Collegiate Aviation Review International

Volume 39 | Issue 2 Proceedings of the 2021 UAA Annual Conference, Article #9

12-17-2021

Certificated AMTs: What Will Encourage More Women to Become Aviation Maintenance Technicians?

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This paper examines practices that are used in STEM fields to attract women. According to the FAA, the estimated active mechanic certificates held as of December 31, 2020 was 306,301. Of those 306,301, it is estimated that 7,860, or 2.5%, were held by women. In 2009, there were 329,027 active mechanics certificates held, and 6,980 or 2.1% were held by women. There was a steady growth of certificated women mechanics from 2009 through 2015 – growing from 2.1% to 2.5%, respectively. In 2016, there was a drop to 2.3%. The percentage for 2017 and 18 was 2.4%. In 2019, the number increased from 2.4% to 2.5%, with a slight increase to 2.56% in 2020. With the increased need for AMTs, it is imperative to determine best practices for engaging women in Science, Technology Engineering, Aviation, and Math (STEAM) fields. There is limited data available specific to women in the aviation maintenance fields. What is known is that in 2018, women earned more than half of all bachelor's degrees in science and engineering fields. Women earned 42.3% of bachelor's degrees in mathematics and statistics and 22.2% of bachelor's degrees in engineering in 2018. Conversely, in 2018, the number of certificated women aviation mechanics was 2.4%. What is drawing women to the fields of mathematics, statistics, and engineering? Can those methods be successful in attracting women to the field of aviation maintenance? Examining the tactics used in STEM disciplines may lead to successful practices to increase the number of women AMTs.

Recommended Citation:
Rouscher, G. Y. (2021). Certificated AMTs: What will encourage more women to become aviation maintenance technicians? *Collegiate Aviation Review International*, 39(2), 298-306. Retrieved from http://ojs.library.okstate.edu/osu/index.php/CARI/article/view/8404/7692

This paper examines practices that are used in STEM fields to attract women to understand how those tactics may entice women to join the ranks of certified AMTs. According to the FAA, the estimated active mechanic certificates held as of December 31, 2018 was 292,002. Of those 292,002, it is estimated that 7,133 or 2.4% were held by women. Comparing the change over time for female AMTs indicates limited growth. In 2009, there were 329,027 active mechanics certificates held, and 6,980 or 2.1% were held by women. There was a steady increase of certificated women mechanics from 2009 through 2015 – growing from 2.1% to 2.5%, respectively. In 2016, there was a drop to 2.3%. For 2017 and 2018, the number remained at 2.4% (Federal Aviation Administration, 2019). In 2019 and 2020, the industry experienced a slight increase in female mechanics with 2.5% in both years (Federal Aviation Administration, 2021). Although the percentage has increased in the past few years, there is an opportunity for further expansion. The industry is experiencing an increased need for AMTs; it is imperative to determine best practices for engaging women in aviation maintenance and Science Technology Engineering Aviation and Math (STEAM) fields.

STEAM is only recently gaining traction as opposed to STEM. There are not much data available that speak specifically to women in the aviation maintenance fields. What is known is that in 2016, women earned more than 40% of bachelor's degrees in mathematics and statistics and more than 20% of bachelor's degrees in engineering. Conversely, in 2016, the number of certificated women aviation mechanics was 2.3% (National Center for Science and Engineering Statistics, 2019). In 2018, women earned more than half of all bachelor's degrees in science and engineering. The number of women that earned a bachelor's degree in mathematics and statistics was 42.3%, while those earning a bachelor's degree in engineering was 22.2% (National Center for Science and Engineering Statistics, 2021). At that time, there were 2.4% female certificated AMTs. What is drawing women to the fields of mathematics, statistics, and engineering? Can those practices be successful in attracting women to the field of aviation maintenance? Examining the tactics used in STEM disciplines may lead to successful practice to increase the number of women in AMT's.

History of Women in STEAM Fields

There have been studies conducted through the years to examine why females do or do not choose to go into or continue through matriculation in STEM fields. There is not much agreement on the why. There is a long-standing precedent for research regarding the lack of diversity in STEAM disciplines. Research has developed many well-meaning but often controversial results. Many of the studies that have been performed are not congruent with the next. As early as 1965, Alice Rossi asked why there were so few female scientists in academic careers when she wrote "Women in science: Why so few?" (Rossi). Now, 56 years later, that same question is still being asked. Is it because males are inherently more intelligent than females? As shared by Sarseke, the study by Smith and Gorard (2011) "did not find any evidence to claim that there was a consistent out-performance of males over females in scientific subjects

between 1965 and 2009" (Sarseke, 2017, p. 92). It is not clear if we have made strides in the number of women in STEAM fields or not.

In 2008, the American Association of University Women (AAUW) Educational Foundation released *Where the Girls Are: The Facts about Gender Equity in Education*. The work of the AAUW has provided a comprehensive longitudinal view of girls' educational success in the past 35 years (AAUW Educational Foundation). This report did not specifically examine the educational path or specific degree women seek but looked at the numbers of enrolled students of all ages, racial and ethnic groups, at different milestones. The report showed that the number of female college graduates has increased in recent decades, and "white and Asian American women are overrepresented in college compared to their respective percentages in the general population" (AAUW Educational Foundation, p. 64).

There have been multiple studies in STEM fields which have focused on engineering. Engineering is a field that is traditionally male-dominated. According to the National Center for Science and Engineering Statistics (NCSES), the percentage of women to men in science and engineering occupations is 15.1% to 33.7%, respectively (2019). According to the National Survey of College Graduates, 2019, there are a total of 7,466,000 men and women employed in science and engineering fields. Of those, 29% are female, and 70% are male. The numbers are much more staggering when examining those specifically in engineering, which equate to 16% female and 84% male (NCSES, 2021). These percentages are much higher than the number of women who are certificated AMTs, but the difference still indicates a disparity. Examining the research conducted in the STEM fields may provide more insight.

Within the science and engineering fields, the National Center for Science and Engineering Statistics states that "women were more likely than men to work in an S&E-related occupation" (2019, para. 2). The data indicate the "net result is that female scientists and engineers were more likely than male scientists and engineers to work in a non-S&E occupation (48% versus 42%)" (para. 2). Sarseke (2017) posits:

Although this research has found various gender differences in many abilities, these studies do not claim that they are key reasons for the shortage of females in science. Instead, most scientists conclude that biology might be a part of the explanation of why women do not aspire to scientific careers. (p. 96)

A study completed for the National Science Foundation (NSF) indicated, "Within the fields of science, technology, engineering, and mathematics (STEM), excluding the social sciences, women only comprised 39% of the bachelor's degrees conferred nationally in 2012" (as cited in Settles et al., 2016, p. 488). A study by Catalyst of women in post-secondary institutions in the U.S. during 2015 and 2016 shows similar results to the NSF study. The Catalyst findings of degrees earned by women in post-secondary institutions indicate women comprised 35.5% of the undergraduate degrees in STEM (Catalyst, 2019).

The under-representation of women in STEM may have a link with biological and social-constructivism theory. Possible factors for the scarcity of women in the sciences, which have been discussed in the work of Sarseke (2017), embrace both the influence of socio-cultural

factors and the influence of genetics. The work has highlighted the subject of "gender and science" and has been examined for at least three decades; the results obtained have not changed significantly. There was a positive shift in the number of female students in the professions of mathematics and biology; however, the fields of engineering technologies and physics remained unchanged (Sarseke, p. 96).

In 2013, Jagacinski conducted a study on competence perceptions and achievement goals of women engineering students. A specific area investigated was "the potential indirect sequential effect of gender on grades through perceived ability and then performance-approach goals" (p. 652). The study found "women report lower perceived ability than men which in turn is associated with lower performance-approach goals and ultimately lower grades" (Jagacinski, p. 652). When examining the study by Robnett and Thoman, similar results were indicated, "The self-doubting achievers were lower than men in success expectancies despite statistically equivalent academic performance" (2017, p. 96).

The studies of women and STEM span many decades. Is the difference all gender-related? A study by Settles et al. examined the perceptions and identity interference with undergraduate women, specifically the role of gender identity (Settles, 2016). The results reveal that those students who were further along in their school program felt there was less woman-scientist identity interference experienced than those in earlier stages of their academic careers. Those students that were at a more advanced stage in their studies were more confident about their science performance and reported greater psychological well-being. Seemingly, as women progress in their major, they feel their identities are more compatible with their chosen field.

History of Women in Aviation Maintenance

Women came to the forefront of aviation maintenance during World War II. Women were called to assist in the factories to replace the men that had been sent to war. To encourage women to join the workforce, "Rosie the Riveter" was created. Women took over the positions that men had traditionally held. By 1944, there were more than 3 million women working in the trades and holding union membership. This number represented 22% of all trade union membership in the U.S. at that time (Hawkes, 2020, p. 1). After the men returned from war, the experience for many women changed. Many women went back to being homemakers, but not all. Those who remained employed at the factory in the riveting and manufacturing sector began working side-by-side with men and experienced both gender and racial discrimination.

In the early 1970s, the number of women in the aviation maintenance industry began to increase. This was a time when women began challenging stereotypes and social restrictions on what women could do for a career. This is not including those involved during the war effort – the now-famous "Rosie's." Women were challenging the idea of doing something different. Mary Ann Eiff, maintenance instructor for American Trans Air at the time, stated, "I was a licensed A&P for six years before I ever met another female aircraft mechanic" (Benoff, 2002, p. 67). During this time, there were many who did not feel women belonged in the hangar, wrenching on aircraft. Mary Linhart shared her experience as a business owner with her husband, stating, "It was easier to work as a mechanic myself and cheaper to hire office help than for me to stay in the office and hire a mechanic" (Benoff, p. 66). Linhart went on to add, "I still

remember I would have to drop the wrenches and run to the office because several of our customers were 'macho men' who would take their business elsewhere if they found a girl working on their planes" (Benoff, p. 67).

The number of certificated female Aviation Maintenance Technicians (AMTs) has not changed significantly over the years. Per the Federal Aviation Administration (FAA), in 2004, there were a total of 317,111 certificated AMTs. The number of female AMTs was 5,932, which represented 1.87% of all certificated AMTs. In 2015, there was a high of 8,419 or 2.45% of certificated female AMTs. In 2016, that number dropped to 6,536 or 2.33% of all AMTs. In 2017 the numbers began to increase again, and for the data available for 2020, there were 7,860 or 2.56% of female AMTs, the highest reported numbers to date (FAA, 2021). Although the numbers are increasing, the percentage of female AMTs has not changed significantly over the years. Comparing the number of female AMTs to the number of female engineers poses a stark contrast. What is happening in other STEM industries to bring women to the field and, more importantly, to keep them there?

Retaining Women in STEM Fields

Is engineering a male-dominated profession? Author Julie Mills (2010) posits the solution is simple. She proposes gender-inclusive engineering education. She also states that there are very few resources (time or money) dedicated to this (Mills). She pointed out, rightly so, to increase the number of females in the classroom…more females equal more female engineers, but is there more to it?

The culture of science was evolved largely by able bodied heterosexual white men, and people who do not fit this mold may encounter discrimination ranging from the subtle to the overt: "Outsiders" may not be able to integrate easily with - or may simply dislike - the dominant culture. (Ambrose et al. 1997, as cited in Mills et al., 2010, p. 10)

In reviewing the research of what has and has not worked to retain women in STEM fields, there is a common theme, mentoring. Research indicates positive academic experiences and increased retention for females in STEM-specific majors, more specifically engineering, if they have a mentor. What is a mentor? An article by Hernandez et al. defined a mentor as:

A mentor is someone who provides guidance, assistance, and encouragement on professional and academic issues. A mentor is more than an academic advisor and is someone you turn to for guidance and assistance beyond selecting classes or meeting academic requirements. (2017, p. 7)

The National Academies of Sciences Engineering and Medicine defines a mentor a bit differently.

In the realm of science and engineering, we might say that a good mentor seeks to help a student optimize an educational experience, to assist the student's socialization into a disciplinary culture, and to help the student find suitable employment. These obligations can extend well

beyond formal schooling and continue into or through the student's career. (nap.edu, 1997, p. 1-2)

For STEM success and positive experiences that lead to retention of female students in the field of engineering, a mentoring program is the place to start. Early engagement or intervention by female faculty members helps to create a sense of belonging within the scientific community. It must be noted, however, that not all mentoring programs are created equal. It has been posited that receiving encouragement from same-gender mentors and same-gender role models is particularly important for women in STEM (Dennehy & Dasgupta, 2017; Hernandez et al., 2017; Robnett & Thoman, 2017). According to Hernandez et al., "Theory and evidence indicate that female undergraduates with a female faculty mentor report receiving higher levels of mentoring support compared to female undergraduates with a male faculty mentor" (2017, p. 3).

A 2017 study by Dennehy and Dasgupta focused on peer mentoring between advanced students and first-year students and the long-term effects of having a peer mentor. Throughout the year-long study, the mentor-mentee met once per month. There appeared to be no difference in how mentors perceived their quality or quantity of interactions with mentees. There was no difference noted in the connection that the mentees perceived of the mentor support. For women with female versus male mentors, the only significant mediator to emerge was social belonging. Women who were paired with male mentors in the first year showed a "consistent decline in belonging" (Dennehy & Dasgupta, 2017, p. 5967). The results indicated that 100% of women with female mentors remained in engineering majors, as compared to 82% with male mentors and 89% with no mentor (p. 5966). In examining the post-degree aspirations of those in the study, "those with female mentors maintained consistent intentions to pursue advanced degrees in engineering over time" (p. 5966).

Peer mentoring is an important key to the success and retention of females in STEM fields. Social support and social integration equate to more positive academic outcomes for those who are underrepresented in STEM fields (Estrada et al., 2011; Hernandez et al., 2017; Hughes & Chen, 2011; Robnett & Thoman, 2017). Robnett and Thoman posit that universities may benefit by establishing a peer mentoring program that will allow connections between self-doubting achievers and confident high achievers in the STEM fields with the thought that shared academic achievement will leverage complementary success expectancies of the self-doubting achievers (2017, p. 98). Interventions that foster social belongingness may contribute to STEM identity among women who doubt their abilities to succeed.

In 2018, Mullen and Baker completed *Gender Gaps in Undergraduates Field of Study: Do College Characteristics Matter?* and concluded institutions with tenured female faculty members might positively influence the institution in ways that shape the educational setting and "directly or indirectly" support women in non-traditional majors, including the establishment of "mentorship programs within male-dominated fields such as engineering" (p. 9). The Association for Middle Level Education (AMLE) has asserted that middle school girls thrive and find success when they have an advocate or mentor to support them (Hayes, 2018). In addition to traditional faculty members, it has also been noted that female students gain valuable experience by visiting their role models and mentors in the workplace. A female mentor that also works within the

industry has a positive impact on female students. It is important that women "see female role models in the workplace that look like them" (Hayes, p. 27).

Other than most of these studies being conducted within the realm of engineering education, the findings could apply to any occupation or field of study that is thought of as gender-based, regardless of gender. There are indications that the institution plays a pivotal role in the success of the female student in non-traditional majors (Estrada et al., 2011; Hayes, 2018; Hernandez et al., 2017; Mullen & Baker, 2018; Robnett & Thoman, 2017). Student success in engineering has been evident with those engaged in a mentoring relationship.

Conclusion

In Conclusion, it has been shown that there are not as many females in the STEAM fields as there are males. Studies on gender-based STEM involvement are not new, have spanned decades, and do not agree on the causal factors that are holding women back from these fields. There are a few consistencies within the studies. It is evident that men are not inherently smarter than women. Men and women have certain traits that may afford a separate subset of skills, but those skills are not mutually exclusive. Females thrive when they experience support within their field of study from the early days of college. Connecting with a mentor in the field of study the female student has chosen has shown time and time again to have a positive and lasting effect on the student. All mentors are not the same. Peer support of the same gender appears to have the largest benefit and positive outcome for the student.

As far back as the 1940s, women have been stereotyped into roles such as homemaker, teacher, seamstress, and others. During World War II, it was demonstrated that women have the skills necessary for manufacturing, physical labor, and doing what is necessary to get the job done in the role of "Rosie." Although the world has evolved, there is still stigma attached to the male and female-dominated roles. Having a mentor will assist those that enjoy and are excited by taking things apart and putting them back together, figuring out why something electrical is not working the way it is expected, watching that aircraft soar into the sky for its first test flight after an avionics upgrade, and to realize their gender is not a reason to not pursue a dream.

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