**Literature Review of Girls in STEM and the Low Presence in Educational Environments.**

Bryan Westman

Department of Education. University of Northern Colorado

ET 725: Educational Technologies

Dr. Ku

Fall 2022

**Literature Review of Girls in STEM and the Low Presence in Educational Environments.**

One of the most important fields in the 21st century is the field of STEM (Science, Technology, Engineering, and Math). Demand is incredibly high for anyone who can work in one of these fields or all of them. Current trends show the desire for these disciplines will increase year after year for the next twenty-plus years. With the high need for the next generation of students to be prepared for these fields, all prospective students are being exposed to the potential benefits of these fields. “STEM learning fosters skills and growth mindsets among all students that lead to lifelong learning and opportunities for postsecondary and career success while expanding access to rigorous STEM courses” (Howard et al., 2019, p. 4). Currently, the number of men in the fields is meeting the trends, but the number of women going into the fields is far lower than what is needed. The current need for experts in STEM fields is constantly increasing, yet the interest in these fields has been gradually decreasing in developed and developing countries over the last decade (Sidekli et al., 2021). When investigating the reason behind these lower-than-expected numbers, there are a few examples of why women may be entering the educational experience at a lower level than men.

The research shows that many studies into why girls are choosing not to pursue STEM fields might be related to a variety of reasons. Some of the most common reasons for the lack of high numbers can be traced to the years of education related to middle school. In the middle school years, we find that most girls are deciding what kind of future careers girls want to pursue (Hughes et al., 2020). Students who attend school in the grades between sixth through eighth grade are classified as middle school students. This is a time when children are transitioning into teens. More importantly, these students may be making career decisions for the rest of their lives. “Women’s representation is low at all levels of the STEM career pipeline from interest and intent to majoring in a STEM field in college to having a career in a STEM field in adulthood” (Howard et al., 2019, p. 6). Many starts on a career path that will take them for the rest of their lives. Based on their education, they commence in middle school and develop through the high school years and so on. “It is important to introduce young children to the topics of STEM and to motivate as well as encourage them to pursue STEM subjects in every grade” (de Melo Bezerra et al., 2018, p. 313). Attitudes towards different subjects and career paths can be established in these formative years. The significant facts that researchers want to know are, why these years are so important to STEM careers and how we can change the impression women have on the fields.

**Literature Review**

**Girls’ Needs for STEM**

At the start of this literature review paper, it is important to know that the number of men in the STEM field compared to women is nearly double. Currently, there are not enough employees in the Science, Technology, Engineering, and Math fields to meet the demand of employers. The most stunning recognition of the study is that so few female students in middle school ages attend classes in these fields. “As there is no single cause for the underrepresentation of girls and women in STEM and technology directions and professions, it has become clear that there is no one-size-fits-all solution to solve this problem” (Ardies et al., 2021, p. 2). Many researchers have narrowed the problem of why the low numbers exist to a few common occurrences that appear to be worldwide in nature.

First of all, the girls’ perception of STEM fields as mostly a boy’s world prevents many from even taking these classes. This perception can be related to stereotypes of girls not being smart enough or that only boys should be doing engineering or technology classes. It is also a prevalent belief in many cultures that girls should still be focusing on areas like home care or medical-related fields. “Historically, women across the globe have been perceived as more suited for specific jobs (generally those with a nurturing component or perceived to be more feminine, such as teaching and nursing)” (George et al., 2020, p. 22). An additional related concern is that girls in middle school ages tend to also have issues with peer pressure when taking these classes. Many girls feel that they are judged by other girls and feel that they must conform to the trends of their peers (Reinking & Martin, 2018). Family dynamics also play a large part in developing girls’ belief systems, and depending on families’ views on STEM careers, girls may also stay out of the fields accordingly. Too many young girls, a further issue related to this question, is that they do not see other women in these fields (Hughes et al., 2020). A girl’s culture and race are equally important when seeing who is a part of the future, they may want to be involved in. At such an important turning point in a person’s life, it is incredibly influential to show potential careers in STEM.

**Parental Factor**

To establish the importance of a young girl’s thoughts on their future, the first, and most important aspect is the family dynamic. In most cases, it is how a girl’s parents view the STEM fields, and how they see the women’s place in these areas that are significant (Ardies et al., 2021). It has been established that if a family sees STEM as a way of improving a girl’s life, then they will encourage her to take these classes. Contrary to this, if a family holds to traditional beliefs that girls should only be taking care of home or should be in the social sciences, then the girls will see little interest in these areas of learning. “Gender inequity is a function of social-cognitive factors, and self-efficacy is one of the most important factors predicting STEM career aspiration of high school students” (Mau et al., 2020, p. 40). Through multiple types of research, it seems to be a changing dynamic. Still, many families believe that if the parent is not good in a particular field, then their child will be bad at this as well. Through these stereotypes, many girls are prevented from succeeding in capacities where they may thrive.

This leads to the problem that some of the STEM fields have, due to how relatively new they are. Math and science have been around for centuries in their current edition, but women have not been accepted into these fields until the last hundred years or so. In general, boys were more interested in pursuing engineering programs, while girls were drawn to health and medicine disciplines. This resulted in greater difficulty in encouraging female students to enter STEM career paths, (Punzalan, 2021). Fields like technology and engineering are considered more recent in the sense of electrical engineering, robotics, coding, and so on. With such new fields, many believe that only men can handle the complexity of the disciplines. “Internal and external factors served as reasons for the gender gaps at all stages of the education system, including the lack of females choosing STEM careers. These factors comprise self-concept, the influence of parents, media, and educators” (Punzalan, 2021, p. 95). This goes back to the family dynamic in which families can see a son working in these areas, but have a hard time seeing their daughter in these capacities.

Girls have also been shown to respond to different stimuli when growing up. If parents provide girls with toys, games, and books that promote a belief in the traditional roles of a girl, then they are less likely to feel supported in STEM development. “An enriched learning environment develops the skills such as problem-solving, adaptation, improvisation, self-management, interpersonal relationships, and cooperative working” (Sayılgan et al., 2020, p. 18). How a family promotes growth can have a very big impact on the development of a young girl. Many times, families that attempt to provide a neutral development of a young girl find that this can improve the future careers of their choosing.

There have been studies that show that allowing a girl to feel confident in any choice they make is a paramount factor in the STEM development process. Significantly, that girls can see the specialties in action; know they can do the work, and see others like themselves in STEM. A family dynamic is very crucial in this process (Ardies et al., 2021). Schools can offer many classes and programs to girls. When parents of young girls provide emotional, intellectual, and overall support for young girls to feel that they are capable of performing in these spaces, then they are far more likely to choose these paths.

**Peer Pressure**

In the developmental years associated with middle school, both boys and girls are under immense peer pressure. This can be from fitting in and not being an outcast, to finding one’s identity based on what other people think of them. It is during this time that young girls are also preparing their future selves with the skills, and interests that they will need in their potential endeavors. Peer pressure can have an immediate impact on day-to-day activities, but in the long run, these choices will also set up a girl’s future. If friends are supportive and see the areas of STEM to be a positive field, then young ladies are more likely to succeed in this area. “Adolescents rely on peers and their judgments to know what to do, how to engage in their school/community, and to know what will be deemed “cool” or “uncool” (Reinking & Martin, 2018, p. 150). When choosing classes like technology, a girl must see other girls also taking the class and enjoying it.

Through the support and instruction of classes, that are engaging, and produce positive experiences, opinions of STEM can be changed. Middle school is an important developmental stage wherein gender differences begin to occur in girls’ perceived sense of belonging and potential future success in STEM careers. Both historical examples and cultural stereotypes come into view in these studies (Hughes et al., 2020). This is only part of the equation for young girls to see themselves as being successful. Often several girls take a class that they feel they are just as successful as boys are, and they will continue to feel like they can also flourish. “Self-efficacy refers to one’s judgment about his or her ability to succeed, with prior research showing that those with higher self-efficacy have higher performance levels and longer persistence in STEM fields” (Essig et al., 2020, p. 2). When girls are placed into classes that are dominated by boys, they see that they are not meant to be in the class and cannot do as well. Often other girls in their peer group may find them to be different for wanting to be in a STEM class. With others shunning the difference, many young girls will turn their back on the program and seek out those that they feel are socially acceptable. This sets up a future that they will not be able to return to the STEM field.

While many see the years of middle school to be a period between the elementary and the more important high school years, these are the years that typically determine a person’s future. When entering high school, many students have already established a clear identity.

“Inclusive and engaging STEM programs that stimulate the feedback loop between activation and success can not only enrich the lives of individual participants by planting the seeds of lifelong STEM learning but also feed the STEM pipeline and inspire a new generation of scientists from diverse backgrounds” (Wheeler & Hall, 2021, p. 75).

From there, they will move into universities, trade schools, or other professions. Ultimately it is the middle school years that establish a young girl’s mindset and identity. “Overall, peers play an important role in the engagement or disengagement in STEM related courses” (Reinking & Martin, 2018, p. 150). For young women to be successful in the STEM fields, they need to be able to see themselves as successful. “Girls’ confidence and performance improvements when they are given specific, positive feedback on things that challenge them but are within their control to overcome” (Hughes et al., 2020, p. 4). The connection to peers and their view of these areas of learning as future occupations become so critical.

**Future Self**

A final consideration in why the number of girls in the STEM career paths is so low is, the fact that there are so few women in these careers. “Women’s representation is low at all levels of the STEM career pipeline from interest and intent to majoring in a STEM field in college to having a career in a STEM field in adulthood” (Howard et al., 2019, p. 6). This is a sad self-fulfilling cycle of potentially keeping girls out of these STEM fields. When looking at potential futures, many girls need to be able to look at the profession and see other women in this field. For girls, internal personal factors like behavior, community, and environmental factors influence their self-efficacy (George et al., 2020). Without being able to see themselves doing this area of study, many see it as a lonely or unwelcoming career.

The more a girl can see others that are like her in the profession, the greater connection they have to it. “Research has shown that the greatest influences on and determinants of success in STEM disciplines for women students is access to same-gender role models” (Howard et al., 2019, p. 6). When looking at other occupations that have changed over time, it is easy to see there is a slow path to change.

“Success leads to more activation, which leads to more engagement with science, which leads to more success, and so on. When young people experience success in STEM, they are more likely to engage in extracurricular STEM activities, study STEM subjects in school, and consider STEM career” (Wheeler & Hall, 2021, p. 69).

Young girls need to see themselves in a role that they can be engaged in, respected, and treated as an equal. For STEM role models that look like them, girls need to be able to see females working as scientists, engineers, astrophysicists, computer programmers, and so forth. When working in a STEM class it is important that girls have experiences that involve building, trial, and error, problem-solving that relate to real-world issues, and working together with other girls (Reinking & Martin, 2018). STEM is slowly building up the numbers of girls in these roles, but it is a slow process. “For this reason, it is recommended to make changes in middle school curricula. Instructional interventions depending on the curriculum changes, may include STEM-based design-oriented activities in which knowledge turns into products” (Sidekli et al., 2021, p. 694). With an improved educational model, the trend of decreasing numbers may be corrected.

For girls of color, the greater challenge comes from a combination of seeing women and their skin color in the STEM fields. “When students see the representation of their culture in their science classrooms, this helps to boost their self-confidence while learning the nature of science (NOS) to become scientifically literate and motivates them to engage in subsequent authentic STEM activities” (Asamani et al., 2022, p. 6). This is an even greater challenge for girls of color who are seeing fewer men of color in these disciplines.

Many see the challenges being greater to cultural views from both their own and from mostly white men who dominate the fields. “African American girls’ performance in science education lagged behind that of their white counterparts due to negative public perception and low self-esteem” (Asamani et al., 2022, p. 3). The biases can come from their own culture as well. “Hispanic girls may face when they choose to pursue programs in science, technology, engineering, and math (STEM). Unfortunately, gender stereotypes and false beliefs persist despite actual abilities” (Howard et al., 2019, p. 3). This is a true challenge to overcome because so many see themselves as being isolated or unable to be treated with equity in the field. “Girls of color must overcome the inherent racist and sexist stereotypes to develop a strong STEM identity to feel like they belong even when they are marginalized and isolated within the field” (Hughes et al., 2020, p. 2). With pressure from seemingly every direction, it is no wonder so many choose not to go into the area of STEM.

**Change the Future**

The research shows that there are several ways to improve the odds of girls selecting the direction of STEM. The use of just one solution to the problems is not enough to make a change in the world dynamic for girls in STEM. A combination of solutions, encouragements, and transformations will show the numbers of future women in STEM improving. This is not a quick fix, and the future will take decades to transform the view of women in STEM.

One major change that needs to happen is the one that will cause the greatest amount of time to bring about. Girls need to be able to see themselves as successful in STEM. “Once girls are able to see themselves in the role of a scientist, their interest and positivity towards STEM-related topics will increase” (Reinking & Martin, 2018, p. 152). While some fields like math and science show very close numbers between boys and girls, it is technology and engineering that show the lowest numbers. Further, it is important to state that even in the fields of science and math, there are areas where the numbers of boys and girls are unequal.

George et al., (2020) stated, “girls tend to have a lower self-efficacy than boys in mathematics and science, so it is imperative to provide opportunities for girls to increase their self-efficacy in STEM to ensure they are just as motivated to consider and possibly pursue STEM careers as their male counterparts” (p. 41).

 Fields like coding and robotics tend to be dominated by men, because of the belief that these are areas that require more tactile and abstract thinking. Those areas are dominated by men since so many developmental areas in the middle school years favor boys. Many in education push boys to find these areas challenging and good for their development. Girls are typically discouraged from these areas as they are seen as inappropriate for girls to be a part of.

Potential ways to change this issue is providing greater girls-only experiences in the middle and high school years of education. Letting girls do things in a hands-on environment is shown to be a great step toward improving their self-view of STEM. “Girls enjoy hands-on, open-ended projects and investigations. Educators and role models can encourage and promote exploration, imagination, and invention by encouraging girls to ask questions and find their paths for investigation” (Hughes et al., 2020, p. 2). Schools need to spark girls’ curiosity in STEM areas through hands-on and mentally stimulating activities (de Melo Bezerra et al., 2018). Girls need to be able to try and fail in a way that they feel like they are learning from their mistakes and that they can overcome the challenges. Supportive environments of both peers and educators make a substantial impact on how a girl sees herself in the future (George et al., 2020). With more girls seeing the positive future of STEM, they will, in return, encourage future generations. “In particular, girls need to meet role models with diverse backgrounds from multiple STEM fields” (Hughes et al., 2020, p. 5). Simply put, the more that are in the field, the more girls will see themselves in the career, and the more who will follow.

By far, the prime impact on a girl’s development and growth in STEM is the family dynamic. While this is true of nearly all aspects of a child’s development, the biggest deciding force is typically how the family sees the potential. Young girls are open to the opinion of their parents. If parents provide a positive form of communication, then girls feel they are allowed to pursue STEM (Ardies et al., 2021). If a family sees STEM as a worthwhile thing that a girl can succeed in it, then they are more likely to encourage the child. For a family that sees this as a waste of time or not appropriate for a girl to do, then the odds of a girl choosing this profession are far lower. A parent’s belief that they can’t do means their child can’t do it also, has a major impact on potential self-beliefs.

More than any other factor in a child’s development is the environment in which they are brought up. “Raising girls' engineering and technology attitudes at this age can positively affect career choices in forward-looking engineering and computer science fields” (Sidekli et al., 2021, p. 694). If a family trusts that the child can do or be a success in a skill, then they will provide the child with every opportunity to be accomplished. Families who were active in the STEM fields also are major impacts on their daughters’ perceptions of the fields and self-efficacy (Ardies et al., 2021). Schools need to provide the resources, educators, counselors, and opportunities to show girls their potential (Howard et al., 2019). Families need to encourage change in their perception of what can be accomplished.

**Conclusion**

In conclusion, there is no one method to improve the number of girls in the STEM field. It is through several methods can the amount be improved. The family dynamic, the ability to see one’s self in the field, and what others think of STEM are all factors. Schools need to provide greater opportunities for girls to take challenges and be rewarded for their attempts. Stereotypes need to be broken, and color berries need to be taken down. When these strategies are put together, then it is probable that girls’ desire to be in a STEM field will improve.

**Literature Review**

Ardies, J., Dierickx, E., & Van Strydonck, C. (2021). My daughter a STEM-career?' Rather not' or' no problem'? A case study. *European Journal of STEM Education*, 6(1), 14.

Asamani, G. A., Adjapong, E. S., & Emdin, C. (2022). Exploring how a hip-hop based science program afforded black/brown girls the space to resist against black/brown negative stereotypes in STEM. *Journal of Urban Learning, Teaching, and Research*, 16(2), 40-70.

de Melo Bezerra, J., Kühl Teles, L., Aparecida Martins, C., Franco de Oliveira, N. M., Margareth da Silva, M., Ribeiro dos Santos, L., & Caratti Piani, R (2018). Fostering STEM education considering female participation gap. *International Association for Development of the Information Society.* *International Conference on Cognition and Exploratory Learning in the Digital Age.*

Essig, R. R., Elahi, B., Hunter, J. L., Mohammadpour, A., & O’Connor, K. W. (2020). Future girls of STEM summer camp pilot: Teaching girls about engineering and leadership through hands-on activities and mentorship. *Journal of STEM Outreach*, 3(1), 1-9.

George, B. T., Watson, S. W., & Peters, M. L. (2020). The impact of participating in a STEM academy on girls' STEM attitudes and self-efficacy. *The Electronic Journal for Research in Science & Mathematics Education*, *24*(4), 22-49.

Howard, A., Gray, P., & Kew, K. (2019). Creating STEM momentum: Culturally relevant leadership and Hispanic girls in high school T-STEM programs in the southwest border region. *School Leadership Review,* 15(1), 19.

Hughes, R., Schellinger, J., Billington, B., Britsch, B., & Santiago, A. (2020). A summary of effective gender equitable teaching practices in informal STEM education spaces. *Journal of STEM Outreach,* 3(1), 1-9.

Sidekli, S., Yıldırım, B., & Karalar, H. (2021). STEM in transition from primary school to middle school: Primary school students attitudes. *International Electronic Journal of Elementary Education,* 13(5), 687-697. <https://doi.org/10.26822/iejee.2021.221>

Mau, W. C., Chen, S. J., Li, J., & Johnson, E. (2020). Gender difference in STEM career aspiration and social-cognitive factors in collectivist and individualist cultures. *Administrative Issues Journal: Connecting Education, Practice, and Research*, 10(1), 30-45.

Punzalan, C. H. (2021). STEM interests and future career perspectives of junior high school students: A gender study. *International Journal of Research in Education and Science*, 8(1), 93-102.

Reinking, A., & Martin, B. (2018). The gender gap in STEM fields: Theories, movements, and ideas to engage girls in STEM. *Journal of New Approaches in Educational Research*, 7(2), 148-153.

Sayılgan, E., Akkuş, A., & Yıldırım, B. (2022). Effect of STEM designed activities on academic achievement of 7th grade elementary school students in force and energy unit. *Science Education International*, 33(1), 18-24.

Wheeler, K. A., & Hall, G. (2021). Exploring STEM engagement in girls in rural communities: Results from GEMS clubs. *Afterschool Matters*, *34*, 68-75.