

Contributing Factors to the Under-Representation of Women in Undergraduate Engineering

Submitted by

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Abstract

This research study aims to explore the factors which influence the under-representation of women within the engineering field. These factors can cause women to avoid participating within engineering programs at the high school or undergraduate level, or leave the engineering field at the professional level. This exploration focuses mainly on the influences affecting young girls at the beginning and throughout the educational pipeline, including gendered stereotypes, perpetuated by children's toys, adult impressed expectations, academic confidence levels, media perception, and a lack of female role models. A qualitative survey was conducted, with participants being comprised of undergraduate students attending Oakland University, to compare resulting trends to those found within existing research regarding the influence of these factors.

Background

During the past several decades, the number of women enrolled in undergraduate level programs within the United States has increased from 45 percent of total enrollment in 1975 [1] to over 57 percent of total undergraduate enrollment in 2009. The National Center for Education Statistics has predicted the total female undergraduate enrollment to plateau and remain stagnant at 58 percent until at least 2020 [2]. Within this expansion of women seeking continued education, STEM (science, technology, engineering, and mathematics) fields have seen the most dramatic shift in gender representations. In 2012, women in the United States accounted for over 59 percent of undergraduate degrees awarded in biological sciences and received the majority of degrees awarded within chemistry, psychology, and mathematics and statistics studies [3]. However, this trend of increasingly proportionate gender representation of women within typically male-dominated STEM fields does not hold true for engineering or engineering technologies.

The engineering field continues to be one of the most diverse and evolving sectors of employment due to its involvement in the ever-evolving landscape of technology. As the reach of technological applications expands and the challenges facing society emerge and evolve, engineering disciplines and sub-disciplines adapt to fill these needs. The engineering field can be divided into four main branches, consisting of mechanical, civil, electrical, and chemical engineering; with each major division including specialized sub-disciplines, or interdisciplinary sectors of engineering. These specialized or interdisciplinary engineering sectors, identified by the American Society for Engineering Education and the United States Bureau of Labor Statistics, include biomedical, aerospace, computer, environmental, engineering science,

metallurgical, materials, and petroleum; with more being developed or expanded as the need arises [4].

The United States Bureau of Labor Statistics predicts that the engineering field, overall, will grow with the national average of around 6 percent by 2024, with more varied results among specialized disciplines of engineering. The largest growth within engineering, over the next few years, will take place within the biomedical and environmental engineering sectors, with a projected growth rate of 23.1 and 12.4 percent, respectively [5]. In part, due to the projected field growth, a surge of interest and participation in undergraduate engineering programs within the United States has been observed within the last decade, reaching a historic high with little indication of slowing [6].

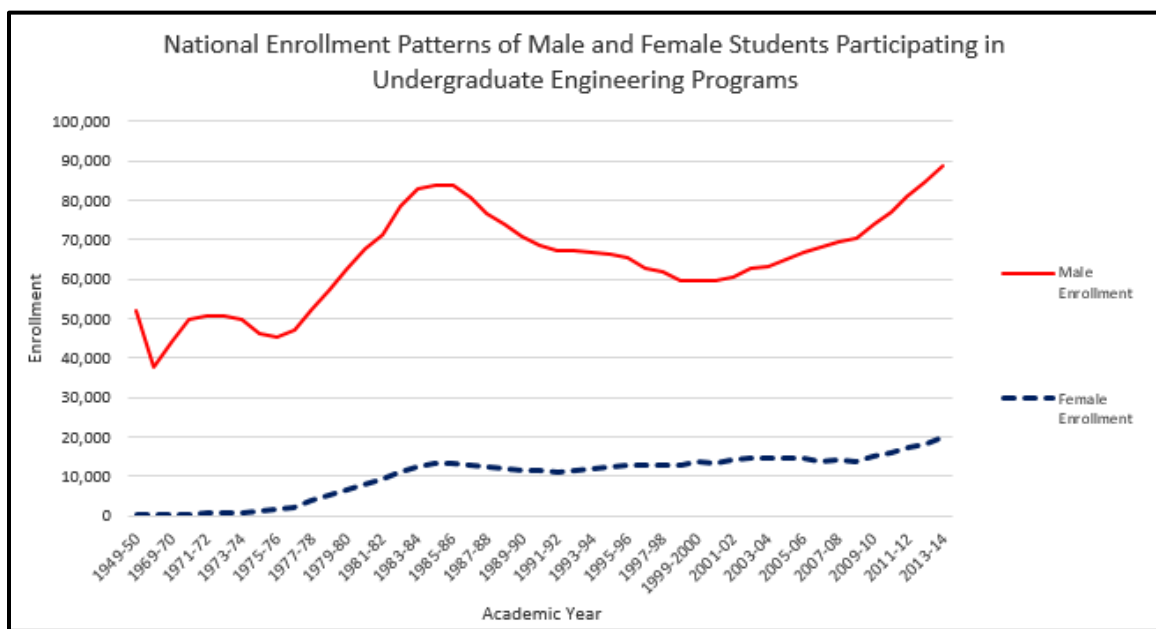


Figure 1 - Number of Male and Female Undergraduate Engineering Enrollment between 1950 and 2014 – Adapted from the National Center for Education Statistics [6]

In spite of the optimistic outlook for promising and lucrative career paths over the next decade, the number of women within the United States choosing to participate in undergraduate engineering programs has become stagnant, fluctuating marginally at approximately 19 percent [6].

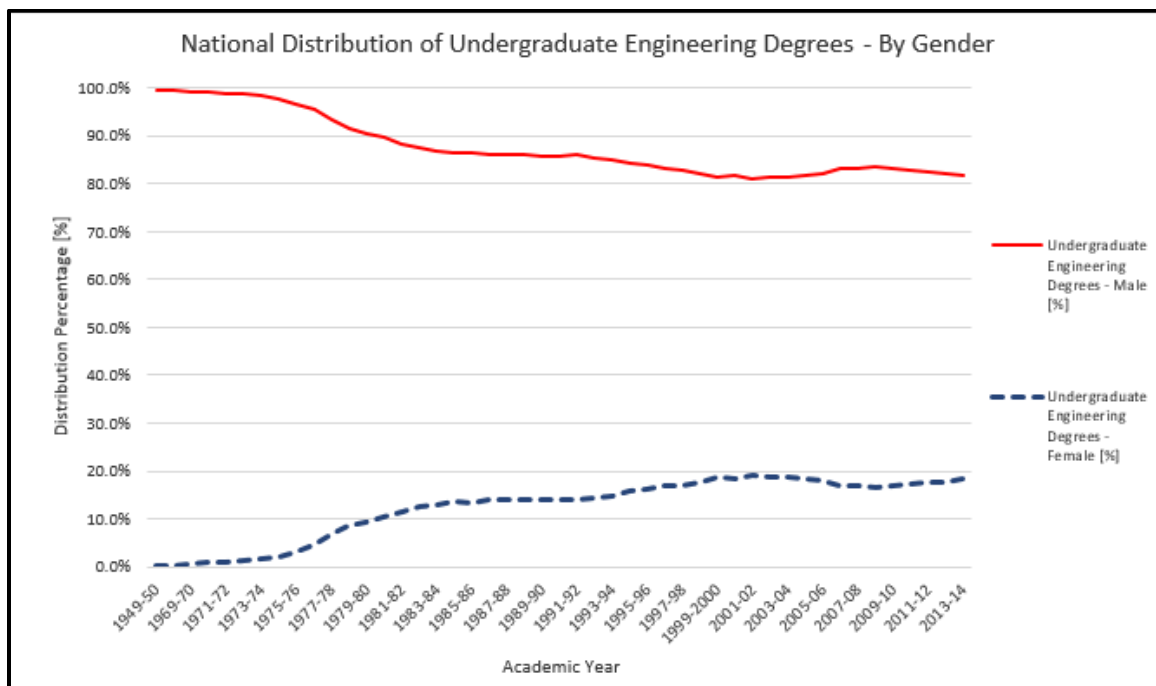


Figure 2 - Percent Distribution of National Undergraduate Engineering Enrollment by Gender between 1950 and 2014 – Adapted from the National Center for Education Statistics [6]

Despite the relative stagnation in the percentage of women participating in engineering programs at the undergraduate level, the relative amount of women has dramatically increased from the 1 percent reported as recently as 1971 [6][7]. It should be noted that the 19 percent of female undergraduate engineering participation is observed for engineering as a collective field, not for specific engineering sub-disciplines. The percentage of female participation varies widely between the specialized engineering disciplines, with some displaying a much higher female representation percentage than that of engineering overall, while some disciplines display a lower rate [4].

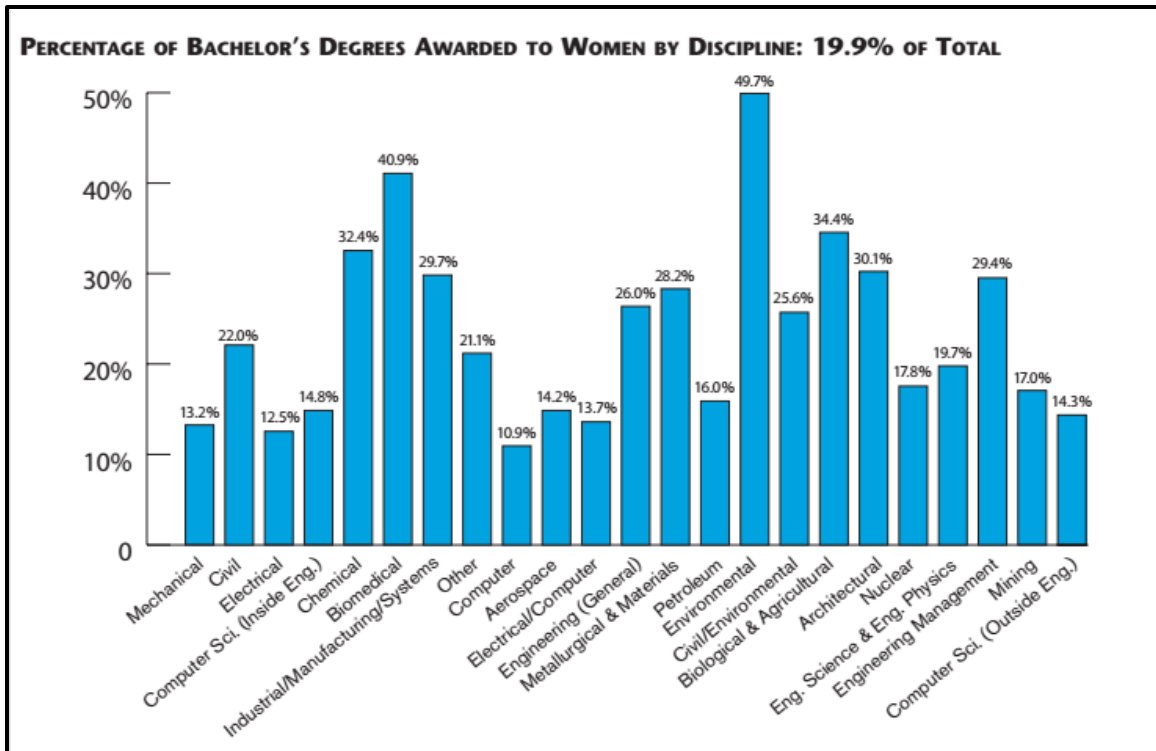


Figure 3 - Percent Distribution of Undergraduate Engineering Degrees to Women by Discipline for 2014
 – Adapted from the American Society of Engineering Education [4]

The American Society for Engineering Education evaluated the distribution of undergraduate engineering degrees awarded to women in 2014 within various engineering disciplines, as shown above in Figure 3. The difference in female participation can be seen with the highest representation being within environmental engineering at 49.7 percent, biomedical engineering at 40.9 percent, biological and agricultural engineering at 34.4 percent, and chemical engineering at 32.4 percent female representation. Computer engineering, electrical engineering, and mechanical engineering are comprised of the lowest female participation percentage occurring at 10.9 percent, 12.5 percent, and 13.2 percent, respectively. The engineering disciplines that contain the higher female participation rates tend to be those with the objective of improving the quality of life or the environment, or higher-level of resource management. On the opposite side, those disciplines that report the lowest participation rates are generally described as branches of engineering that focus on the development and production of a product

[8]. It can be seen that female engineers tend to choose engineering disciplines which are more openly focused on bettering society.

At the local level, Oakland University's School of Engineering and Computer Science has experienced an overall 12.4 percent growth rate per year in undergraduate enrollment since 2008; reaching an all-time high enrollment level of just under 2,500 students in the autumn of 2016. While this increase in enrollment may seem impressive, Oakland University's engineering programs follow the national trends for male to female enrollment rates. From 2008 to 2015, the percentage of female participation in undergraduate engineering programs fluctuated between 12 and 15 percent, slightly below the national average. In the fall semester of 2016, however, the percentage of female student enrollment increased to 16.5 percent, bringing it closer to the current national average than previous years, as shown below in Figures 4 and 5 [9].

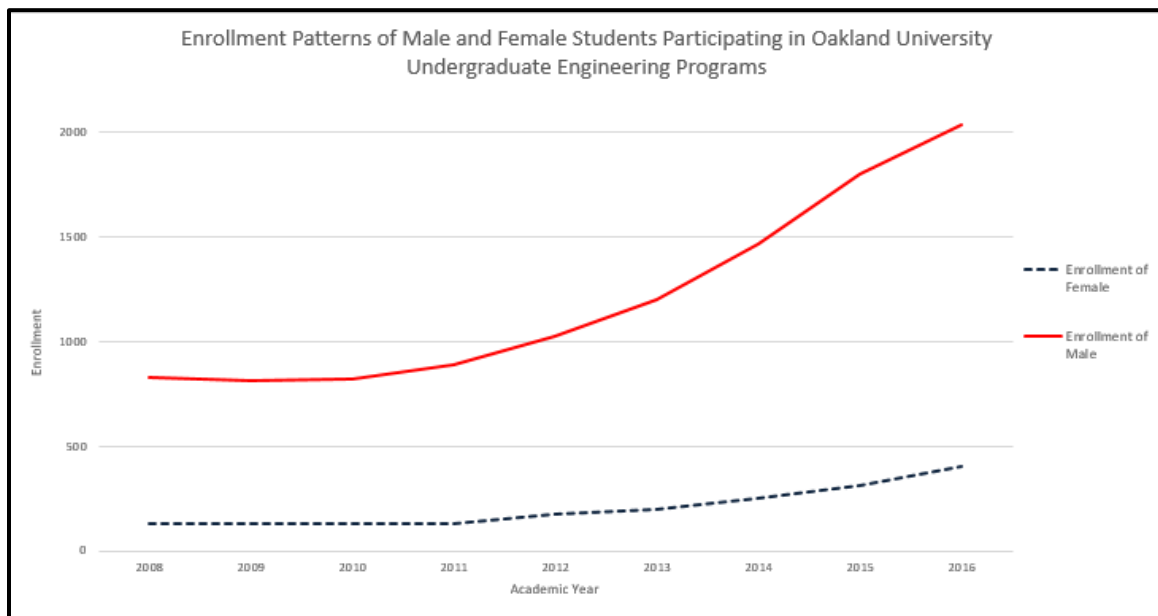


Figure 4 - Number of Male and Female Undergraduate Engineering Enrollment between 2008 and 2016 – Adapted from the Oakland University Office of Institutional Research and Assessment [9]

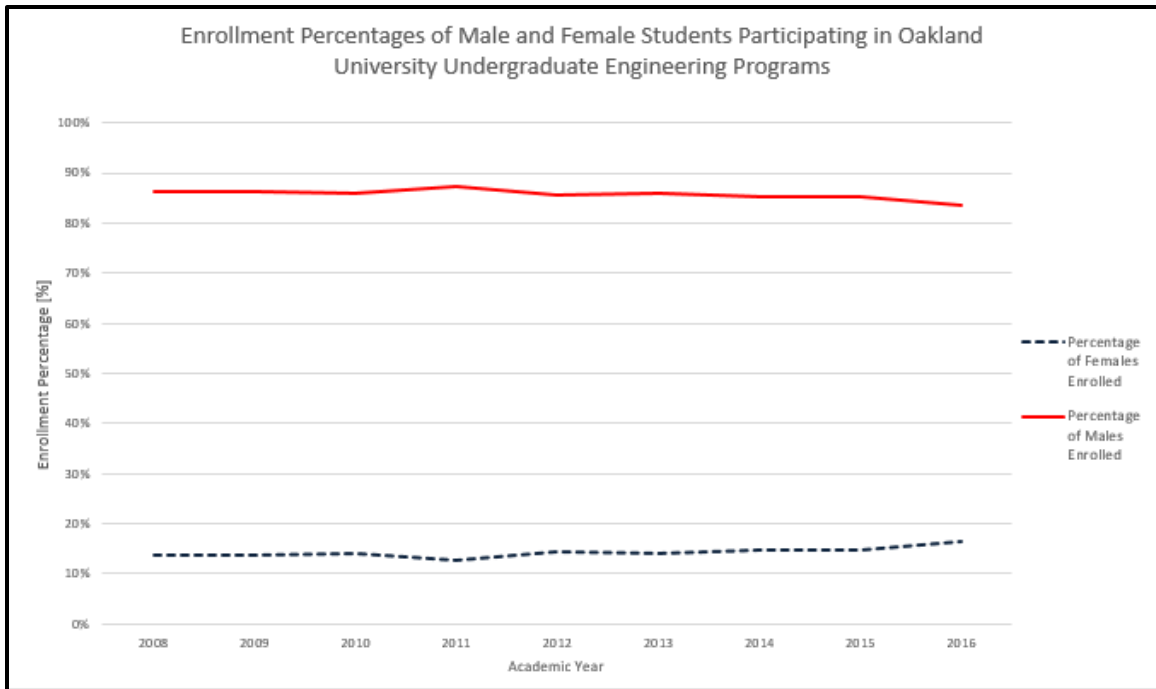


Figure 5 – Percent of Male and Female Undergraduate Engineering Enrollment between 2008 and 2016 – Adapted from the Oakland University Office of Institutional Research and Assessment [9]

A trend similar to that of national trends can be found when reviewing female enrollment rates for specific engineering disciplines offered as majors at Oakland University. The engineering majors offered through the School of Engineering and Computer Science at Oakland University include computer engineering, electrical engineering, mechanical engineering, industrial and systems engineering, engineering chemistry, engineering biology, biological engineering, and engineering physics.

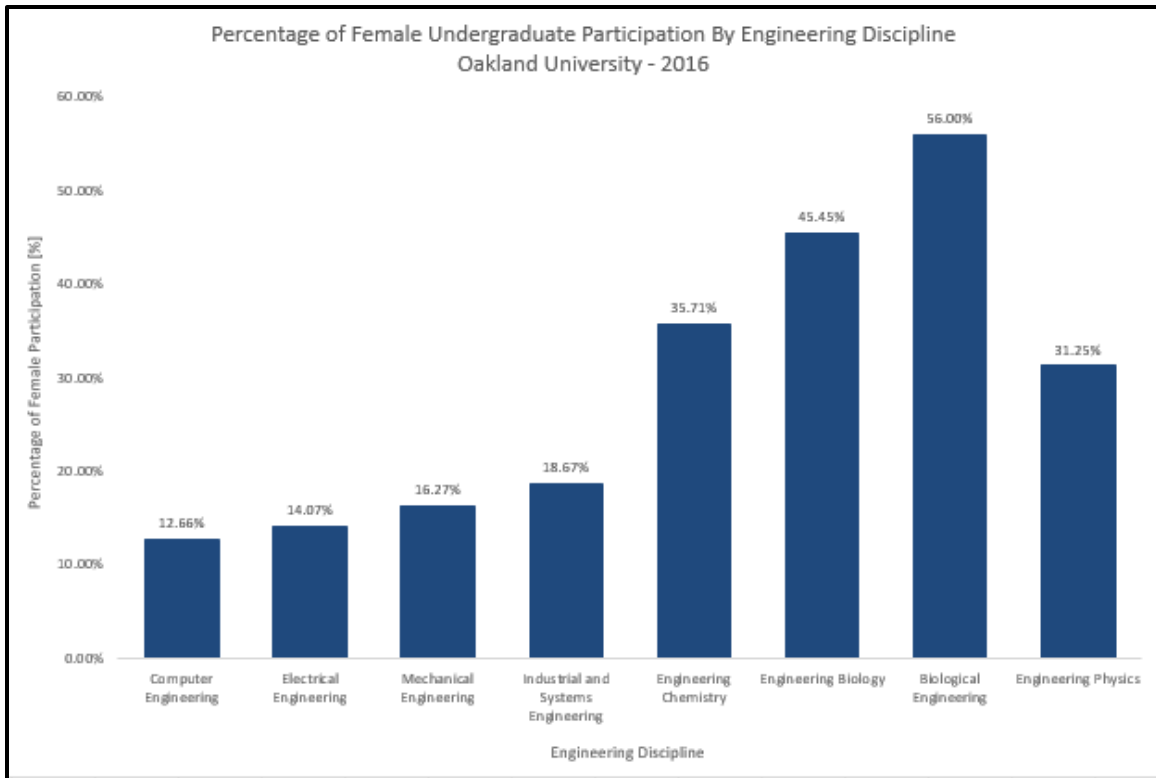


Figure 6 - Percentage of 2016 Female Undergraduate Engineering Enrollment by Engineering Discipline – Adapted from the Oakland University Office of Institutional Research and Assessment [9]

As with the national trends for female representation, the highest percentage for 2016 was reported within biological engineering with 56 percent, engineering biology with 45 percent, and engineering chemistry with 36 percent. While the lowest female participation percentages can be observed within computer engineering at 12 percent, electrical engineering at 14 percent, and mechanical engineering at 16 percent; similar to the national enrollment rates in 2014. As with the national trends, it can be observed that undergraduate female engineering students at Oakland University also display a bias of choose engineering disciplines which are considered to be more openly focused on bettering society.

Research Survey

To better evaluate the potential influences which drive the under-representation of females within engineering at the undergraduate level, a voluntary qualitative online survey was conducted at Oakland University in October of 2016. The target audience for this survey was undergraduate Oakland University students, unrestricted by major, however with a focus for students with an intended STEM major, specifically those pursuing engineering. The survey itself was conducted in an anonymous nature as the only identification collected from participants was the gender they identify with, their age range, their current level of education, and their intended major of study. The survey included questions that were open-ended, multiple-choice, and those structured with a ranking spectrum. The questions focused on participants' involvement with a variety of toys, testing their spatial skills, beliefs regarding academic confidence and stereotypes, and participants' experiences within STEM and engineering fields. Most of the survey prompts were structured to be used to compare participants' responses by gender and intended major to allow for a comparison to be made against previous research results and national trends. Participants were recruited through an inquiry email distributed through email lists connected to the following organizations at Oakland University: Oakland University Honors College, Presidential Scholars Tau Beta Pi Engineering Honors Society, Alpha Lambda Delta Honors Society, Phi Sigma Pi Honors Society, Society of Automotive Engineers, Society of Women Engineers, American Association of University Women, and the Engineering Graphics and CAD course.

Overall, the survey received 234 responses with a gender distribution of 65 percent female and 35 percent male participants, with all participants being 18 years of age and older. Of the participants, 161 responded with intended majors that were classified as STEM majors,

and 102 responded with an intended major in an engineering discipline. The majority of all participants, 89 percent, reported their current level of education ranged between having just graduated high school to being within the third year of their undergraduate degree. For further details regarding this survey's questions or prompts, and participant demographics, the survey in its entirety is included in the Appendix located at the end of this research thesis.

Literature Review

The persistence of inequalities in the participation of women within engineering has insurmountable effects for those women who wish to potentially pursue an engineering career and for society as a whole. Within their research, Cheryan, Master, and Meltzoff [10] discuss the missed opportunities and fractious effects for women not pursuing engineering currently.

“Gender disparities in ... engineering are problematic for at least three reasons. First, jobs in these fields are often high-status, lucrative, and flexible (Kalwarski et al., 2007), and thus women are missing out on jobs that are potentially beneficial for them. Second, engineers ... design tools that shape modern society, and diversifying the field can help to ensure that these fields are creating designs appropriate for a broad population (Margolis and Fisher, 2002). Third, the U.S. is currently not training enough ... engineers to keep up with demand (Soper, 2014). Attracting more women ... would be an effective way of reducing this gap” [10].

In spite of the potential advantages available for women pursuing an engineering profession, female students are choosing to not participate in engineering programs at higher rates than other typically ‘male-dominated’ fields, including other STEM fields. Due to the persistence of this drastic difference, researchers have focused on discovering and addressing the

influences that attribute to the low representation of females within engineering. When questioning the lack of women within engineering, Professor Gelernter, a computer science professor at Yale, stated that there is an obvious reason for the underrepresentation of women within engineering fields. “Women ... must be choosing not to enter, presumably because they do not want to; presumably, because they (by and large) don’t like these fields.” [10] These statements, which equate lack of female participation to lack of interest, use an assumption that a woman’s choice is made freely of outside influence and is unconstrained by social constructs or beliefs; which have been found to be false through scientific research.

It is proposed that these barriers, or social beliefs and constructs, influence a female student’s decision to participate in engineering programs. As a largely exploratory study, this research thesis’s aim is to explore conclusions of existing research on influences and social barriers to female participation in engineering and compare those to surface-level trends of a collected survey.

Research studies pertaining to the causes of female attrition within engineering fields has been thoroughly conducted throughout stages of the educational ‘pipeline’, or the educational pathway of students beginning at early education and ending at the professional level [11]. These studies focus mainly on identifying and addressing causes of female under-representation and attrition at the professional level. Research suggests that by addressing the ‘chilly climate’ at work, gender wage gap, discriminatory hiring practices, and unrealistic expectations, the number of women involved in the engineering fields will increase and reduce their disproportionate gender representation [12][13][14]. These recommendations only address the causes of professional attrition for female engineers to close the gender gap. A larger contributor to the gender gap, which is often overlooked, is the influences that cause young girls to choose

not to pursue a future in engineering [10][15]. The contributing causes of the lack of interest from young girls at the beginning of the educational pipeline have been linked by several research studies to gendered stereotypes, perpetuated by children's toys, adult impressed expectations, academic confidence levels, media perception, and a lack of female role models.

While the root causes of gender stereotypes, especially those regarding educational abilities, are not fully recognized, it is understood that their influence affects students at the very beginning of the educational pipeline, as young as five years of age. Francisca del Rio and Strasser [16] conducted a study on preconceived stereotypes in kindergartners regarding academic achievement based on gender in a variety of educational subjects. The participants believed that boys would show preference, ease, and higher achievement regarding language and math, while girls would only show preference and demonstrate higher achievement in only linguistics. When questioned regarding difficulty and dislike, the kindergartners reported that girls would dislike math more than boys would and girls would demonstrate a lower success level towards math. Within their study, Francisca del Rio and Strasser concluded that children as young as kindergarten age already have preconceived beliefs regarding the different preference and academic abilities of males and females [16]. It can be hypothesized that these deep-rooted stereotypes can be carried over from the previous generation's disputed belief that biology drives gender differences in cognitive abilities and interests. "The classical formulation of this idea is that men "naturally" excel in mathematically demanding disciplines, whereas women "naturally" excel in fields using language skills [17]." These taught, learned, or lingering notions of gendered stereotypes towards academic ability and assumed preference have far-reaching and potentially detrimental consequences on society and the following generation of young boys and girls.

An economical and societal consequence of the gendered stereotypes that influence younger children is the use of gendered toys and their marketing. In America, toys marketed to young children today are more explicitly market, or ‘gendered’, than toys more than half a century ago. The methodology driving the marketing of toys has been fluid throughout the 20th century, fluctuating from deeply gendered stereotypical targeting from the 1920’s to the 1960’s, to extremely gender neutral in the 1970’s, and back to increasingly gendered marketing following the 1990’s to present day [16][14].

Despite sexism and gender discrimination in today’s society being much less prevalent or accepted compared to fifty years ago, the current method of marketing for children’s toys is structured in the similar gender binary and stereotypical model, reminiscent of the 1960’s. Throughout the 1920’s to the 1960’s, girls’ toys were marketed explicitly towards domesticity, perpetuating the stereotype that domestic and nurturing skills are interesting and should be a focus for young girls. For instance, an advertisement for a toy broom-and-mop set circulated in the Sears’s catalog in 1925 contained the tagline “Mothers! Here is a real practical toy for little girls. Every little girl likes to play house, to sweep, and to do mother’s work for her” [18]. During the same period, boys’ toys were emphasizing practical skills training for the industrial-focused economy; displayed in an advertisement in the same 1925 Sears’s catalog for an Erector Set. The slogan used to draw interest from young boys and their parents was phrased as, “Every boy likes to tinker around and try to build things. With an Erector Set, he can satisfy this inclination and gain mental development without apparent effort. ... He will learn the fundamentals of engineering” [18]. This mentality of targeted advertisement leaning into gender norm stereotypes faded to the background in the 1970’s but made a resurgence during the 1980’s and 90’s.

By 1995, more than half of the overall advertising within the Sears's catalog consisted of binary gendered toys [18]. This trend of increasingly gendered categorization of toy marketing was evaluated in a research study conducted by Auster and Mansbach on the Disney store website. It was found that while a few toys appeared in both categories of 'For Boys' and 'For Girls' toys, there was no explicit category labeled as 'Gender-Neutral' or 'Toys for Boys and Girls' [16][19]. Liu explained the effects of targeted marketing on not only the children but the parents as well.

“As a guy, I’ve always been turned off by the huge “pink” aisle in toy stores — it’s like hanging a big “keep out” sign for boys, and telling girls “Hey, ignore everything else in the store except this aisle.” We don’t spend a lot of time in big box toy stores now, and I know my daughters have a mix of things that are “boy” or “girl” toys. But it’s so hard to fight the marketing [20]”

These defining binary labels lend themselves to the preconceived notions that the children's parents, who are purchasing these toys, have regarding the preference and interest of the children.

The influence of gendered children's toys consists of more than binary advertising; it also includes the ideals and beliefs of the parents, who are the primary purchasers of the products. In the hypothetical that non-gender biased options for children's toys were as prevalent as those marketed which incorporate gendered stereotypes, a child's experience with toys is dependent on which toys their parents purchase for them. A research study completed by Bleeker and Jacobs found definitive evidence that “mothers disproportionately purchase math and science toys for boys rather than girls, a trend that persists across all age levels in children” [19]. It has been accepted through extensive research that parents harbor expectations of their sons to outperform

their daughters in science and mathematical fields throughout their academic experiences. Parents are also more accepting of their daughters interacting with cross-gendered toys while being more restrictive with their sons; limiting them to own-gendered toys. Furthermore, Bleeker and Jacobs discovered that the rate at which parents purchase science and mathematically related toys at a young age often precipitated and causes the child to display continued interest in science and mathematics in later academic years [19].

In addition to parental influence regarding children's preference towards gendered toys, research studies have been conducted that have concluded that at the very early stages of a child life, between 9 and 32 months of age, children develop preference towards gendered toys due to social interactions and differences in play methods. It was determined within a study by Bussey and Bandura that the combination of gender-specific socialization and the development of gender-typed behavior through the interaction of peers influences a child's toy preference, as early as nine months [21]. Kohlberg also determined that children as young as two years old learn gender identity and begin to apply it to themselves and their peers, the influence of learned gender stereotypes prompts young children to engage in gender-typed play or toy selection [21]. Furthermore, during infancy, the play behavior and innate difference in aptitude of children contribute to their preference of toys. In a 2011 research study conducted by Benenson, Tennyson, and Wrangham, it was discovered that for children between 6 and 9 months of age, boys tended to be drawn towards toys which imitated propulsive motion and more spatial manipulation, like balls and wheeled toys. On the other hand, girls preferred toys which contained animate-features, such as faces or eyes, and those which allowed for fine manipulation of detailed parts [21]. These seemingly innate preferences for an early age in combination with learned gender stereotypes feeds into the gendered marketing of 'boy' and 'girl' toys.

In an attempt to define what constitutes a ‘boy’ or ‘girl’ toy, Blakemore and Centers conducted an extensive research study to expound precise interpretations on the distinctive identifying characteristics of gendered toys. They concluded that girl’s toys consisted of qualities that were more focused on nurturing and domestic skills; while boys’ toys were described as more exciting and rated higher on scientific qualities and educational value [16]. Due to parental preference regarding gendered children’s toys, boys have more exposure to mathematical and scientific concepts through gendered toys, such as chemistry sets or building toys, and, as Orenstein concluded, are more likely to have access to a computer and video games at home at a young age [22].

To determine if gendered stereotypes in combination with biased marketing, innate and parental preference had an impact on the types of toys and activities children experienced at a young age, a question regarding involvement with a variety of types of items was included in the survey conducted with undergraduate students at Oakland University. The items included in the survey question consisted of eleven different toys or activities that range from stereotypically masculine to gender neutral to stereotypically feminine, as identified by Blackmore and Center’s study of gendered toy categorization and identification [16]. Initially, all participants’ responses were included in the evaluation, as not to isolate intended major as a controlled variable. As seen below in Figure 7, the survey responses were separated by gender to conduct a high-level comparison of gender participation with select toys and activities. Of the eleven included items, action figures, Lego/ K’nex / building toys, video games would be characterized as stereotypically masculine, arts and crafts, dance, dolls, dress up, playhouse, and stuffed animals are recognized as stereotypically feminine, and computers and organized sports are categorized to be gender-neutral [16].

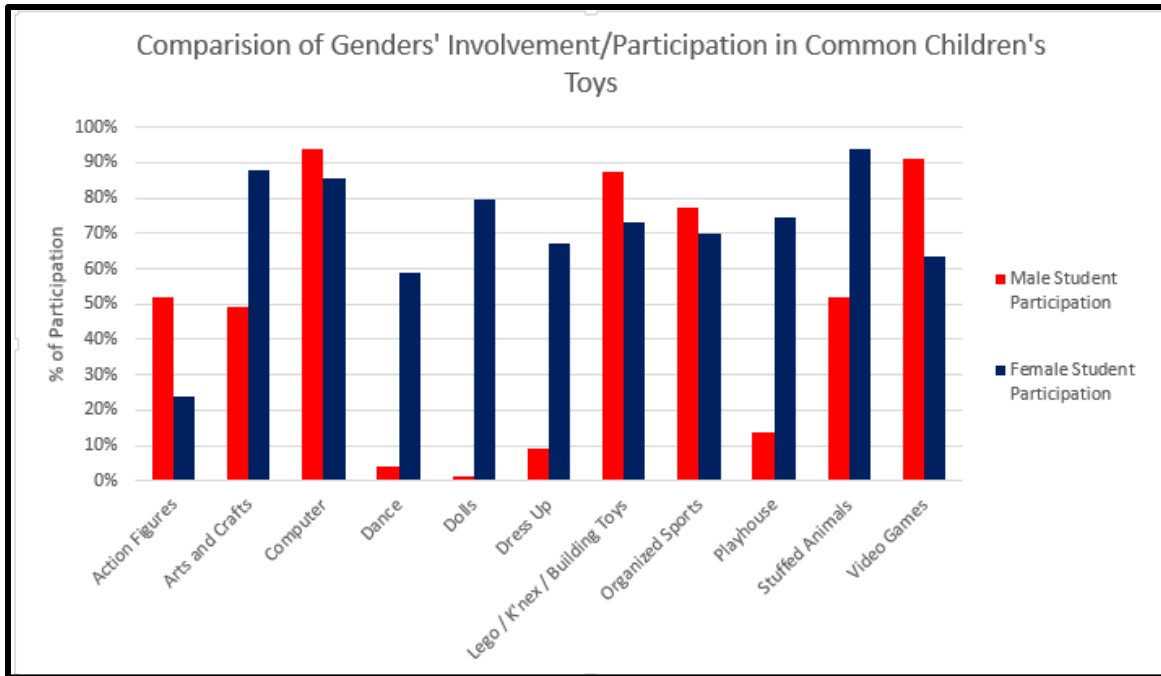


Figure 7 - A comparison of survey responses to experience with a variety of toys and activities from Oakland University undergraduate students— adapted from collected survey data.

When observing the trends pertaining to all of the stereotypically masculine items, female student participation is reported to be more than fifteen percentage points lower than male student participation, with video games and action figures having the largest male-biased difference. A similar trend emerges when evaluating the difference in gendered responses for the stereotypically feminine toys or activities; for all of these identified items, there exists a substantial female bias for student participation. For the gender-neutral items, a more uniform distribution between male and female student participation is seen.

The only contradiction to this male-biased surface trend for the stereotypically male toys occurs with the Lego/K'Nex/Building Toys. When observing the male and female participation reported for these 'building toys' from the survey results, the difference is much smaller than those of other stereotypically masculine toys. The difference of fourteen percentage points, biased towards male participation, is closer to the reported difference of those gender neutral

items. One could hypothesize that as a result of the research and actions taken by Lego in the past decade to address the neglected market of young girls by releasing more Legos marketed specifically for girls, Legos have become increasingly more equal in its distribution in gender participation [23].

To explore the potential effects of toy and activity involvement at a young age to the decision pertaining to undergraduate major selection, specifically for engineering, the survey data was filtered to only include those participants who indicated an intended major within engineering. The results were analyzed and shown below in Figure 8.

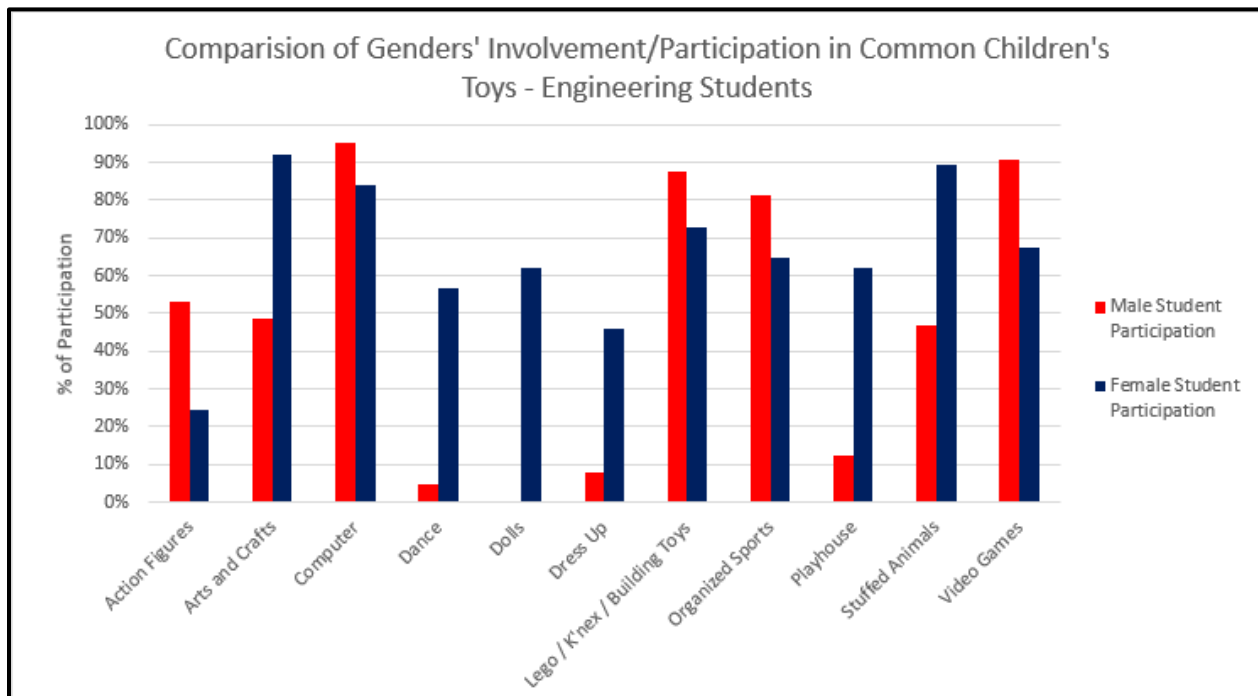


Figure 8 - A comparison of survey responses to experience with a variety of toys and activities from Oakland University undergraduate engineering students– adapted from collected survey data.

Similar to the results evaluated for the survey responses not filtered by intended majors, the female participation for the stereotypically masculine items was lower than male participation by at least fifteen percentage points. A similar trend emerges for the stereotypically feminine toys or activities; for all of these identified items, there exists a substantial female bias

for student participation. However, a slight difference can be seen for the trending of gender-neutral items between all survey participants and those who indicated an intended engineering major. For the gender-neutral items, the participants with an intended engineering major reported a more male-bias than what was reported by participants across all majors. For both the computer and organized sports, the difference almost doubled for the engineering participants. However, it is not enough of a significant variation to warrant a hypothesis for the difference or the potential implications of it.

Within a 1995 research study, Orenstein found evidence that at a younger age, boys had more exposure to computers than young girls did [16]; however, this seems to have changed to communicate near equal exposure to computers at a young age for both genders. Based on the collected survey responses, it can be hypothesized that gendered toys and biased parental preferences or beliefs impact the exposure young children have to different toys and activities. An unfortunate consequence of the combination of binary gender categorization of children's toys and parental expectations of preference is the divide in the cognitive development of different skills between genders.

During the formative ages, young children cultivate and hone different cognitive skills through the use of toys selected for them, in part, by their parents. Toys that are marketed for boys promote math, science, visual-spatial and problem-solving skills and girls' toys endorse verbal and linguistic skills, promoting a difference in cognitive proficiencies among genders and expanding the educational gaps. "This difference in cognitive skills carries on throughout a child's lifetime, influencing their academic interests as a child, the major they choose to pursue in college, and the occupation they will have in their postgraduate life" [16].

A byproduct of the combination of deficiencies in cognitive skills developed through exposure to stereotypically masculine toys and lowered parental expectations or encouragement; young girls can develop low self-confidence in their abilities in mathematics and scientific subjects. This can be seen within Francisca del Rio and Strasser study, where children as young as kindergarten display the belief that girls do not naturally excel in mathematics, as boys do [16]. At a young age, boys are not as intimidated by mathematics or scientific topics because they have received exposure and developed skills to assist with these subjects through the use of ‘boy’ toys and parental encouragement; something that most girls neglect to receive.

For children within less fortunate socioeconomic groups, specifically, young girls, the effects of the lack of exposure to stereotypically masculine toys and lowered parental expectations or encouragement can be more detrimental to their development of cognitive skills. Hsueh and Yoshikawa determined that within a lower socioeconomic status, parents tend to be less able to provide their children with as much time or attention as parents of a higher socioeconomic status as they are working extra hours or multiple jobs to make ends meet [24]. On top of that, with limited resources, children within a lower socioeconomic status are not afforded as much cognitive stimulation as those children within middle-income families. “They also have fewer play areas in their homes; have less access to computers and the Internet (and use them in less sophisticated ways); own fewer books, toys, and other recreational or learning materials; spend more time watching television; and are less likely to have friends over to play” [24]. Due to these factors, children within lower socioeconomic groups display a lower cognitive achievement level, earning below-average standardized test scores in mathematics, science, and linguistics [24]. For young girls within a low socio-economic status, these influences combine to have a detrimental effect on cognitive skill development.

Though it is not a matter of ability or level of knowledge, young girls are prone to believe that they are not ‘smart’ enough to excel in these subjects, in part due to their lower academic confidence. As a result of this mindset coupled with the impact of these influences, mathematic and scientific subjects can be viewed as ‘too difficult’ to grasp regardless of effort for young girls. In 1992, Mattel Inc. released a Barbie doll, marketed towards young girls, which said the phrase, “Math class is tough!” [20]. With the combined influences from gendered toys leaning into the stereotype of girls being deficient in math and insecurities in personal cognitive abilities, the harmful fix-minded stereotype can perpetuate to future generations of boys and girls without being addressed or taking corrective actions.

In an attempt to compare the long-term effects of academic confidence and stereotype belief influence from the typecast that girls are not good in mathematics, a series of statements were posed to undergraduate students at Oakland University within a voluntary study. These statements included prompts for self-confidence in academic abilities within mathematics, science, and linguistics, as well as prompts affiliated to the stereotypical belief supported by either gender for the same subjects. The results of the 228 participant responses, consisting of 65 percent female and 35 percent male response, compared by gender and not restricted by major, can be observed below within Figure 9.

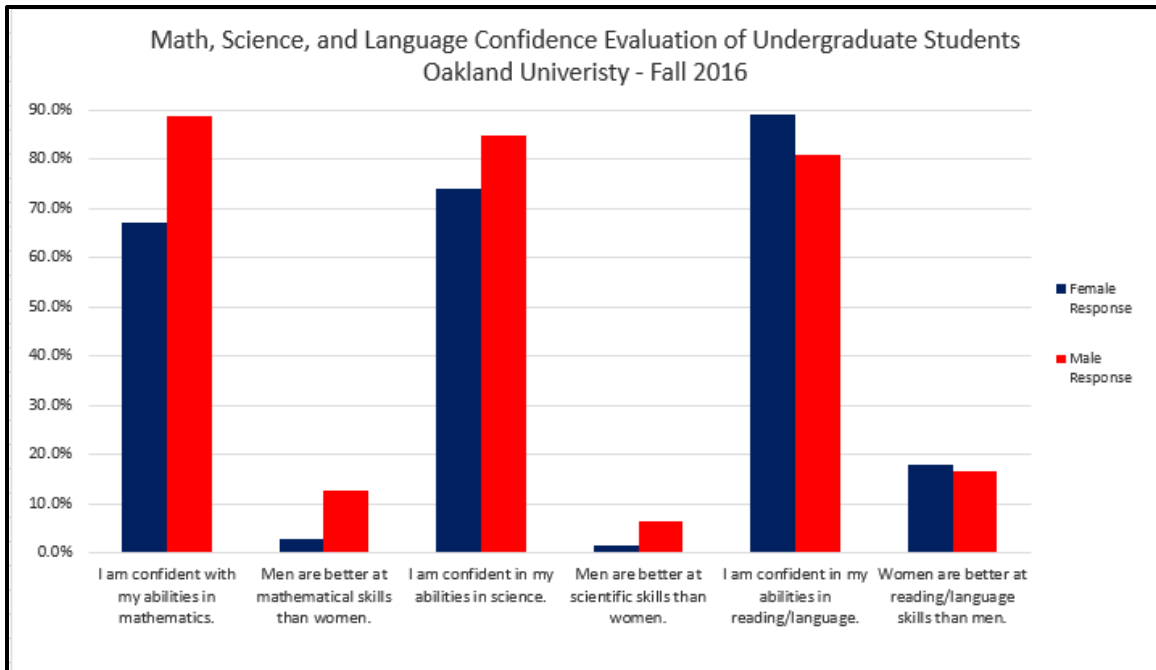


Figure 9 - A comparison of survey responses of self-reported confidence within academic subjects from Oakland University undergraduate students – adapted from collected survey data.

The overall trends of the collected data seem to support the conclusions determined within other various research studies evaluating academic confidence and belief in stereotypes regarding gender biased academic achievement in various subjects. For mathematics and scientific subjects, male participants reported a higher confidence within their abilities by more than 10-20 percent compared to female participants. Regarding confidence in linguistics skills, female participants reported a higher confidence than males by just under 10 percent. These findings are consistent with boys' toys focusing on problem-solving, mathematic, and scientific skills; while girls' toys concentrate on linguistics.

To compare, the self-confidence in academic abilities within mathematics, science, and linguistics, as well as belief in gender stereotypes, the survey responses were filtered to only include those who indicated an intended engineering major. The responses were then separated

by gender, there were a total number of 100 responses with 65 percent being male and 35 percent were female participants.

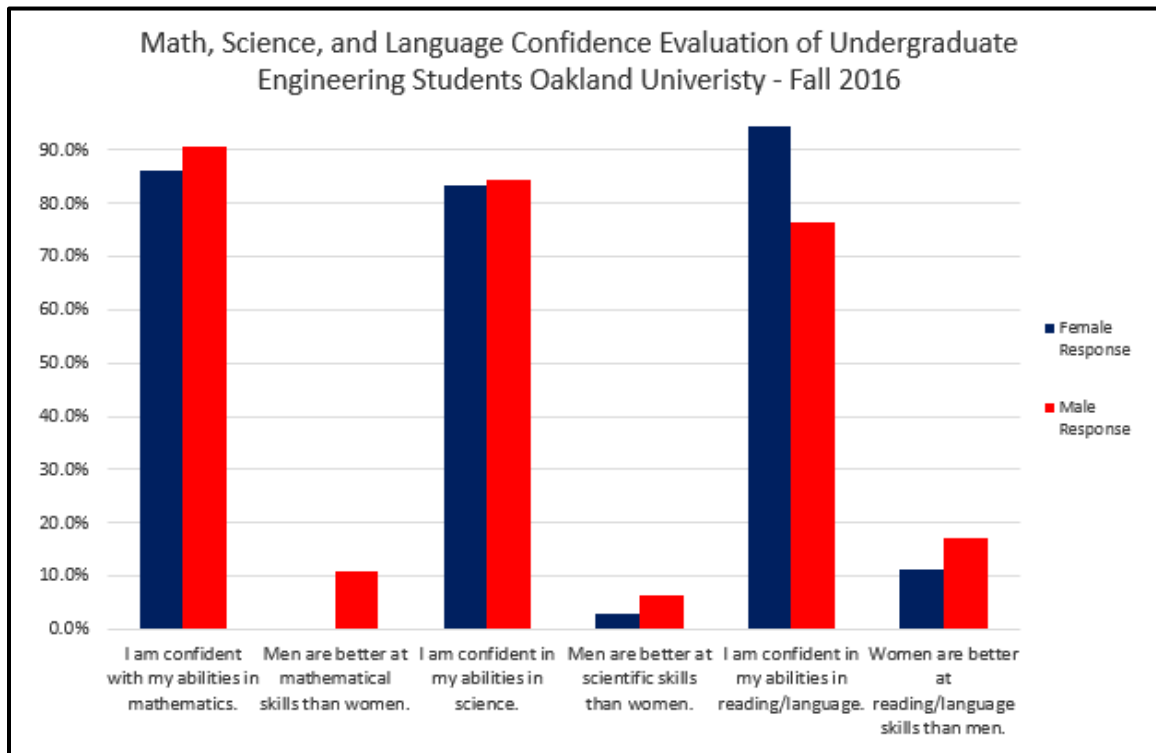


Figure 10 - A comparison of survey responses of self-reported confidence within academic subjects from Oakland University undergraduate engineering students – adapted from collected survey data.

For engineering specific participant responses, there were distinct differences when compared to the results from all survey participants. The most telling difference is the female participants reported self-confidence in academic ability across all subject. Female engineering students reported a higher confidence in mathematical skills by nineteen percentage points, scientific skills by ten percentage points, and linguistic skills by six percentage points, while male students' responses to academic confidence varied by less than four percentage at most for linguistic skills. In addition, both male and female engineer students were less likely to believe gendered stereotypes pertaining to academic skills than other survey participants.

For both versions of analysis, all majors and specifically engineering majors, the participants' responses to the stereotypical statements to gender and ability pertaining to the academic subject are telling to the current mindset of students. While female students may not report levels of confidence in their math and science abilities as high as those reported from male students, female participants agreed with the statements of 'men are better at mathematical and scientific skills than women' at a lower rate than male participants. For the stereotypical statement of 'women are better at language/reading skills than men', while male participants did report a lower rate of agreement than females, the difference is noticeably smaller for all survey participants. Both female and male participants were more agreeable with the stereotype favoring their gender's academic success. Despite this, young women now seem to be less accepting of those academic stereotypes representing them less favorably, while young male students seem as agreeable to less favorable gendered stereotypes against males across all majors. This emerging trend of young female students actively disagreeing with detrimental gendered stereotypes of female academic success specifically in mathematics and scientific subjects may be an indication to the future closing of the educational gap.

Within the last three decades, research has uncovered trends showing educational achievement gaps between the genders; with girls excelling in linguistics, verbal subjects, and advancing in mathematics; while boys are continuing to show higher scores in scientific subjects. Despite the evidence showing that there is no longer any statistical gender difference in mathematical performance and young girls from grades 2 through 11 are currently performing at similar academic levels to boys, young girls are not performing as well as boys in advanced STEM subjects at the high school level. In her study, Correll discovered that compared to their equally proficient female peers, boys are 1.2 times more likely to enroll in calculus courses. She

attributed this disparity to the differences in self-confidence in mathematics, which in part influences young girls to avoid participating in mathematics and science intensive classes [17]. In 2013, girls outnumber boys nationally in the participation in the Advanced Placement (AP) exams for biology; however, for every other STEM-focused AP exam (chemistry, calculus, computer science, and physics) boys not only continued to outnumber girls but also outscored them in every AP STEM domain test [16]. This inequality of female students participating in science and mathematically intensive subjects is in part influenced by the disproportionate development of spatial skill between genders.

It has been determined through multiple investigative studies that a foundational skill for STEM topics is spatial skills, specifically those engineering specialties which are heavily reliant on design and physical manipulation, such as mechanical and electrical engineering. Tracy defines spatial skills to be the capacity or ability to understand and reason spatial relations between objects or space, which include spatial perception, spatial visualization, mental rotation, and mental folding [22]. Spatial skills are developed at a young age through the use of ‘boy’ toys, ones that promote spatial awareness and manipulation of three-dimensional space. Due to gendered stereotypes and parental preferences involved in children’s toys, young girls are at a disadvantage with the development of spatial skills. Through research completed within a university level engineering course, Sorby and Baartman [17] determined that if young women gained experience that improves their spatial skills, the female students’ self-confidence within mathematics and science would increase and may consider a future within STEM. Improving spatial skills through the use of stereotypically masculine toys within young girls is a method to increase girls’ interest in engineering, while also addressing academic confidence and gendered stereotypes.

Within cognitive skills, the area of spatial skills has shown a consistent gender gap with boys consistently outscoring girls. To evaluate spatial visualization skills, Purdue University developed a test consisting of a series of multiple choice questions involving mental rotation of simple three-dimensional images. It was observed within this spatial visualization test that females were three times more likely to fail than their male peers [17]. An example of desired image rotation is provided and an additional three-dimensional cube image to rotate in the same manner of the example, matching the resulting image to the multiple-choice options.

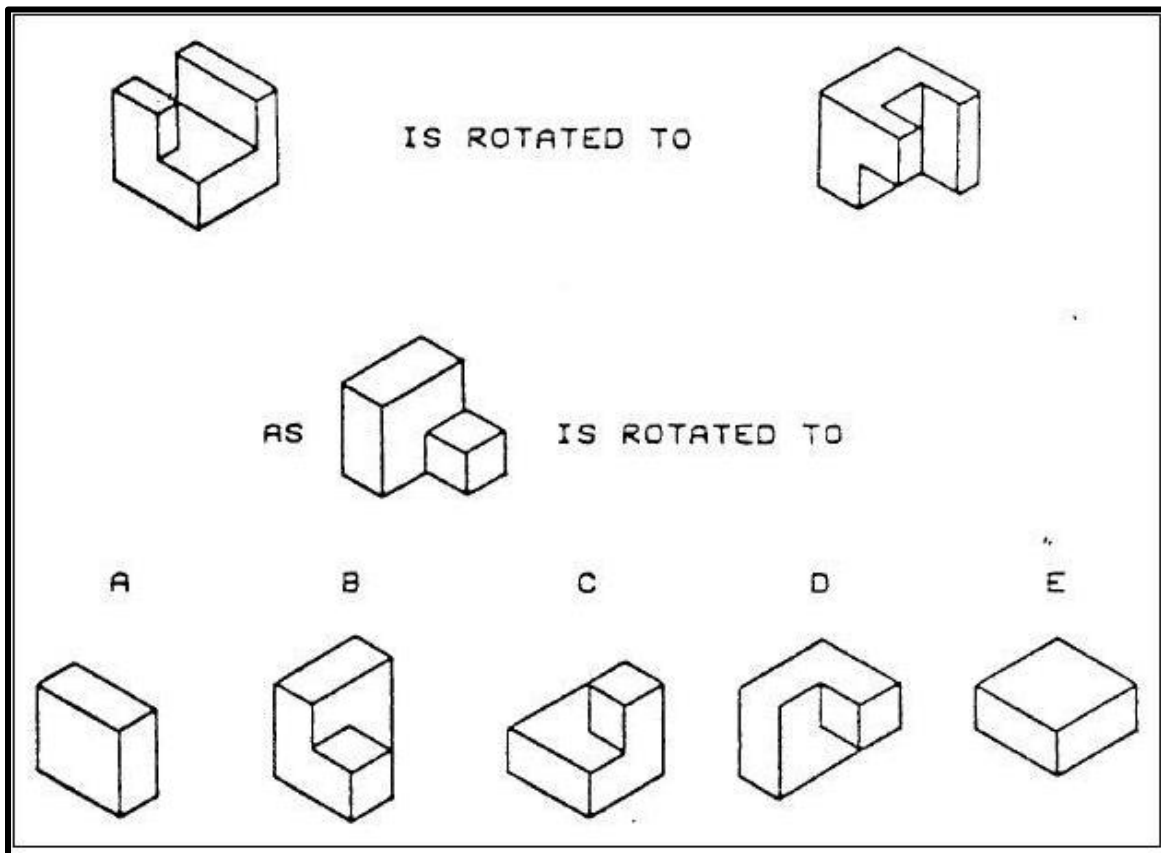


Figure 11 - An example of Purdue Spatial Visualization Test: Rotations, used within a survey of Oakland University undergraduate students. [17]

Within the volunteer survey conducted with Oakland University undergraduate students, an example of the Purdue Spatial Visualization Test: Rotations, as shown above in Figure 11,

was included to compare correctness between the genders. No participant responses were disregarded in relation to this question as to include all potential majors and academic background and not isolate intended majors as a factor in the high-level analysis. The results of this question are depicted below in Figure 12.

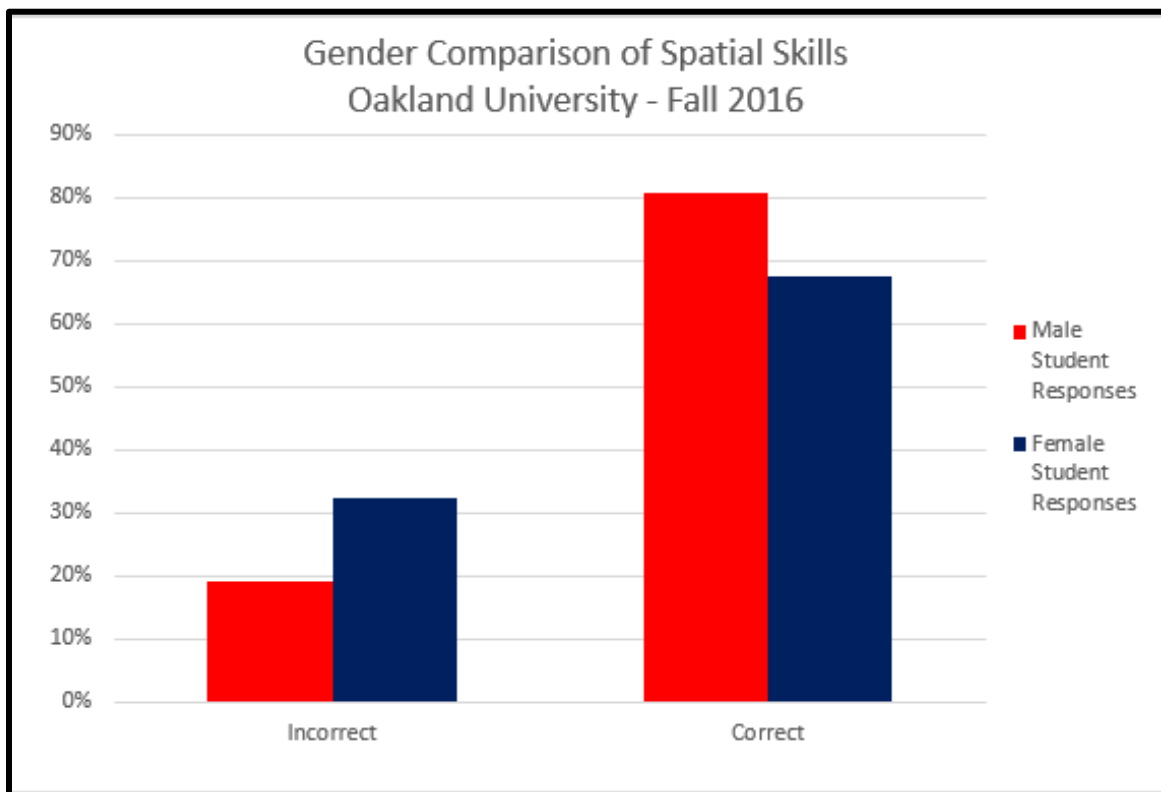


Figure 12 - A comparison of survey responses of Purdue Spatial Visualization Test: Rotations from Oakland University undergraduate students– adapted from collected survey data.

In the evaluation of the results from the Purdue Spatial Visualization Test: Rotations conducted within the survey, the results seem to align with previous research regarding the difference in spatial skills between genders. In a 2000 study conducted by Sorby and Baartman, using an expanded version of the same Purdue Spatial Visualization Test used within the voluntary survey performed at Oakland University, it was determined that approximately 39 percent of women failed the exam, while only 12 percent of men failed [17]. These results from

Sorby and Baartman’ study are highly similar to those of the survey responses where male students incorrectly answered 19 percent of the time compared to a 32 percent failure rate of female student participants.

For comparison, the survey responses were filtered to only include those participants who indicated an intended major within engineering to see if engineering students are more proficient in the use of spatial skills. The results are depicted below in Figure 13.

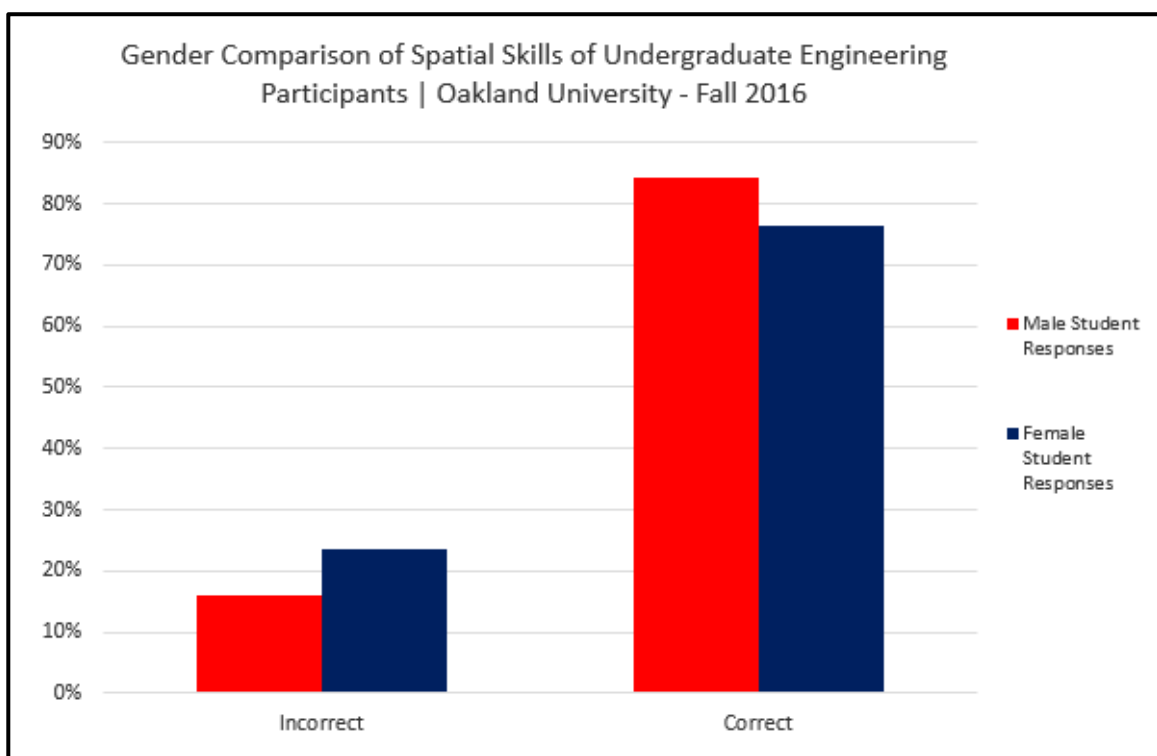


Figure 13 - A comparison of survey responses of Purdue Spatial Visualization Test: Rotations from Oakland University engineering undergraduate students– adapted from collected survey data.

For the survey participants who indicated an intended engineering major, the results of the Purdue Spatial Visualization Test: Rotations were similar to those reported from all survey participants. The difference between these two analyses is the failure percentage for female students, where female engineering students were eight percent more likely to pass the test. It can be hypothesized that female engineering students are more proficient in spatial skills,

potentially strengthened through engineering courses, their upbringing, or interaction with gendered engineering toys. Spatial skills are immensely important to mathematics and scientific academic achievement, specifically in engineering. Without the development of necessary cognitive skills through a well-rounded exposure to childhood toys, young girls will continue to be steered away from engineering, perpetuating stereotypes that women don't 'fit' within the field.

At a young age, children develop perceptions and beliefs in response to their personal experiences and are often prone to the influence of stereotypes in situations where their experience is lacking. Since engineering courses are not required or even readily offered within American high schools, many students lack direct exposure and experience with engineering. As a result, to gain knowledge about the engineering field, students rely on interpolations from cultural stereotypes and from their circle of family and friends, skewing their assessments of who engineers are and what they do. The majority of high school students, 84 percent, described engineers using at least one of the following descriptors: technically orientated, technologically focused, intelligent, socially awkward, masculine, or having physical traits such as pale skin or glasses [10].

Within the volunteer survey conducted with Oakland University undergraduate students, participants were asked if they agree with the statement that engineering is a masculine field. Overall, 35 percent of participants agreed with the stereotype that engineering is a masculine field, 36 percent of female participants and 33 percent of male participants, which is consistent with the 40 percent reported by a 2014 study completed by the American Society of Engineering Education [25]. To determine if there is any trend between genders or those within STEM and

specifically engineering intended majors, the survey responses were filtered by intended major and then by gender, depicted below in Figure 14.

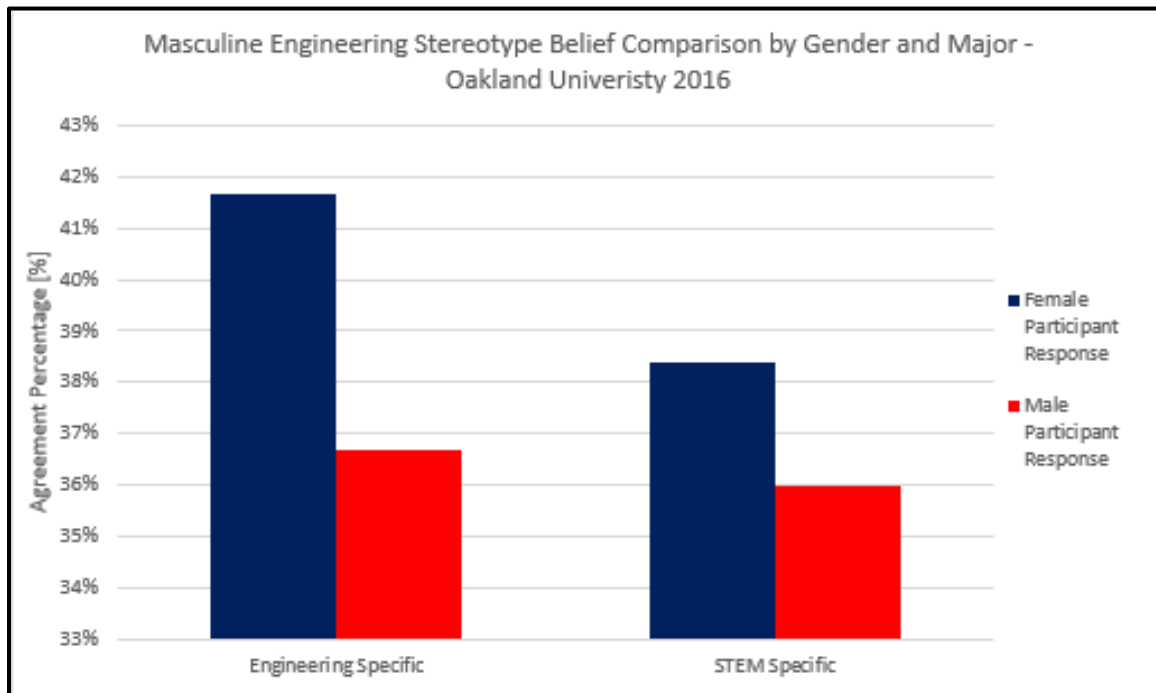


Figure 14 - A comparison of survey responses of participants who agree with a masculine engineering stereotype from Oakland University STEM and engineering undergraduate students— adapted from collected survey data.

For both STEM and engineering major specific responses, the percentage of participants who agreed with that engineering is a masculine field is consistent with the percentage reported by participants across all majors. It can be seen that for both STEM and engineering specific majors, female participants agree with the stereotype that engineering is a masculine field, with female engineering participants being slightly more agreeable to the stereotype. It can be hypothesized that female students are more susceptible to gender stereotypes than their male peers.

To evaluate the potential influence of the gender distribution ratio of male and female students within engineering courses on the stereotype that engineering is perceived a masculine

field, a voluntary survey was conducted of undergraduate students at Oakland University. Participants were asked “Do you notice a discrepancy in the male/female ratio within your major?” and were offered a scaled response including largely female, slightly more female, equal representation, slightly more male, and largely male. The participants’ responses were filtered by intended major to only include STEM majors and further filtered for those students who specified an intended engineering major. The high-level analysis was used to compare surface trends of the participant’s qualitative responses to determine if there was a comparable difference in students’ perceptions of gender representation within STEM and engineering courses at Oakland University. The results are depicted below in Figures 15 and 16.

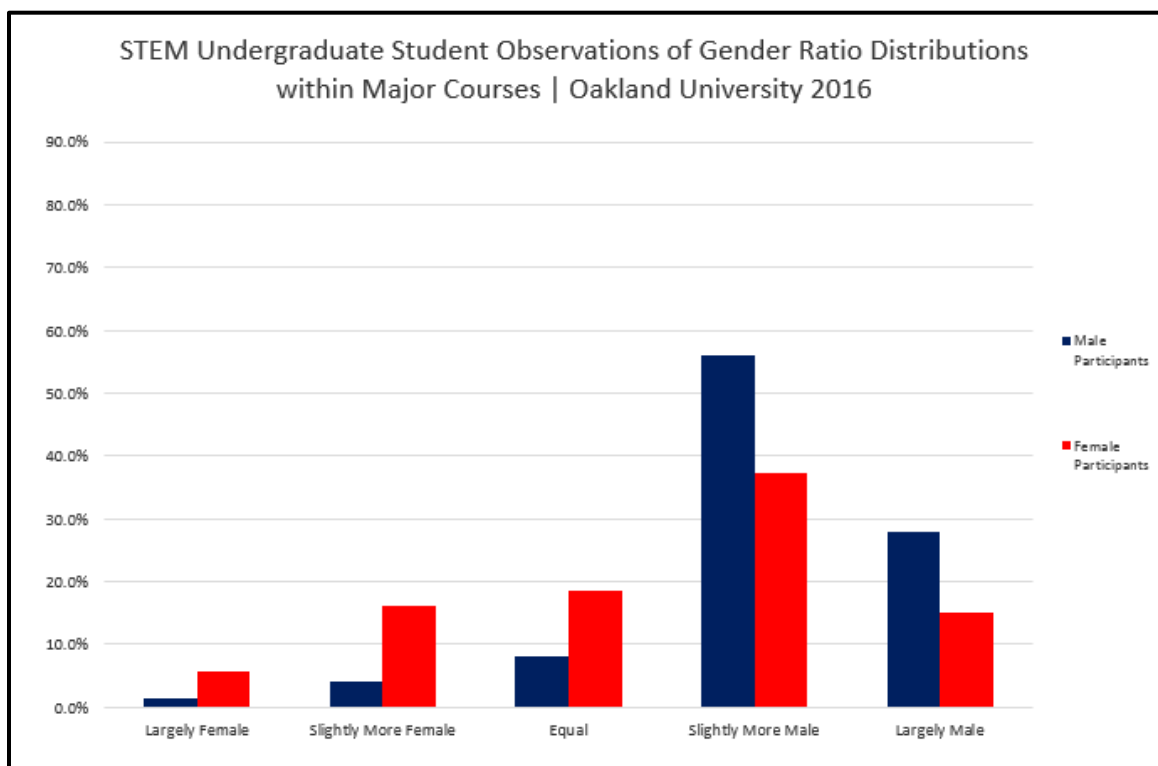


Figure 15 - A comparison of survey responses of observed gender distributions within Oakland University STEM major courses – adapted from collected survey data.

The participants who indicated intended majors within STEM fields, including biochemistry, environmental sciences, psychology, engineering, actuarial science, mathematics,

and more, indicate a perception of STEM major courses having a male-bias. Male participants with intended STEM majors show a larger male-bias in their perception of gender representation within their courses than female participants with intended STEM majors. Female participants, while still showing a male bias to gender representation, were more likely to report an equal to female-biased representation within their STEM major courses. This observation of female participants perceiving a larger female representation within their major courses could be driven by their lower expectation of female representation. This expectation could lead them to believe that the presence of a relatively small number of female peers within their course constitutes a higher female representation than would otherwise be reported.

In an attempt to determine if the gender distribution within engineering courses at Oakland University reinforces the national trend of a female minority and the stereotype of engineering being a masculine field, the same analysis was conducted on the responses regarding gender ratio distribution in major courses for those participants who indicated an engineering major, as shown below in Figure 16.

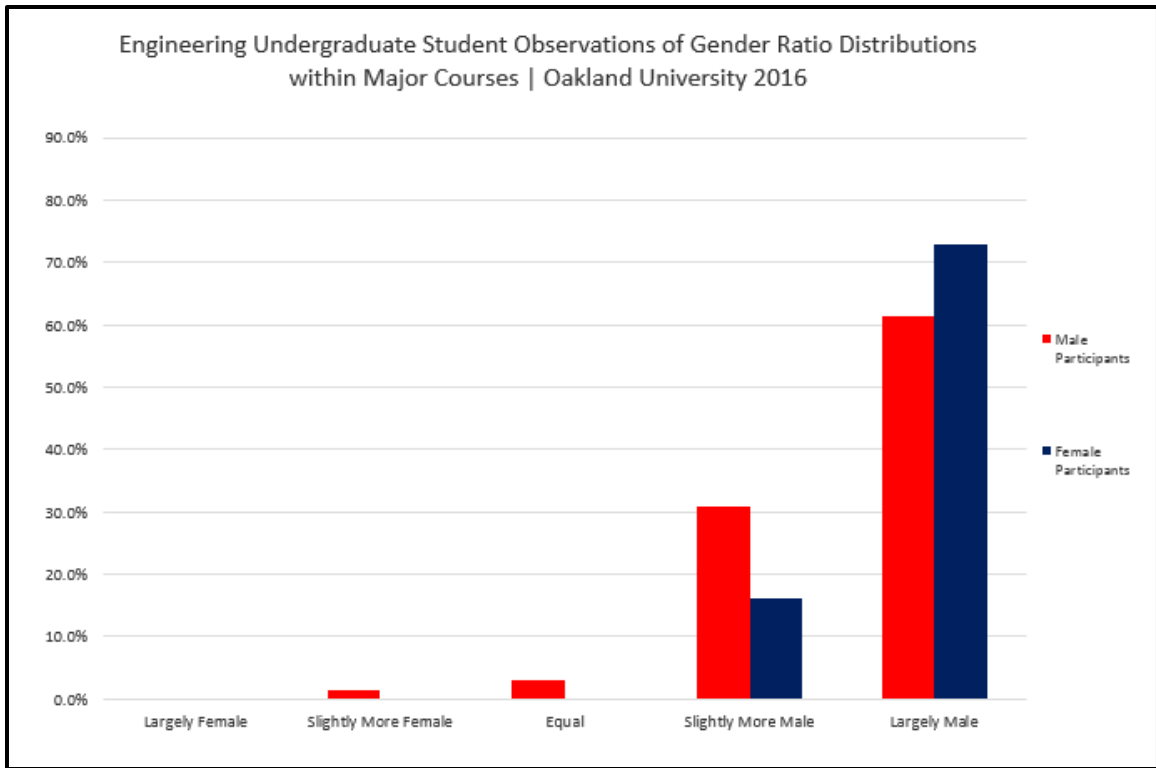


Figure 16 - A comparison of survey responses of observed gender distributions within Oakland University undergraduate engineering major courses – adapted from collected survey data.

Through the analysis of the survey results, it can be observed that within engineering courses both male and female survey participants reported a male-biased gendered distribution at Oakland University. Compared with the results of the STEM majored courses gender distribution ratio, the male-biased distribution within the engineering courses is much stronger for both male and female undergraduate participants. It can be seen that both male and female participants reported a largely male gender distribution ratio for their engineering courses, with a greater percentage of females reporting a largely male distribution than male participants. Unlike STEM majored participants' responses, the gender distribution ratio observed by female engineering majored participants only reported 'largely male' and 'slightly more male' while male engineering participants reported 'slightly more female', 'equal', 'slightly more male' and 'largely male'. This can be reasoned that as female students are the current minority regarding

enrollment within the engineering programs at Oakland University within the classroom, female students are more aware of this under-representation compared to their male peers. The largely male-biased observed gender distributions within engineering courses at the undergraduate university level can perpetuate the stereotype that the engineering field is to be viewed as masculine, potentially dissuading young women from engineering in response to the lack of other females within the field or the imposed feeling of being a minority. Due to the persistence of these masculine stereotypes, students were less likely to consider the engineering field being used to benefit society or be people orientated, or stereotypical perceptions pertaining to women [10]. A principal source of engineering stereotype reinforcement emanates from the depictions of engineers within the media and popular culture.

High school students indicated that they are influenced by the media, more than any other source, in their perception of what engineers are like. Engineers are commonly depicted in popular movies and television shows, such as *The Big Bang Theory* and *Bill Nye the Science Guy*, as predominantly technology obsessed, reclusive, Caucasian or Asian men [10]. These biased portrayals are representative of a small percentage of today's engineers [1] and providing a false perception of who the engineering field consists of. Cheryan conducted an analysis to evaluate the effect of stereotypical media representations of engineering on female interest in engineering [10]. It was determined that the women who read an article containing clichéd portrayals of engineers reported less interest in engineering than those women who read the article containing a non-stereotypical depiction of engineers. The women who read the non-stereotypical article also expressed a larger interest in the engineering field than those women who read no article [10]. When girls and women are unable to relate to the prominent stereotypes, they are influenced to believe that they are dissimilar to those involved in

engineering and convey a lower ‘sense of belonging’. The less young women feel like they belong in the engineering field, the less likely they are to pursue engineering [10]. It follows that if positive depictions of engineers were presented in popular culture and media, it could result in increased aspiring identification of engineers for young girls [26].

As media portrayals of female engineers remain scarce in comparison to other fields and the continued under-representation of females within engineering, young girls observe this as a lack of female engineers to act as role models to them. The importance of female role models and mentors within engineering is crucial as the impression of the under-representation of female engineers can influence young girls away from pursuing engineering careers [27]. As teachers and professors are commonly viewed as role models or mentors to students, a disproportionate representation of females engineering academic leaders can dissuade young girls from pursuing engineering.

The faculty at Oakland University’s School of Engineering and Computer Science has a minority 20 percent female representation [28], influencing students’ perceptions of the number of female engineers to act as mentors or role models. Oakland University’s School of Engineering and Computer Science has a higher representation of female engineering faculty compared to the national average of 15 percent recorded by the American Society of Engineering Education in 2014 [24].

When undergraduate survey participants from Oakland University were asked whether they believed there were a decent number of female role models in engineering or not, 65 percent indicated that there were not enough. Mentoring of female students has been proven to decrease overall feelings of segregation and decrease attrition rates among female students pursuing studies within engineering [29]. As explained by Aronson, “exposing students to role models

who can help students see their struggles as a normal part of the learning process rather than as a signal of low ability” can boost the test scores of ... girls” [17]. Actively increasing the number of female role models or mentors available to young girls interested in pursuing engineering, by increasing the rate of female engineering faculty and conducting more outreach programs targeting young girls that include young female engineers or engineering students within leadership roles, would assist in decreasing the attrition rate and increase the amount of girls’ interested engineering.

The focus has been increasingly drawn on the under-representation of women in engineering and the persisting societal, cultural, and academic factors which influence young girls in their choice to pursue engineering as an academic or professional career. With increased attention from mainstream media, social movements taking actions to address these detrimental stereotypes and mentalities affecting young girls have gained momentum in recent years.

The conversation addressing the consequences of gendered children’s toys and their marketing has found root within the last decade, drawing questions as to what is beneficial for children today and their futures. In 2010, Mattel held a contest to select the next Barbie doll’s occupation from environmentalist, surgeon, architect, news anchor, and computer engineer. When this was publicized, those within technological fields initiated an online campaign to vote for Computer Engineer Barbie in a hope that future generations of young girls would have the ability to use a gendered girls’ toy that would expose them to engineering [10]. While not fully addressing the issue of gendered toys, this campaign’s objective was to change the perspectives of young girls playing with these toys and provide the opportunity to allow for them to relate to an engineering profession as a young girl. The toy manufacturer, GoldieBlox, took a different approach to addressing the effects of gendered toys and their impacts on the development of

young girls' cognitive skills by producing engineering toys specifically for young girls [30]. By increasing the number of engineering toys marketed at young girls, parents would be persuaded to consider purchasing toys that would otherwise be gendered specifically towards boys; resulting in the gender gap of spatial and cognitive skill development to begin to shrink.

The GoldieBlox toys gained attention from a marketing video which went viral on YouTube, involving a young girl losing interest in a stereotypically feminine princess show and instead becoming involved in a technologically intense mechanical Rube Goldberg mechanism. The interest in the female-targeted GoldieBlox engineering toys increased the discussion about the effects of gendered toys and their impact on the disproportionate female representation within engineering. In response to the increased discussion of the effects of gender stereotypes perpetuated through the division of children's toys, toy stores in London have made strides to remove blue and pink labeling and reconfiguring their store's layouts to be organized by theme rather than gender. The societal and economic impacts from these changes have yet to be evaluated to determine if they have had any positive effect of dispelling gendered stereotypes of children's toys [30]. Gender stereotypes are also being addressed by social media campaigns, corporations' advertising, Hollywood movies, and even through university press.

Social media campaigns have a unique ability to reach and recruit a substantial number of people for a seemingly endless number of topics or areas of focus. Due to this, social media campaigns focused on the gender stereotypes of female engineers have increased in frequency and popularity in the past few years. In response to sexist comments to a recruitment promotion for OneLogin, a technological and engineering company, which featured a female engineer, a social media campaign was conceived. Isis Anchalee, the 22-year-old engineer featured in the promotion, called for people who "do not fit the cookie-cutter mold" to help redefine "what an

engineer should look like” using the hashtag #ILookLikeAnEngineer [31]. This hashtag was used on Twitter over 50,000 times within the first seven days of the movement, as women engineers from all over the world reached out to fight the gender stereotypes of what engineers look like in hopes to encourage aspiring female engineers [32].

Corporations’ recruitment advertising for engineering has also taken a tone shift to focus on targeting and encouraging young women to see engineering as a potential field to pursue. ExxonMobil’s marketing campaign has included focusing on raising engineering interest in young children as well as directing advertisements directly at females. An ExxonMobil television commercial, which debuted in late November of 2016, shows multiple women and their profession, which include biochemist, physicist, oceanographer, engineer, and more. Included within the professions shown, throughout the commercial are descriptions correlating with attributes displayed by women within engineering, such as relentless, leader, Ph.D., and fearless. These attributes and careers are used within this advertisement to actively contradict the cultural stereotypes that involve women within the engineering field, in an attempt to appeal to more young girls. The final spoken line within this video, “don’t let anyone tell you, you can’t” [33], is used to empower young women to pursue their interests and actively fight against the barriers that would restrict or dissuade them. The combined impact of social media movements, similar to #ILookLikeAnEngineer, and mainstream corporate advertising fighting against cultural female stereotypes on the next generation of female engineers will assist in reducing the influence of these stereotypes on young girls.

Hollywood movies have also taken interest in the topic of the under-representation of female engineers, increasing the number of films that include representations of female engineers. The recently released film, *Hidden Figures*, is a previously untold story chronicling

the team of female engineers and physicists who were critical to the 1962 NASA mission which put the first American into orbit. *Hidden Figures* depicts how these women were trailblazers in the scientific and engineering communities while breaking stereotypes and misconceptions about female engineers [34]. As more movies like *Hidden Figures* include strong, accurate representations of females within the engineering roles, more young girls will relate to potential role models and may choose to pursue engineering.

Dispelling gendered stereotypes pertaining to female engineers doesn't require a large production movie, corporate advertising, or even a social media movement; being aware and actively confronting stereotypes can assist in reducing their harmful influences. An example of addressing stereotypes on a smaller level is the letter Jared Mauldin wrote that was published in his college's newspaper, *The Easterner*, at Eastern Washington University. Mauldin, a senior mechanical engineering student, became aware of how cultural bias and gender stereotypes affected his female peers and so he spoke up to address them. Within his letter, he stated,

“To the women in my engineering classes. While it is my intention in every other interaction I share with you to treat you as my peer, let me deviate from that to say that you and I are in fact unequal. Sure, we are in the same school program, and you are quite possibly getting the same GPA as I, but does that make us equal? I did not, for example, grow up in a world that discouraged me from focusing on hard science. Nor did I live in a society that told me not to get dirty, or said I was bossy for exhibiting leadership skills. In grade school, I never had to fear being rejected by my peers because of my interests. I was not bombarded by images and slogans telling me that my true worth was in how I look and that I should abstain from certain activities because I might be thought too masculine. I was not overlooked by teachers who assumed that the reason I did not

understand a tough math or science concept was, after all, because of my gender. I have no difficulty whatsoever with a boys club mentality. And I will not face added scrutiny or remarks of my being the ‘diversity hire’. When I experience success the assumption of others will be that I earned it. So, you and I cannot be equal. You have already conquered far more to be in this field than I will ever face [35].”

Mauldin stated that he wanted to stand up and break the silence about the barriers that women face before and during their involvement within the engineering field. He hopes that if enough people listen, these influences and barriers will have less effect on young girls’ choices regarding engineering as a career path.

Growing concerns regarding the low participation of females in the engineering fields have caused increased research into the factors and barriers that cause young women to disregard engineering as a viable option for them. Whether the factors involve cultural stereotypes fueling unrealistic expectations of what engineering involves, what attributes engineers must have to be successful, what cognitive skills must be ‘innate’ within prospective engineers, or the current lack of female role models and mentors available to reduce the feeling of isolation or exclusion, these influence young girls’ choices throughout the educational pipeline. As the scholastic gender gap closes for the remaining educational subjects and female students’ academic confidence increases, advanced mathematic and scientific courses will hold more appeal to young girls, aiding in closing the under-representation of females participating in engineering. In addition, with the increased mainstream attention being placed on causes of these influences within the past few years, and the active movements being conducted to address the stereotypes, ideally the attrition rates of female engineers will decrease long term. The data collected in this

research thesis can be viewed as a jumping off point for further insight into the factors that influence the under-representation of females participating in the engineering field.

Appendix

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Gender Representation in STEM

Welcome to My Survey

Information Sheet for a Research Study

Contributing Factors to the Under-Representation of High School and Undergraduate Women in Engineering

Introduction

You are being asked to participate in a research study that is being done by researchers from Oakland University. This study is being done by Marissa Solnik under the direction of Laila Guessous, Professor of Mechanical Engineering, the research study advisor for this project. This study is being conducted as part of the requirements for graduation from the Oakland University Honors College. The purpose of this Information Sheet is to let you know more about the study so you can decide whether to volunteer for the study or not. Please read the form carefully. You may ask questions about why the research is being done, what you will be asked to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. You may talk with your friends and family about this research study before making your decision. When all your questions have been answered, you can decide if you want to be in this study. This process is called 'informed consent.' If you decide to participate, your participation will indicate that you have read this information sheet and that you understand what it says.

Why is this study being done?

The purpose of this research study is to identify and understand some of the causes that fuel the under-representation of women within the engineering field, specifically within academia.

Who can participate in this study?

You are being asked to participate in the study because you are a current or recently graduated (within the last 3 years) high school student. To participate in this study, you must be 18 years of age or older.

Who is sponsoring this study?

None.

Where is this study being done?

This study will be taking place at Oakland University through an online survey conducted through SurveyMonkey.

What procedures are involved with this study?

If you agree to take part in this research study, you will be asked to fill out an online survey.

How long will participation in this study last?

If you elect to participate, the online survey will take about 15 minutes to complete.

How many people will be participating in this study?

I will be requesting the administrator of selected email lists to distribute the survey link to those included on the lists. The total number of students reached out to, assuming full participation, would be around 4,000 students. Therefore optimistically, no more than 4,000 students would participate

What are the risks, side effects or discomforts that can be expected from participating in this study?

By taking part in this study, you may be at risk for the following:

A breach of confidentiality is a possible risk. Breach of confidentiality means that it is possible that individuals not associated with this research may accidentally gain access to information that personally identifies participants. Appropriate safeguards are set in place to minimize a breach of confidentiality (e.g. researcher's office is secure and computers and external storage devices are password protected); but no researcher can ever guarantee that this sort of breach will not occur.

Are there any known benefits from taking part in this study?

There are no direct benefits to you for participating in this study. However, the results of this study may benefit others in the future.

What are the alternatives to participation in this study?

You may choose not to participate in this study.

What are the costs of taking part in the study?

There is no cost to you for participating in this study.

What compensation is being provided for participation?

For those participants who complete the survey, you'll have the opportunity to enter a raffle for one of twenty-five \$20 gift cards.

What are your rights if you participate in this study?

Your decision to participate in this study is voluntary. You may choose to leave the study at any time, or refuse to answer any questions that may be asked during the study. You will not lose any benefits to which you are otherwise entitled and your decision will not affect your present or future relationship with Oakland University, the researcher, the Mechanical Engineering department; or the Honors College. If you are a student or employee at Oakland University, your decision about participation will not affect your grades or employment status.

What will be done to keep my information confidential?

Every effort will be made to keep your study-related information confidential.

Personal information regarding your participation in this study may be disclosed if required by law. Also, your research records may be reviewed by the following groups

Regulatory authorities involved in the oversight of research (Office for Human Research Protections or other federal, state, or international regulatory agencies)

Members or representatives of Oakland University Institutional Review Board (IRB) (in order to ensure that your rights as a research participant are being protected);

When study results are presented at professional conferences or published in professional journals, your name will not be used.

What do you do if you have questions about the study?

For questions about the study you may contact Marissa Solnik at mrsolnik@oakland.edu or faculty advisor Laila Guessous at guessous@oakland.edu.

For questions regarding your rights as a participant in human subjects research, you may contact the Oakland University Institutional Review Board, 248-370-2762.

* 1. ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the "Agree" button indicates that

- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older

- ☐ Agree
- ☐ Disagree

Gender Representation in STEM

General Information

2. What gender do you identify with?

- ☐ Male
- ☐ Female
- ☐ Other

3. What is your age?

- ☐ 18-20
- ☐ 21-23
- ☐ 24-26
- ☐ 27-29
- ☐ 30+

4. What is the highest level of education you have completed?

5. What is your intended major/ was your graduating major?

Gender Representation in STEM

Mindsets

6. Evaluate the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I believe intelligence is innate, a gift with which people are born.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
You can learn new things, but you can't really change your basic intelligence.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your brain is a muscle and you can be as smart as you want to be.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I consider difficult tasks a challenge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When a task is difficult, it means that you are not smart enough to overcome the challenge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoy overcoming difficult tasks by working towards solving them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I value looking "smart" in comparison to my peers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

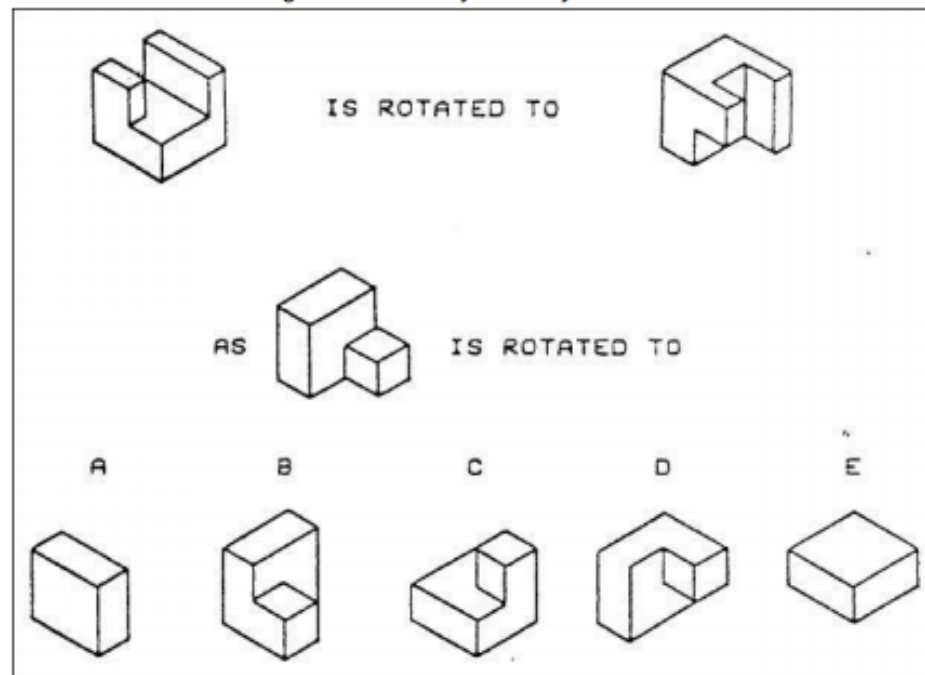
Gender Representation in STEM

Stereotypes

7. Select all of the following items/activities that you owned/participated in as a young child:

- | | | |
|---|---|--|
| <input type="checkbox"/> Computer | <input type="checkbox"/> Lego / K'nex / Building Toys | <input type="checkbox"/> Playhouse |
| <input type="checkbox"/> Organized Sports | <input type="checkbox"/> Video Games | <input type="checkbox"/> Stuffed Animals |
| <input type="checkbox"/> Dolls | <input type="checkbox"/> Arts and Crafts | <input type="checkbox"/> Dance |
| <input type="checkbox"/> Action Figures | <input type="checkbox"/> Dress Up | |

8. Choose the correct image to the best of your ability



- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E

9. Evaluate the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am confident with my abilities in mathematics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Men are better at mathematical skills than women.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Women are better at mathematical skills than men.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident in my abilities in science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Men are better at scientific skills than women.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Women are better at scientific skills than men.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident in my abilities in reading/language.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Men are better at reading/language skills than women	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Women are better at reading/language skills than men.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Gender Representation in STEM

Representation

10. Have you ever noticed someone being treated differently in an academic or professional setting based on their gender, including yourself? If so, please describe the situation.

11. Do you notice a discrepancy in the male/female ratio within your major?

- ☐ Largely Female
- ☐ Slightly More Female
- ☐ Equal
- ☐ Slightly More Male
- ☐ Largely Male

12. Do you think it is an issue that there are significantly fewer women in STEM majors?

13. Do you have any ideas about how to improve the current situation concerning gender representation within the STEM fields?

14. Evaluate the following statements.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Your academic experience has included an inclusive environment, especially in regards to the STEM fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are a good number of female role models within the STEM fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
STEM fields, especially engineering, are masculine fields.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Gender Representation in STEM

Thank you for your participation

* 15. Would you like to enter the raffle for a \$20 gift card?

☐ Yes

☐ No

Gender Representation in STEM

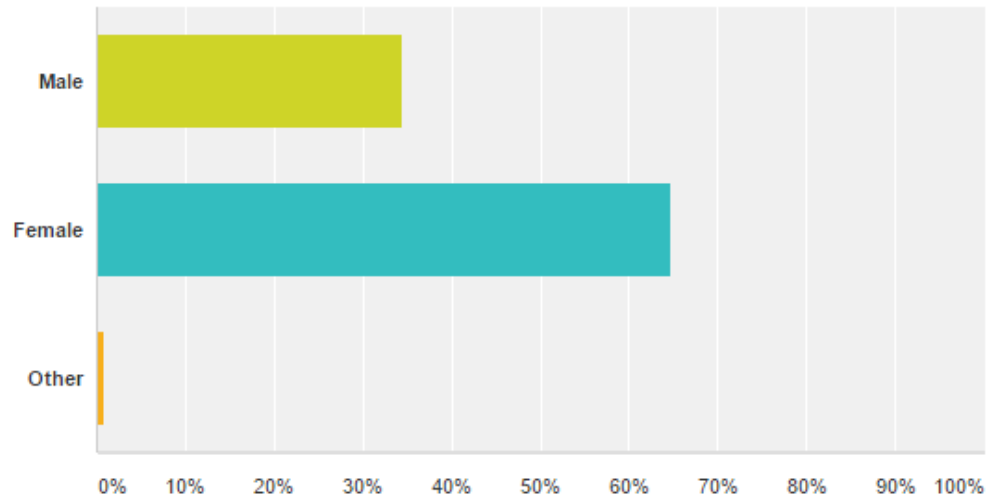
Raffle Contact Information

16. If you would like to take part in the gift card raffle, please provide your email address. This information will only be used to randomly select the winners of the raffle and to contact those who've won the gift cards.

Participant Demographics

What gender do you identify with?

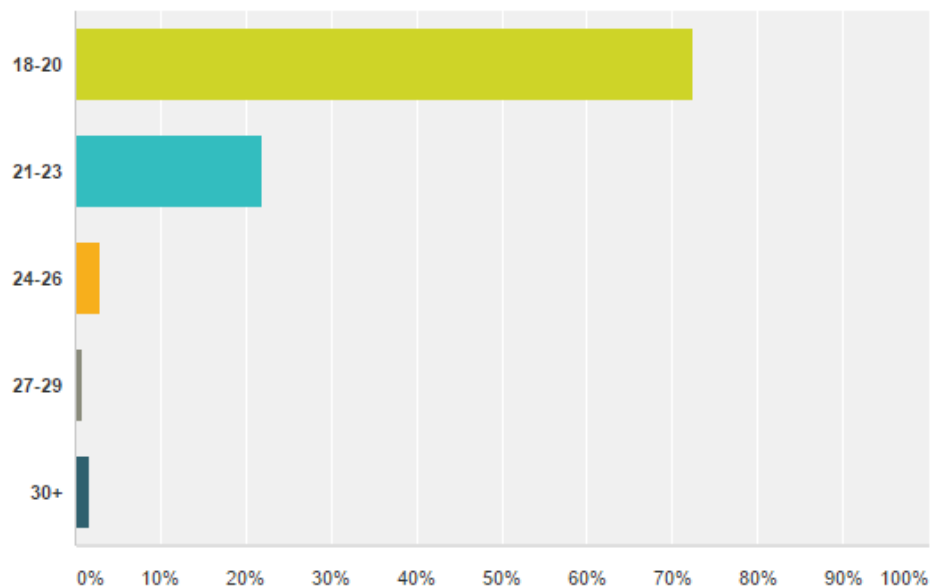
Answered: 232 Skipped: 3



Answer Choices	Responses	
Male	34.48%	80
Female	64.66%	150
Other	0.86%	2
Total		232

What is your age?

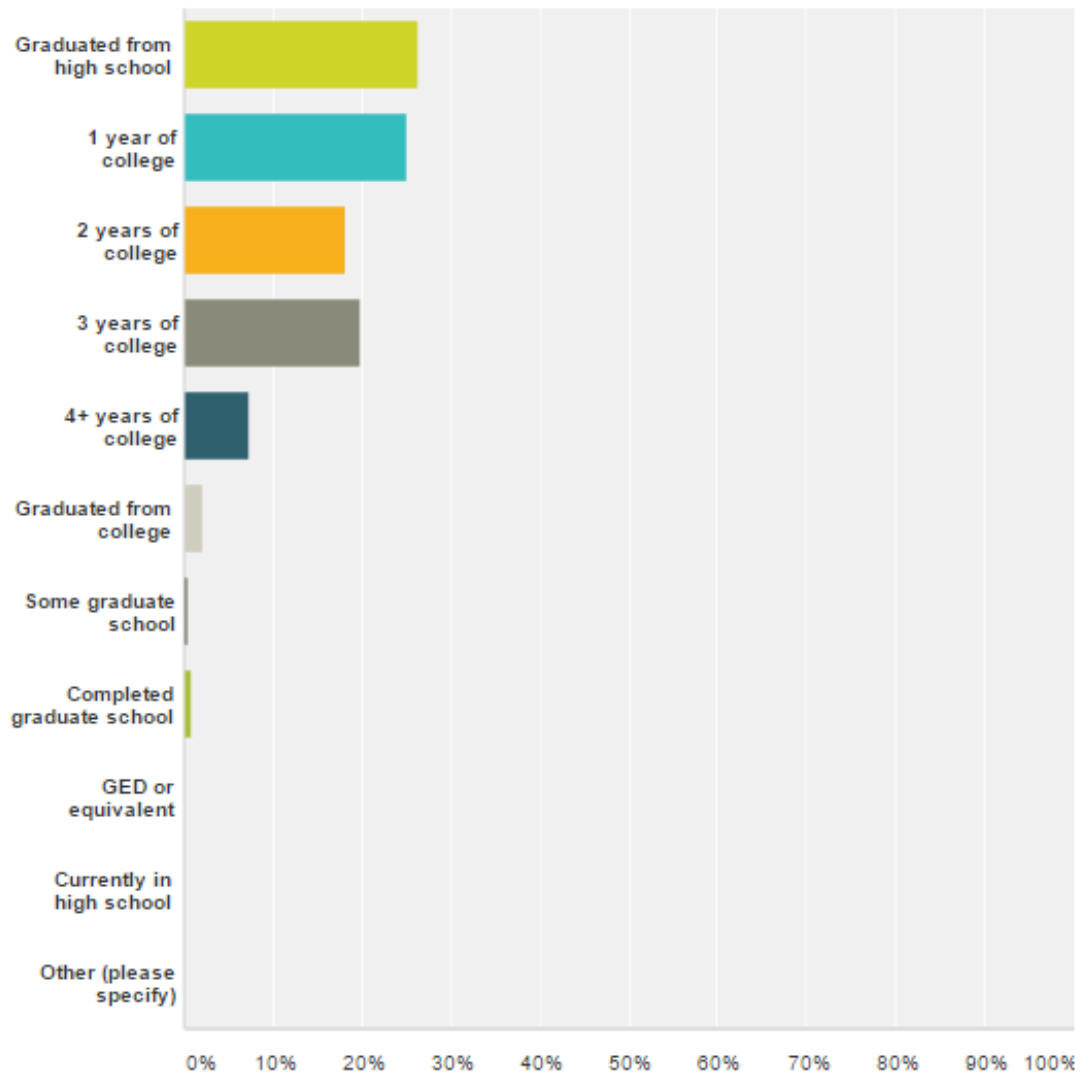
Answered: 232 Skipped: 3



Answer Choices	Responses	
18-20	72.41%	168
21-23	21.98%	51
24-26	3.02%	7
27-29	0.86%	2
30+	1.72%	4
Total	232	

What is the highest level of education you have completed?

Answered: 232 Skipped: 3



Answer Choices	Responses	
▼ Graduated from high school	26.29%	61
▼ 1 year of college	25.00%	58
▼ 2 years of college	18.10%	42
▼ 3 years of college	19.83%	46
▼ 4+ years of college	7.33%	17
▼ Graduated from college	2.16%	5
▼ Some graduate school	0.43%	1
▼ Completed graduate school	0.86%	2
▼ GED or equivalent	0.00%	0
▼ Currently in high school	0.00%	0
▼ Other (please specify) Responses	0.00%	0
Total	232	