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| Appalachian State University |
| Annotated Bibliography |
| Recruiting Female Students into STEM classes |
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**Successful recruiting of female students into the STEM classroom**

The focus of my research is in the interest of implementing a strategy for enhanced inclusion for ~~all~~ female students interested in signing up for my elective classes. The ensuing bibliography highlights an insiders’ take on the challenges several highly successful women faced when entering their fields of study, coupled with that of antidotes in how to market your classes to the female gender.

Teaching in Career Technical Education always presents challenges in terms of enrollment, and we need to ensure that we’re doing all that we can to recruit not only those interested, but also those with a strong background in STEM. Based on the empirical evidence I’ve gathered; this has unreasonably led to an unbalanced low number of female students in my classroom. Based on my two-year effort in recruiting more students to my classroom, I’ve come to realize in conducting this research, that I was not doing enough to target the female students. The disproportionality with female students in STEM classes was revealed to be one not based on ability or interest, but rather inclusion. As my annotated bibliography will articulate, this can be addressed in casting a wider net to more effectively recruit the female student population at large.

Overall there were a number of strong takeaways from this research. For one, a common thread presented itself to where we need to market ourselves to young female students at an early age. Another impression one was left with in interviews was how many women felt pressure from their parents to follow a path outside of the STEM related fields. It would also appear as though they were in part, following the lead of the most influential adults in their lives growing up, their parents. Quite often children also follow the social norms seem on television and in movies. There is only so much we can do to combat that, but as the ensuing bibliography will indicate, it all begins with the effective marketing of classes to more directly include young female students, either directly or indirectly, through the school and with social media outlets.

Conner, C. (2016). *How to Involve More Women and Girls in Engineering*? Retrieved from <https://www.usnews.com/news/stem-solutions/articles/2016-10-17/how-to-involve-more-women-and-girls-in-engineering>

In this discussion, the author speaks to a very specific method of recruiting female students into the STEM fields. That point of emphasis was on storytelling as a method of encouraging students to enroll based on the inspirational stories of successful engineers. According to their numbers, at the time of the article in 2016, women were making up only 13% of all mechanical engineering undergraduate students nationwide. Interestingly, that compared favorably with the 14% of women studying for their doctorate in mechanical engineering. This article was chosen as it speaks directly to the classes I teach in that they teach students the tools eventually utilized in the field of mechanical engineering. While TED talks and examples of female success stories are fine, I believe that it stops short of providing a solution to the shortage. We need to address the interest level at an earlier age in order to include more inclusion at the elementary and middle school level. This would help to destigmatize the subject matter to female students who may later consider the subject matter in high school.

Greenwald, S., & Thomley, J. (2018) Appalachian State University. Women and Minorities in Mathematics: *Incorporating Their Mathematical Achievements into School Classrooms.* Retrieved from <http://mathsci2.appstate.edu/~sjg/ncctm/activities/rolemodels.pdf>

This article looks at the interesting self-reflection that young women go through when considering a career path in a STEM related field. In contrast to the aforementioned article, this position is a take on how women see themselves cast in the image of what’s been portrayed in media, as it applies to positions in the technical arena. While there are glorified perceptions of men in print media outlets, women are typically cast in a more unattractive or less than positive manner.  As noted within the article, “Simple one-shot exposure”, won’t attract capable women into the engineering fold, as evidenced by fans of “Star Trek Voyager, which contained strong, positive images of women engineers.  No, it’s actually a matter of breaking down the stigma associated with that of a career in the STEM fields at large, which this article offers up plenty of evidence on; with respect to where women can find role models from a wide range of lifestyles.  This is offered in the appendix, with a list of readings in what’s referred to as a “Mathematician Role Model Checklist”.  While nicely woven in to the article as a means of measuring your student’s interest, this falls short of the real need here in making the class content attractive to the already inspired STEM female student. To this point, it would appear as though this effort will require a multi-tiered approach.

Colmenares, C. (2017). Media Release. *Women engineers discuss “Hidden Figures” and lingering challenges*. Retrieved from <http://newsstand.clemson.edu/mediarelations/black-women-engineers-discuss-hidden-figures-and-lingering-challenges/>

What lured me in to this press release was the necessary ingredient in rounding out my research to finally hit on the additional hurdles that woman of color face when considering a study of STEM subjects. As I later learned with a look at Katherine Johnson’s career, these women of color reflected on how they related to the stigma of studying engineering, as featured in the movie “Hidden Figures”. Interestingly it requires a more communicative effort when introducing women to STEM classes. That being said, much like in socio-economically disadvantaged students, these women lamented in how they’re looked at as somehow not prepared, in spite of the evidence shared that would suggest otherwise. This provided me with a look that I needed in understanding the challenges that women face in business already, much less in a STEM related field. These stories, while providing some insight, still fell short of what I was looking for in the way of a methodology in how to better recruit. My feeling is that it’s again a matter of inclusion at a much earlier age, but further research will dictate that pathway I’m sure.

Oliver, M. C., McConney, A. W., Maor, D., & McConney, A. (2017). Research Open Access. *Female senior secondary physics students’ engagement in science: a qualitative study of constructive influences.* Retrieved from<https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-017-0060-9>

While delving into the specific field of Physics with respect to their study, Dr. Oliver and her colleagues interviewed 18 female students on the influences they considered crucial to their aspirations in science education, particularly as it would pertain to the eventual study of Physics. It becomes apparent in the study that interest wains during high school with females falling out of favor with STEM related subjects in favor of medicine and health. Within the reported study involving a wide range of female students, the authors are able to dissect a cross-section of 18 students in learning directly from the source as to the perils socially in pursuing STEM classes. In discovering the attitudes toward the question of influence,we’re able to review from the interview just what the road blocks are, and perhaps come away with a counteractive approach. This research was one that delved deep into the Australian culture and one where I felt it necessary to concentrate on the consistencies therein with that of the U.S. specific enrollment issues. While an interesting study to review, there was no concrete takeaway here as to an approach this problem of sustaining the female students interest in STEM related fields during their high school years*.* The study did offer some perspective when in considering all the influences polled, the largest number of those interviewed likened their own self as the primary barometer from which their interest in influenced. All of which tells me that again, the suggestion here would be to influence them early on in their academic career with an outreach program that welcomes them in.

Carbero, R. (2017). Research in progress blog. *Inspired women in science take a stand against gender inequality.* Retrieved from <https://blogs.biomedcentral.com/bmcblog/2017/02/10/inspired-women-science-take-stand-gender-inequality/>

An excellent account here on how there’s still a stigma where it pertains to females in STEM related fields. Whether it’s cultural or political, the support just has not been traditionally there for the inclusion of female students specifically. This article highlighted for the first time the contention that yes; we do have to target the female student very directly. Young men have had influences and figures to look up to their whole lives, now we need to highlight for the women that, while societally not as well known, there are plenty of success stories to share on accomplished women in STEM related fields. As the article indicates, with the vast turnover occurring in our workforce, what with the baby-boomer generation retiring in larger numbers, this is as much a need in recruiting to secure our global standing in business, as much as there’s a need to recruit in the classroom. While a great complement to my earlier findings, this article left me wondering still, on how we can get through to the families of young girls, in sending the message of positivity when entering the arena of STEM related pathways for a career.

Gilbreath, L., (2015). Undergraduate Thesis. *Factors Impacting Women 's Participation in STEM Fields.* Retrieved from <https://scholarworks.uvm.edu/cgi/viewcontent.cgi?article=1077&context=hcoltheses>

A welcome personal reflection and study on the part of an undergraduate student who could speak first hand as to the challenges women face in the study of STEM related courses. While her experiences were in the interest of eventually teaching Mathematics, the research applies in that women, whether it is in the private or public sector, face the same challenges insofar as acceptance is concerned in STEM. Interestingly enough, her study indicates that women are “*socialized away from STEM”,* in such a way where it would appear sexism is in play here. It is the author’s contention here that the equality of women in the workforce could be a discriminating factor learned from an early age, in recognizing on the part of the student, the imbalance between their parents’ careers. As noted here, many of the myths associated with the female student’s ability to perform in STEM related fields are falsehoods. We’re in a battle however in having to compete with what’s revealed as the “norm” where it pertains to the images in media that young women are exposed to as societal norms, where it pertains to STEM related career participants. While addressing the issue, I came away with the impression that unfortunately I was only able to work with what I could control, that being the classroom. The paper falls short of the mark on how to address the issues, and yet at the same time highlighted many additional issues I needed to address in my research. All of which left me, if nothing else, with a list of questions for my eventual interviewee on the subject.

Dasgupta, N., & Stout, J, (2014). STEMing the Tide and Broadening Participation in STEM Careers. *Girls and Women in Science, Technology, Engineering, and Mathematics, VOL* (1), 21-29. Retrieved from <http://journals.sagepub.com/doi/full/10.1177/2372732214549471>

In this substantial study of the issue of women in STEM related careers, there was again the issue of a job growth in STEM related fields not being adequately addressed. This issue goes beyond the matter of not having enough interested women in these related fields, but rather addresses the problem in a much larger context: without all otherwise qualified men and women in STEM related courses, how are we possibly going to remain competitive in the world market? For the second time, there were references here in how parents themselves do not associate careers in STEM for their daughters. This is shortsighted and needs to be addressed, but how!? If we’re able to market the subject matter to female students successfully, what challenges might they face when moving on?! It’s my contention that, after reading yet another affirmation on this point, that we have to intrigue them early on. In this way the hope is that the strong willed will not be negatively influenced later in life to bail on the pursuit. The article here goes a long way into this point in emphasizing the importance of mentoring and providing young women with positive role models, something I’m going to focus on as part of marketing campaign for my classroom moving forward!

Riegle-Crumb, C., & Morton, K. (2017). Gendered Expectations: *Examining How Peers Shape Female Students' Intent to Pursue STEM Fields*. Retrieved from <https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00329/full>

Here the authors conducted a statistical study on the effects of peer pressure, coming from both fellow male and female students, in reporting on the outcomes with respect to positive and negative reinforcement of female student inclusion within the math & science classes. In the investigation, data was collected from both middle and high school students in a predominantly Hispanic, low-income, urban district. After a thorough analysis, it was argued that many young men are less than supportive of females in the STEM related courseware, and in how addressing that issue may help to provide more equality for females in the STEM fields. The impression I came away with was in how young male and female students tend to follow what society is promoting in terms of the longstanding stereotypes of what men and women represent in the workplace, based on what they see on television and in movies. This would obviously not favor young students who at their most impressionable age, are without peers to encourage them toward the STEM fields. Once again, the research here went to the roots of gender inequality being a factor in the early age of adolescence and as noted previously, needs to be addressed at the earliest opportunity on the home front and in elementary schools.

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