# STEM Educators' Perceptions of Gender Bias and the Contributing Factors that Persist for Women in STEM Education

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Gender bias is considered an influencing factor that affects the decisions of female high school students to participate in STEM education. This action research used a convergent mixed method design to investigate perceptions of high school STEM educators pertaining to gender bias in STEM education. This descriptive study also sought to identify and examine the key factors that STEM educators perceived as influential factors for female high school students' participation in STEM education. Three main factors of influence - behavioral, individual, and environmental - were used to categorize the perceived factors of influence from the STEM educators' perspectives. The perceptions of high school STEM educators regarding gender bias found biological influences, social norms, stereotypes of STEM students, and the underrepresentation of female students to be most significant.

# Introduction

Female representation in Science, Technology, Engineering, and Mathematics (STEM) continues to decline even with the increase in educational programs and technological advancements in society demanding STEM professionals. In 2019, statistics from the National Center for Science and Engineering found that 38.9% of women graduated with a STEM undergraduate degree (Freyman & Rotermund, 2019). This phenomenon has called for researchers to explore the influential factors that contribute to the decline of women in STEM education and careers that have created a gender gap in STEM education (Card & Payne, 2021). The gender gap has called researchers to explore the key factors of behavioral, individual, and environmental influences that contribute to the decrease in females in STEM education and careers. In this descriptive action research study, the two research questions were: what are high school STEM educators' perceptions regarding gender bias in the STEM School of Study cluster at Skyler High School (pseudonym used)? and What factors do high school STEM educators perceive as contributing to low participation among female high school students within the STEM School of Study cluster at Skyler High School?

# Literature review

The literature review provided an understanding of previous research on gender bias in STEM education and the previous studies conducted to determine factors that influence high school female students' STEM choice selection. The factors that were determined from past research included three main categories: behavioral, individual, and environmental (Bandura, 1997). The categories provided evidence that influencing factors are complex and that individual choice can be determined at an early age by societal and family beliefs (Hand et al., 2017). These beliefs are then carried throughout the educational process and have been described to be influential in the underrepresentation of females in STEM education (Kong et al., 2020). There exists a gap in the literature on the specific topic of gender bias, specifically in STEM education referring to gender. The two main theories that investigate the perceptions pertaining to gender bias in STEM education are the Social Cognitive Theory (Bandura, 1986) and Social Domain Theory (Yoo & Smetana, 2022).

# Methodology

This study took place at a mid-size suburban high school in the southeastern United States. The Skyler High School student population in 2021 was approximately 2586, with 183 faculty/staff. This site was selected because Skyler High School offered six STEM programs for students to enroll in and receive Career and Technology Education, as well as 32 Advanced Placement or Dual-Enrollment courses. Both quantitative and qualitative data were collected and analyzed to provide a comprehensive understanding of the research questions related to gender bias in STEM education. Quantitative data was collected using the Perceptions of STEM Participation Survey, Sex Typing Occupation Survey, and DASS Instrument. The Perceptions of STE Participant Survey was a cross-sectional survey using a 5-point Likert scale response. The Sex Typing of Occupation Survey consisted of 27 items rated on a 7-point bipolar scale to assess the perception of occupations as "masculine" or "feminine" from the participant's perspective. The Draw a Scientist Instrument (DASS) was adapted from a previous instrument and aimed to produce both quantitative data. This instrument assessed stereotypes related to STEM students. The surveys and the DAAS were distributed to participant Survey, two open -ended questions from the DASS Instrument, and semi-structured interviews. A standardized image was used to compare the DASS Instrument, and semi-structured interviews. A standardized image was used to compare the DASS Instrument, and semi-structured interviews.

# Results

Descriptive statistics were calculated using Microsoft Excel to analyze the quantitative data from the surveys. The frequency of artifact indicators (e.g., lab coat, eyeglasses, and symbols of research) occurring on the DASS participant drawing was calculated. Qualitative data was analyzed using an inductive approach. The data was transcribed, reviewed for accuracy, and analyzed to identify recurring themes about the participant's perceptions.

The Perceptions of STEM Participation Survey assessed high school STEM teachers' perceptions regarding female students' involvement in STEM courses and the presence of gender bias. The mean score of responses was 2.75 out of 5 (SD = 1.03), suggesting that high school STEM educators were between slightly disagreement

and neutral about the statements presented concerning female high school students' participation in STEM courses.

The top four occupations, as identified in the outcomes of the Sex Typing Occupation Survey, where the mean scores were found to represent a feminine occupation, were Dental Hygienist, Certified Nursing Assistant, Registered Nurse, and Physician Assistant. The top four occupations where the mean scores were found to represent a masculine occupation were Waste Management, Land Surveyor, Air Traffic Controller, and IT Manager. The top four occupations where the mean scores were found to represent a gender-neutral occupation were Computer Support Specialist, Chemist, Statistician, and Architect.

The DASS Instrument asked the participant to "List three words that come to mind when you think of this STEM student." A frequency count was used to analyze the words provided, and a word cloud was generated to display the findings (see Figure 1). Of the 45 unique words collected, "studious" was reported the most. More than one participant used seven words: studious, intelligent, creative, determined, drive, inquisitive, and problem solver. Words that were synonymous were combined into one dominant word where ten overarching word categories used to describe a STEM Student prevailed: academic subject analyzer, creative, dedicated, intelligent, introverted, kinesthetic learner, problem solver, researching, and stressed.

#### Figure 1

Word Cloud of DASS Instrument List of Three Words



In summary, the quantitative findings of this study showed that the teachers at Skyler High School perceived certain careers as more feminine or masculine and that female students are more successful in interactive science fields, such as behavioral or medical fields. The faculty participants perceived STEM students as intelligent and dedicated, with math and science students being kinesthetic learners and creative problem solvers. The educators perceived STEM students as smart students taking more rigorous hard science courses, working on computers, and being inquisitive and critical thinkers. Specific to female STEM students, the educators' perceptions of female STEM students were the opposite of the stereotypical perception of a STEM student found in the existing research (Kong et al., 2020; Moss-Racusin et al., 2015). Stereotypical perceptions of female STEM students included traits like emotional, sensitive and nurturing. Teachers of this study perceived female STEM students as having a caring and quiet demeanor, choosing easier academic paths, and fearing failure. Lastly, the findings of the study indicated that STEM educators do not see a significant gender bias in STEM education at Skyler High School but identify a continued overall gender bias by societal norms that are seen through the underrepresentation of women in STEM careers.

The combined qualitative data sources were analyzed using Delve software themes emerged: (1) Teachers perceived the female students fear of failure to influence why they take STEM classes, (2) Teachers perceive cultural influences to impact the choices female students make, and (3) Teachers perceive slight growth away from the traditional school aura that female students are not capable of succeeding in STEM course.

Teachers perceived female students' fear of failure to be a major factor that contributes to low participation from high school female students in STEM education. Also, teachers perceived female students' personal life choices, combined with being afraid of failure and not being shown they could be successful in STEM areas, as factors for low STEM enrollment. The findings showed that Skylar High School teachers perceived female students to assume STEM areas are too hard and that female students tend to stray away from the STEM curriculums that are perceived by society as masculine. Self-determination was also perceived by the teachers to be a barrier for female high school students in pursuing STEM courses.

STEM education enrollment can be influenced by parental and environmental factors that are placed on female students, either in the classroom or at home (Pinquart & Ebeling, 2020). One cultural influence identified in the qualitative outcomes of this study was educational opportunities and the parent's ability to provide supplemental education or continuing education for their child. A student's access to technology also influences how females' behavior and attitudes relate to STEM education. The Skyler High School teachers agreed there are social norms that create a larger cultural holdover when referring to STEM careers and education. Lastly, the STEM educators perceived a push from middle school guidance counselors to enroll female high school students in humanitarian courses, such as nursing; which is also tied to societal norms that are placed on STEM careers as either masculine or feminine.

The findings of this study were interpreted in comparison to what past research has determined about gender bias in STEM education; teachers have a stereotypical view of STEM students and STEM careers (Kong et al., 2020). The data was converged and considered through a lens of conceptual understanding about gender bias pertaining to female high school students and the research-based literature. This study found several key findings related to gender bias in the perceptions of high school STEM educators at Skyler High School: biological influences, social norms, stereotypes of STEM students, and the underrepresentation of female students in STEM education. The converged data supported these teachers' views on certain career choices to weigh heavily on one's gender in STEM areas. Additionally, acknowledges that gender development starts at an early age through childhood experiences that influence female students in decision-making skills.

# Conclusion

The study emphasized the importance of early intervention in recruiting and promoting females toward STEM education. Teachers believe that exposing female students to STEM from a young age is essential to influence their decisions and increase their participation in STEM courses. While recruitment efforts were present at Skylar High School, the study suggested that these efforts needed to start early to have a meaningful impact on female high school students' decisions to take STEM courses. In summary, the study highlights the complex interplay of stereotypes, biases, and societal norms that affect female students' choices in STEM education.

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