they look to develop methods for increasing the professional development of females in the field of engineering. This paper will give a brief literature review on women in professional fields, present the research question and the results and conclude with a discussion of what the survey showed.

## **Literature Review**

Professional development is a broad topic, with many different types of recognized professional development and corresponding issues. This literature review will briefly cover a few common

types of professional development to clarify what was asked about in the survey. Work-life balance and the traditional expectations women face are also discussed since they may serve as a barrier to women participating in professional development opportunities. The travel and location of professional development is also discussed as it may be another barrier. Additionally, recruitment and retention of women in STEM, with a focus on engineering, is discussed as it served as the motivation of this work.

## Professional Development Programs

Professional development encompasses a wide variety of programs aimed at improving or maintaining skills and training for success in the workforce. However, literature focused specifically on women in engineering and their professional development experiences is limited. This section will briefly cover some of the common types of professional development including advanced degrees, certifications and licensure, conferences and online training, and corporate training.

### *Advanced Degrees*

Professional development can come in the form of advanced degrees. A Masters or a Ph.D. can provide specialized knowledge that can be of value in the workforce, either in technical knowledge for a field or in management knowledge. The percentages of women earning upper-level degrees in engineering are low when compared to their male counterparts, leading to underrepresentation in professor positions [1]. This may be because women finishing their graduate studies report feeling that women cannot get ahead and that they are overwhelmed by the pressure of work [2]. However, obtaining an upper-level degree in engineering can lead to salary increases and more compelling work [1]. An MBA specifically is important for career advancement and moving into higher business leadership positions, but some women may be discouraged from pursuing one due to a lack of female presence in MBA programs [3].

### *Certifications/Licensure & Continuing Education*

A Professional Engineering license is the primary form of licensure for engineers and required by some fields of engineering, especially civil and structural as it allows the engineer to sign off on drawings for public use projects such as bridges and roads [4]. This licensure is also required for those who operate their own engineering consulting business or any other business with “engineering” in the name [4]. However, licensing is not always required in other engineering positions, such as at large corporate firms as an exemption allows companies to use engineers without licenses to design products [4]. Women tend to pass the professional engineering exam at a lower rate than males, and fewer women overall take the exam [5].

Certifications indicate that the holder is trained in a specific area or profession. For example, certification in cost engineering can allow for job promotions and other career advancement opportunities [6]. Certifications require that specific criteria be met and sometimes obtained through specific education and experience requirements [7]. An examination is sometimes

required to award the certification [7]. For individuals, certification can help to show that the individual is committed to a certain profession, they are masters in their specialty, and that they are interested in continuing education as certifications often need to be renewed [7].

Certifications can also be offered in specific methods or topics, with Six Sigma and Lean Sigma certification programs being popular among industrial engineers [8].

To maintain these licenses and certifications, continuing education is sometimes required. For professional engineering (PE) licenses specifically, the number of hours and what those hours must entail varies by state [9,10,11]. It has been found that continuing education in developing leadership skills is especially helpful for women in STEM careers as it encourages retention and career advancement [12].

### *Conferences and Online Training*

Attending conferences is important for those in STEM fields, as it provides them with an opportunity to learn the most up-to-date information and developments in their field [13]. It serves as a form of formal continuing education, and often involves listening to presentations from a variety of sources including university personnel and for-profit institutions [14]. It also provides an opportunity for networking with other individuals in the field, potentially leading to further career development opportunities [14].

Distance learning can be utilized to allow a larger audience to attend a conference, as it eliminates the need for travel [14]. Online conferencing can present events synchronously, asynchronously, or a combination of both, providing more flexibility to participants [14]. It also provides participants to engage with the information before and after the conference as they can download the appropriate materials [14]. However, this type of conferencing eliminates the ability to participate in the informal networking that a traditional face-to-face conference provides [14].

### *Corporate Training*

Many employers offer professional development on-site to their employees. This may come in the form of corporate training expenditures which include specific internal training or financial support for education that encourages employees in developing their own needs through conferences or other professional development activities [15]. These programs cost corporations a significant amount of money but result in development of human capital for their organization [15]. For some engineering positions, especially construction engineering, project management training is vital and can be provided by employers on or off-site [16].

However, age plays a large role in motivation to continue professional development. As employees age, they are less willing and less interested in continuing professional development [17]. This is partially due to a decline in cognitive abilities or other formed beliefs about aging [17]. To encourage these workers to continue learning, supervisors need to support employees both with beliefs and resources [17].

## Work-life Balance and Traditional Expectations

It is difficult to maintain family responsibilities and a successful career, especially in engineering where work-life balance can be demanding. As a result, women who persist in engineering tend to have fewer children and be married less often than women who leave the engineering profession [18]. This may be due to personal preference but also due to the demands of childcare and commitment level of spouses or partners to childcare, which can create work-family conflict [13]. To combat this, programs like NSF's ADVANCE award academic institutions for their day-care centers for faculty and students [19].

Working women also face demands on their time from disabled and elderly individuals in their lives. Although they are working, women can often be expected to care for these elderly and disabled individuals, resulting in difficulties with work schedules, job security, and support [13]. For women caring for disabled spouses, role-strain becomes a significant issue, with women balancing between caregiving for the disabled spouse, their career, and caring for children if applicable [20]. These women are six times more likely to develop depression or anxiety than others not participating in this type of caregiving [20]. With these extra demands on their time, women who are also caregivers may be less able to take time to travel to professional development conferences or they may not have the time to participate in online options [13].

Working women may also be subject to workplace harassment or discrimination resulting from traditional expectations, with women who have no children and mothers who spend less time on caregiving experiencing more harassment than their peers following traditional expectations [21]. Further, women can become discouraged from joining or continuing in a STEM field due to stereotype threat, which may cause them to fear confirming certain stereotypes about women, such as "girls can't do science" [13]. Those who choose to have children may feel that the optimum time to have children interferes with their professional advancement or that their job demands pose a risk during pregnancy [13].

Another issue for women is being part of a dual-career couple, with many women in STEM having partners who are also in a similar, or the same, STEM field [13]. Thirty-nine percent of women believe their partner's career is more important than their own, resulting in careers being put on hold [13]. This poses another barrier to career advancement and professional development. Abusive relationships can also threaten the career advancement of women as their partner may prevent them from being successful in the workplace or from attending needed professional development events [22].

## Travel for Professional Development & Location

Conference participation often involves advanced planning to secure a hotel reservation and making travel arrangements as they are often held in larger cities and last three to four days [14]. The time involved with traveling for professional development may serve as a barrier as women may not feel comfortable leaving their children, especially if they are breastfeeding [13].

Further, they may not be able to get time off work to attend professional development events, as their position may require around the clock availability [2].

For online training, location may play a role. While it eliminates the need for travel and thus eliminates those costs, rural areas often have weaker or non-existent internet connectivity, making participating in online conferences from home not an option [14, 23].

## Representation and Retention of Women in STEM

As is general knowledge, the fields of science, technology, engineering, and mathematics (STEM) typically see an underrepresentation of women. Women now make up 13% of engineers in the United States [24]. However, the percentage varies by discipline, with women making up only 8% of mechanical engineers while they make up 15% of biomedical engineers for example [25].

Much work is being done to encourage female middle school and high school students to consider engineering through after-school STEM programs and other campaigns [26, 27]. This includes work being done to gauge expectations of what an engineer looks like and does, as they are typically not depicted as female [27, 28]. Other efforts, such as the National Science Foundation's (NSF) program ADVANCE are working to encourage more women to participate in the STEM fields through positions in academia [19].

There are existing issues with retaining women in STEM fields at both the collegiate level and in the workforce. There are many possible explanations for why women leave STEM fields in greater numbers than in others, with some citing the underrepresentation of women as making them uncomfortable in the field or leading to discrimination [12]. Society's traditional idea of who an engineer is may make it hard for women to identify as an engineer, with the masculine environment making them more likely to leave the field [2]. However, social media campaigns, such as #ILookLikeAnEngineer, are working to show the diversity of women in the field, speaking out against gender bias in the engineering field, and challenging traditional expectations of what engineers look like [27]. Other reasons for leaving affect all fields, with child raising and family managing serving as another reason for women leaving the workforce [13].

To retain women in engineering, some suggest that managers and organizations should support on-going learning, challenges, and novel work to retain their female employees in particular [18]. For women in the construction industry, employers can encourage recruitment and retainment by providing training in both soft and hard skills [29]. Re-entry into STEM is another barrier for some women who may leave due to caregiving, childbearing, or other responsibilities. Thus, it is important that companies utilize online options to allow women to stay connected and continue training while away from the profession [2]. Further, combining online learning with networking events, webinars, and returnships can help overcome the barriers associated with returning to the

STEM profession for many women [30]. Returnships are internship-like experiences for individuals returning to the STEM field from not working for an extended period of time [30].

Experiences of discrimination based on gender and sexual harassment are common among women who leave the engineering field [2,18]. Although there is increasing pressure on society to correct for discrimination towards women, more work is needed to ensure that women are leaving the profession due to discrimination.

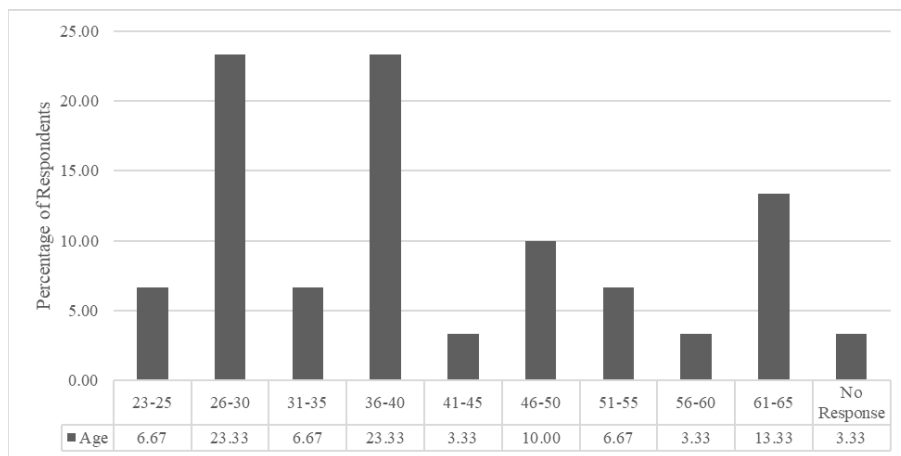
### Research Question

The researchers noted the traditional difficulties professional women face in obtaining professional development when balancing the time commitments of managing a family and a career. Thus, the researchers wished to understand how professional women, specifically female engineers, obtained their professional development and what obstacles prevent women from seeking development opportunities. Therefore, the research question to be answered with a survey directed at this population was:

*How do professional women in the field of engineering obtain professional development and what obstacles do they face in obtaining this development?*

### Findings

The survey obtained usable responses from 53 self-identified professional females, of which 30 respondents work in an engineering field. These 30 women will be the focus of this study as the goal is to understand professional women in engineering. The remaining portion of the responses will be the focus of future work. Figure 1 below presents the ages of the respondents.



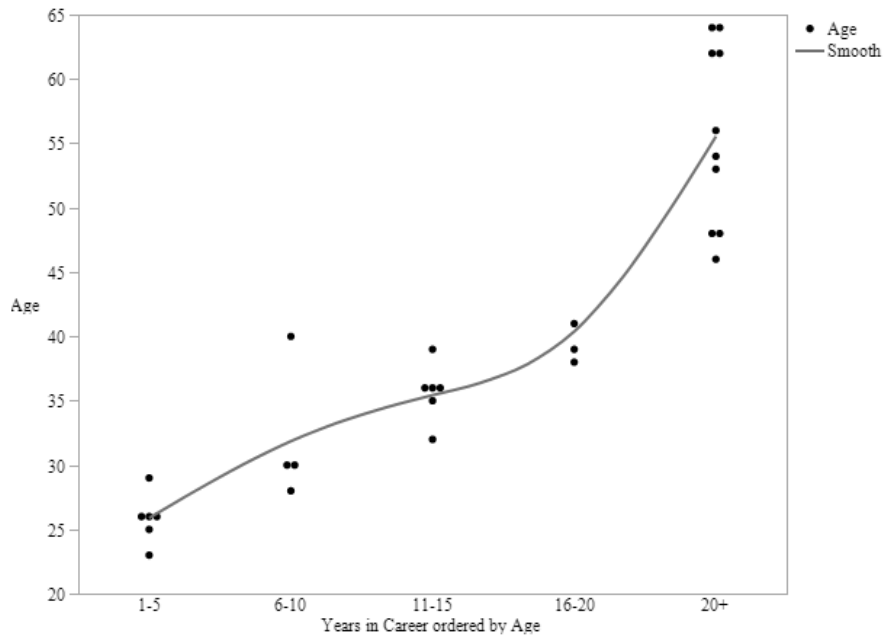
**Figure 1: Age of Respondents**

From Figure 1, the survey reached women in all stages of their career. About 23% of respondents were early in their career at age 26-30, some in the middle, with 23% of women at age 36-40, and some women nearing retirement with 13% at ages 61-65. This suggests that the survey will provide some insight to women at all career stages. The women were also asked to report their



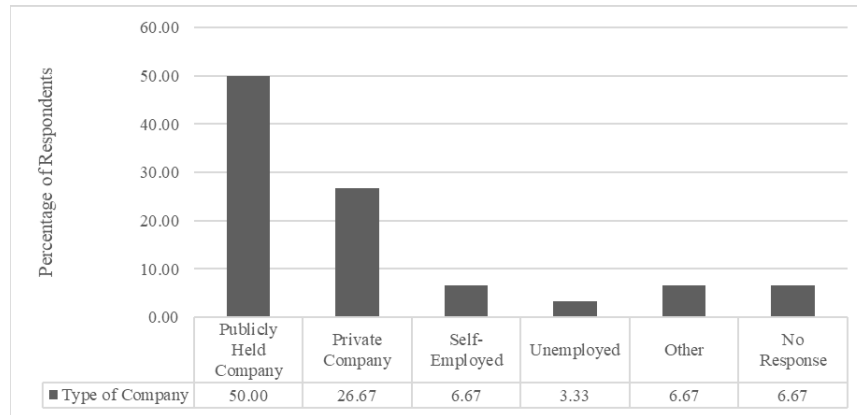
ethnicity, with the survey reaching primarily white individuals (73%), equal percentages of Hispanic, Asian, and African American Individuals (7%), and one Middle Eastern Individual (3%). These statistics match closely with known ethnic distributions of scientists and engineers, except for Asian individuals, who are represented less in this survey [31].

In addition to age, the survey asked women to indicate how many years they had been working. This is shown in Figure 2. The figure shows the expected trend of increasing years working with increasing age. There are some outliers of individuals who have worked more or fewer years than is typical of their age.



**Figure 2:** Age of Professional Women versus Number of Years Working

The survey asked respondents about the company they are currently working for in terms of number of employees and type of company (private versus public or self-employed). Most responding women work at a company with more than 101 employees (80%), with a few working for smaller companies with 1-10 employees (10%) and the remainder not responding (10%). Further, the distribution of what company type the respondents work for is shown as Figure 3 below.



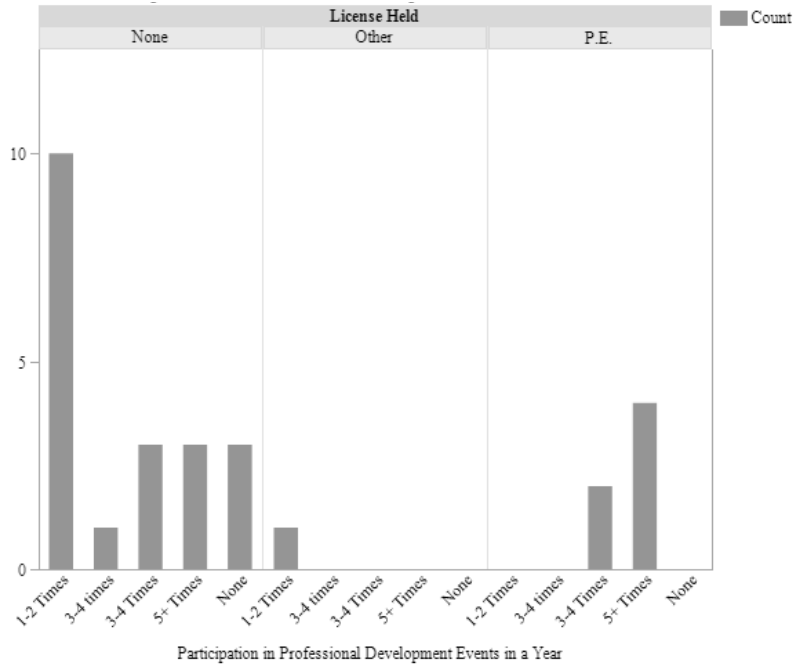
**Figure 3:** Types of Employers Listed by Respondents

Most respondents work for a publicly held company, while fewer work for private companies. Those indicating “other” noted that they were the owner of a company or worked for the state.

Respondents were next asked questions about their current level of professional development. For engineers, a Professional Engineer (P.E.) license is a necessary level of development for certain disciplines, especially Civil. The respondents were asked what type of licensing they held if any. Of the respondents, 20% hold a P.E. license, while 70% held no license at all. As of 2018, there were 925,929 licensed professional engineers in the United States [32]. In 2018, 11,006 civil engineers passed the license exam while only 1,794 electrical and computer engineers and 2,951 mechanical engineers became licensed [32]. This is due to field requirements and may explain the survey results.

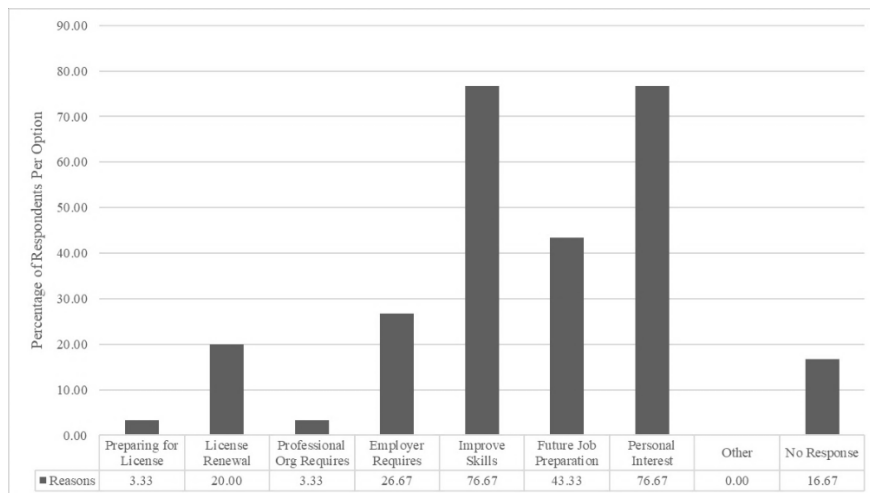
It is possible that some of these women didn’t feel that a professional license was necessary for their career goals, though future study is warranted to determine the reason why so few of these women are licensed. Based on the result that many women work for a large, publicly-held firm, a P.E. license may not be required for their career or they may be in a discipline where licensing is not necessary as often, for example, electrical or mechanical engineering.

The women were also asked if they are required to reach a certain level of professional development in their profession. The term “required” was not strictly defined in the survey, so it could have been interpreted as “hard requirements” such as those necessary to maintain a license or “soft requirements” such as those not strictly required but often needed to advance. Most women surveyed (53%) believed that a certain level wasn’t required, while 30% believed it was and 13% believed that it is sometimes required. This warrants future study, especially by discipline, as these women may not be aware of what a P.E. license allows them to achieve in their career or what they are legally unable to do without it. Refinement is also necessary to more clearly define “required”. Next, the participants were asked to indicate how often they participate in professional development activities, what those activities are, and why they participate in them. Figure 4 below shows the frequency at which respondents participate in professional development versus their level of licensing.



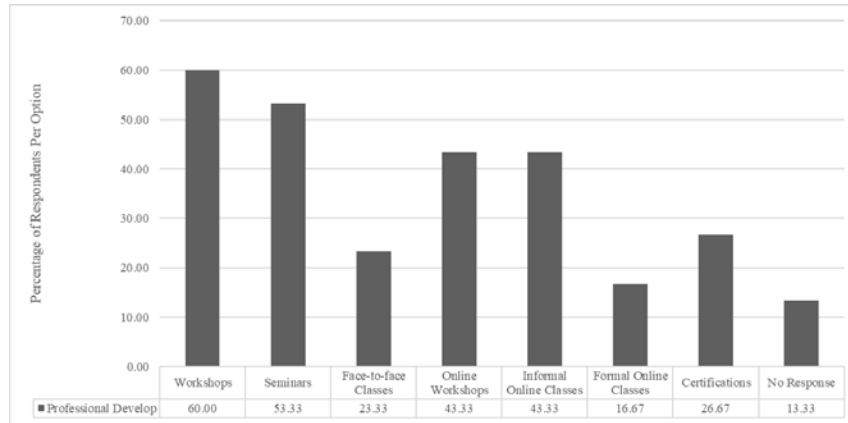
**Figure 4:** Frequency of Professional Development Activities versus Licensing

From Figure 4, it is seen that those with no licensing participate in professional development activities with various frequencies, though most participate in activities 1-2 times per year. This is different from those with a P.E. license, who participate in professional development activities 3-5 times per year. Respondents were next asked to indicate why they participate in professional development. The results of this question are shown as Figure 5 below. Since respondents were able to select multiple answers for this question, the percentages do not sum to 100. Of the respondents, 24 people selected multiple responses, with only one individual selecting one option, and the remaining 4 individuals not responding.



**Figure 5:** Reasons for Pursuing Professional Development Activities

For those not participating in professional development activities, they were asked to indicate why. The reasoning from these individuals was that the company they worked for did not support the activities so they were unable to participate due to time and cost, they were busy paying off student loans so they could not pursue further education, and they were unable to locate professional development near them. Respondents were also asked to indicate the types of professional development opportunities they most often participated in. Figure 6 below presents the results of this question. Again, since respondents selected more than one option, percentages are calculated for each option out of 30 and do not total 100.

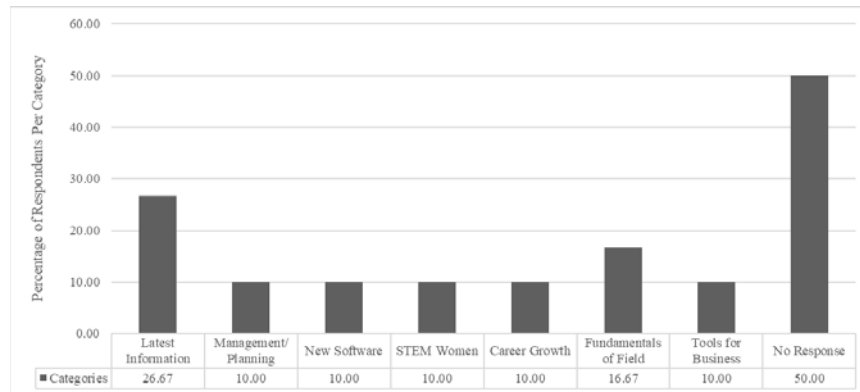


**Figure 6:** Types of Professional Development Sought

Responding women indicated that they mostly attended workshops and seminars, however, online options also drew many participants. The results suggest that online options for professional development may be an area for researchers to consider in the future as this provides an option that avoids the monetary cost and time lost due to travel for in-person options as they can be participated in from anywhere with an internet connection. The participants were also asked to indicate which of these options they most preferred. Workshops were the most popular among respondents (30%), with informal online classes (23%), and online workshops trailing (17%). No correlation was found between the age of the individual and the type of professional development they preferred, suggesting that traditional methods, such as workshops, are still valued.

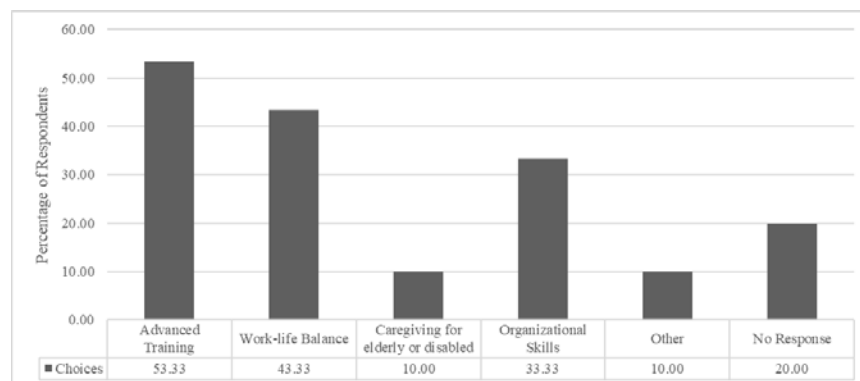
For the next portion of the survey, respondents were asked an open-ended question about what types of professional development training they would like to receive. These responses were categorized and the results follow. Since these were open-ended responses, some participants' answers fell into multiple categories, and thus, percentages don't sum to 100. The categories identified included "latest information" encompassing those who wanted to know the latest research and development in their fields and others, "management and planning", including those focused on management and leadership skills, "new software", including those who wanted to know the latest software tools, "STEM Women", a category including those who wished to know more about how to encourage women in STEM, "career growth", for development focused on

networking and career growth skills, “fundamentals of field”, for refreshers on knowledge of their field or high-level exposure to other fields, and “tools for business” focused on basic skills for doing business. Figure 7 below presents the results.



**Figure 7:** Categories of Professional Development Sought

It should be noted that there was a relatively low number of responses for this question, with 50% not responding. However, there was significant interest in the latest information and the fundamentals of various fields. The STEM Women category is notable, where 10% of the surveyed women wish for more assistance in learning how to navigate as a female in STEM and how to encourage girls to join the field. The results of this question may be useful for researchers as they seek to develop professional development opportunities. Respondents were also asked a selected choice question for what types of career or lifelong learning opportunities they would be interested in. The results of this question follow as Figure 8.



**Figure 8:** Lifelong Learning Opportunities Sought

Again, respondents were able to select more than one option, so percentages are calculated as above and don't sum to 100. Those responding “other” to the survey listed leadership and support group style training for personal life as lifelong learning opportunities they would pursue. Advanced training and work-life balance are the two most popular options, so researchers and others should consider these for training opportunities.

## Discussion

The results of this survey provide areas to further research. The survey population was 30 women who have spent varying numbers of years in the engineering field, suggesting that input from women at all levels of professional development was obtained. Age and number of years working correlated as expected with older individuals having worked for more years. However, there were some outliers. These outliers may be due to those individuals having spent years out of the workforce, potentially due to caregiving, though future study is needed to clarify this. Another potential explanation may be individuals leaving the workforce to pursue an additional or alternate degree.

Most women responding work for publicly held companies with 101 or more employees. Regarding licensing, only 20% of respondents had obtained their P.E. license. The survey did not ask for discipline of engineering as it was directed at all professional women. However, further research is warranted to understand why so few women have obtained their P.E. license. It may be partially due to discipline as it is recognized that a P.E. license is more vital in some disciplines, especially civil. However, the results contrast with responses from querying the women on whether they believed a certain level of professional development was required for their field or not. Thirty percent of women believed that a certain level was required, but the question warrants rephrasing for future iterations as it could be interpreted in various ways.

When asked how often women participate in professional development activities, it was found that those holding a P.E. license participated in the highest number of professional development activities per year. This is as expected as licensing renewal for P.E. licenses requires varying amounts of continuing education per state, for example, Indiana and Michigan require 30 hours to renew a P.E. license while Texas only requires 15 [9,10,11]. Others, such as California, have no continuing education requirement [33]. Those without a license participated in varying amounts, though most individuals participated in 1-2 opportunities per year. For these individuals, reasons for participation are varying, but personal interest and the desire to improve skills were the most cited reasons for participation. Further, most individuals participate in these activities through the traditional workshops and seminars, though online classes play a significant role. No correlation was found between age and how the opportunities were attended, suggesting that online options work as well for those nearing retirement as those who are just beginning their career. This may be of interest to researchers and others as professional development could be administered through online classes as these are often more convenient to individuals with many different commitments.

The participants were asked to provide the types of professional development they most wished to participate in. The categorized responses suggested that the latest research and new topics in the field of engineering and others is of the most interest. However, some women also suggested training on how to encourage other females to join STEM fields and on how to develop in their career using skills such as networking. It may be valuable for a professional development opportunity combining all of these various aspects to be devised. Responding women are also

seeking development in work-life balance, suggesting that for professional development to best reach them, it must be convenient and fit in with their already busy schedule. It may be of value to work more closely with employers to encourage them to provide employees with beneficial and easy ways to attend these professional development opportunities, as one woman noted she was unable to attend due to her company not supporting the costs.

## **Conclusion**

The results of this survey showed that women are participating in professional development opportunities but have needs for certain areas that are not being addressed by the opportunities available to them. Women seek support in how to further their career while maintaining a healthy work life balance and staying up to date on the latest information in their field. A smaller group of the respondents seek assistance in mentoring young women and encouraging them to pursue a career in STEM. These results suggest that a training conference or a series of online courses combining these various aspects would be received well and strongly beneficial to women in engineering.

The researchers wish to note that this is a relatively small study of professional women in engineering. Further research on a large population is warranted to determine specifics of the program that would best serve these women. Future iterations of the survey are possible, with more specific questions concerning discipline and beliefs about licensing.

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