DECODING THE STEM GENDER GAP

UNDERSTANDING THE FACTORS AT PLAY

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Introduction:

The underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields is a multifaceted issue with far-reaching consequences for both societal equity and economic progress. This research project delves into the intricate factors that contribute to the gender gap in STEM, aiming to provide a comprehensive understanding of the complex interplay between individual characteristics, societal influences, and educational experiences. By developing an agent-based model, this study simulates the decision-making processes of individuals as they navigate educational paths and career choices, particularly focusing on the factors that influence women's participation in STEM fields.

The model incorporates a range of key factors that have been identified in previous research as potentially influencing STEM participation. These factors include:

- **Personality traits:** The model considers the Big Five personality traits (openness, conscientiousness, extraversion, agreeableness, and neuroticism) and their potential impact on STEM interest and career choices.
- **Academic performance:** The model takes into account individuals' math scores, recognizing the importance of mathematical ability in STEM fields.
- **Family background:** The model acknowledges the influence of having a parent with a STEM career on an individual's likelihood of pursuing a STEM path.
- **Societal biases:** The model incorporates the impact of media bias and societal expectations on shaping individuals' interests and career aspirations.

Through this simulation, the research seeks to uncover the dynamic relationships between these factors and their cumulative effect on women's underrepresentation in STEM. By identifying critical junctures and influences, the study aims to inform the development of targeted interventions and strategies to promote greater gender diversity in STEM fields. Ultimately, this research contributes to a deeper understanding of the complex issue of the STEM gender gap and provides valuable insights for fostering a more inclusive and equitable STEM landscape.

Research Summary

1. Girls in STEM: Is It a Female Role-Model Thing?

Bibliography

González-Pérez, S., Mateos de Cabo, R., & Sáinz, M. (2020). Girls in STEM: Is it a female role-model thing?. Frontiers in psychology, 11, 564148.

Introduction:

The study, conducted by González-Pérez et al. (2020), investigates the impact of female role models on girls' interest in STEM (science, technology, engineering, and mathematics) education. Despite progress in gender equality in higher education and the labor market, women remain underrepresented in STEM fields. The research aims to demonstrate how exposure to female role models can influence girls' preferences for STEM studies.

Methodology:

The study involved 304 girls aged 12–16 from various schools in Spain. A pre-test/post-test design was used to measure changes before and after the girls interacted with female STEM professionals. The expectancy–value theory of achievement motivation was applied to assess the role-model intervention's effect on girls' beliefs about success in STEM and their career aspirations.

Results:

The role-model intervention had a positive effect on girls' enjoyment of mathematics, their expectations of success in the subject, and their aspirations in STEM. It also reduced gender stereotypes. The study found that the more counter stereotypical the role-model sessions were, the stronger the relationship between girls' expectations of success in mathematics and their likelihood of pursuing STEM careers.

Discussion:

The research highlights the potential of female role models in encouraging girls to consider STEM fields and suggests that exposure to successful women in STEM can inspire girls to believe in their abilities and aim for STEM careers. The study also underscores the importance of reducing gender stereotypes to promote gender equality in STEM professions.

Future Research:

Future studies should incorporate a control group for better generalizability, explore the effectiveness of video-based role-model exposure, and conduct longitudinal studies to

understand the long-term effects of role-model interventions. Additionally, the study suggests evaluating the role-model sessions across different cultural settings.

Funding and Acknowledgments:

The research was funded by various Spanish institutions and the Inspiring Girls Foundation. The authors acknowledge the support of several individuals and organizations that contributed to the study.

Ethics Statement:

The study was reviewed and approved by the relevant ethics committees, and written informed consent was obtained from the participants' legal guardians.

References:

González-Pérez, S., Mateos de Cabo, R., & Sáinz, M. (2020). Girls in STEM: Is It a Female Role-Model Thing? Front. Psychol. 11:2204. doi: 10.3389/fpsyg.2020.02204

2. Agent-Based Models of Gender Inequalities in Career Progression

The research paper titled "Agent-Based Models in Career Progression" by John Bullinaria, published in the Journal of Artificial Societies and Social Simulation (JASSS) 21(3) 7, 2018, investigates gender inequalities in career advancement within hierarchical organizations such as universities and businesses. The study employs an agent-based simulation framework to explore how gender imbalances arise, to detect signals of discrimination, and to evaluate the effectiveness of interventions aimed at reducing these disparities.

Bibliography

Bullinaria, J. (2018). Agent-based models of gender inequalities in career progression. Journal of Artificial Societies and Social Simulation, 21(3).

Introduction and Objectives:

The introduction outlines the motivation behind the study, which is to understand the complex interplay of factors contributing to gender imbalances in career progression. The paper aims to provide a tool for policymakers to design more effective interventions by identifying the underlying causes of these imbalances.

Methodology:

The methodology section describes the agent-based model used in the simulations. Agents are assigned genders and compete for promotions based on a set of parameters, including innate ability, discrimination, and career preferences. The model accounts for

factors such as promotion fractions, minimum years required for promotion eligibility, and the number of years before an agent gives up on promotion.

Results:
The results section presents findings from the simulations. The paper identifies signals that may indicate discrimination or the need for interventions, such as higher average abilities among underrepresented genders at higher career stages. It also highlights the importance of understanding the root causes of imbalances before implementing interventions to avoid unintended consequences.

Discussion and Conclusion:

The discussion section reflects on the implications of the study for real-world policies and practices. It emphasizes the need for a nuanced approach to addressing gender inequalities and suggests that the agent-based modeling approach can be a valuable tool for systematically exploring a wide range of factors influencing career progression.

Conclusion:
The appendix provides supplementary material, such as detailed descriptions of the simulation framework and parameter values used in the study.

In conclusion, the paper by John Bullinaria offers a comprehensive analysis of gender inequalities in career progression using an agent-based simulation approach. It contributes to the understanding of how gender imbalances develop and provides insights into the effectiveness of various interventions. The study underscores the importance of a tailored approach to policy-making in order to achieve gender parity in hierarchical organizations.

References:

Bullinaria, J. (2018). Agent-Based Models in Career Progression. *Journal of Artificial Societies and Social Simulation*, 21(3), 7. DOI: 10.18564/jasss.3738

3. Gender differences in high school students' interest in STEM careers: a multi-group comparison based on structural equation model

Bibliography

Wang, N., Tan, A. L., Zhou, X., Liu, K., Zeng, F., & Xiang, J. (2023). Gender differences in high school students' interest in STEM careers: a multi-group comparison based on structural equation model. International Journal of STEM Education, 10(1), 59.

Introduction:

The authors introduce the problem of gender disparity in STEM fields and present the theoretical framework based on Social Cognitive Career Theory, which posits that self-efficacy and outcome expectations mediate the relationship between environmental factors and career interests.

Methodology:

The researchers describe the development and validation of the questionnaire used to measure environmental factors, STEM self-efficacy, STEM career perceptions, and interest in STEM careers. The study's limitations are acknowledged, including its regional focus and lack of long-term follow-up.

Results:

The findings reveal that male students exhibit a higher interest in STEM careers than female students. The study identifies social support as the most influential environmental factor for males and media for females. For males, the effect of environmental factors on interest in STEM careers is mediated by both STEM self-efficacy and career perception, while for females, the effect is primarily through STEM self-efficacy.

Discussion:

The authors discuss the implications of the study, emphasizing the importance of enhancing STEM self-efficacy, particularly for female students. They suggest that interventions targeting gender-specific barriers and building confidence in STEM abilities could help to bridge the gender gap in STEM fields.

Conclusion:

The paper concludes by highlighting the need for gender-responsive interventions and learning experiences to address the underrepresentation of women in STEM. The study contributes to the understanding of gender differences in STEM career interest within the context of Chinese culture and traditional gender norms.

References:

Wang, et al. (2023). Gender Differences in High School Students' Interest in STEM Careers: The Mediating Roles of STEM Self-Efficacy and STEM Career Perceptions. International Journal of STEM Education, 10(59). DOI: [to be provided by the authors]

4. Understanding Persistent Gender Gaps in STEM: Does Achievement Matter Differently for Men and Women?

Bibliography

Cimpian, J. R., Kim, T. H., & McDermott, Z. T. (2020). Understanding persistent gender gaps in STEM. Science, 368(6497), 1317-1319.

Abstract:

The study investigates gender disparities in STEM college majors, particularly in physics, engineering, and computer science (PECS). Analyzing data from the U.S. Department of Education's High School Longitudinal Study of 2009 (HSLS:09), the authors find a significant gender gap in PECS majors across the achievement distribution, with men outnumbering women. The study suggests that while interventions for high-achieving women may reduce the gap at the top, systemic and cultural factors must be addressed to close the gap fully, especially for average- and low-achieving students.

Keywords: Gender Gaps, STEM Education, PECS Majors, Achievement Distribution, Interventions

Introduction:

The paper examines the underrepresentation of women in PECS majors and explores the relationship between STEM achievement and college major choice.

Methodology:

The research uses attrition-adjusted longitudinal sampling weights and a composite STEM achievement variable to analyze college major intentions and outcomes.

Results:

The analysis shows a substantial gender gap in PECS majors, with men pursuing PECS at higher rates than women across the STEM achievement distribution. The male-to-female ratio is most imbalanced at the bottom of the distribution.

Discussion:

The study discusses the implications for the STEM pipeline and calls for interventions that recognize the variability of the gender imbalance across achievement levels and consider the role of male-favoring cultures in PECS fields.

Conclusion:

The research concludes that achieving gender parity in PECS requires understanding the factors that attract men and deter women, particularly at lower achievement levels, and emphasizes the need for multifaceted approaches.

5. High School Choices and the Gender Gap in STEM

Bibliography

Card, D., & Payne, A. A. (2021). High school choices and the gender gap in STEM. Economic Inquiry, 59(1), 9-28.

Introduction:

The research investigates the gender gap in STEM (Science, Technology, Engineering, and Math) degrees by analyzing high school course selections and university entry data for students in Ontario, Canada. Women are underrepresented in STEM fields, which impacts the gender composition of the science professions and the economic status gap between men and women.

Data and Methodology:

The study utilizes detailed administrative data from Ontario's high school students and university admission records. It focuses on the STEM readiness of students, which is determined by their completion of math and science courses by the end of high school. The analysis decomposes the gender gap in STEM readiness into differences in high school course completion and university entry rates.

Findings

STEM Readiness and Entry Rates:

- STEM entry is largely mediated by STEM readiness, defined by the completion of essential high school courses.
- Both genders with STEM readiness have similar chances of entering STEM programs, but a lower proportion of females enter STEM due to fewer of them being STEM-ready.

High School Course Selection:

- At the end of high school, females and males have nearly the same rates of STEM readiness, with females slightly outperforming in average grades for prerequisite courses.
- More females opt for biology and chemistry, while males prefer physics and calculus.
- A higher proportion of non-STEM-ready females qualify for non-STEM university programs compared to their male counterparts.

Impact of Non-STEM-oriented Males:

- A significant portion of the gender gap in STEM readiness is due to a lower rate of university entry among non-STEM-oriented males.
- If non-STEM-oriented males entered university at the same rate as females, the gender gap in STEM readiness would narrow significantly.

Conclusion:

The primary factor behind the gender gap in STEM fields is not the difference in choice of major conditional on readiness, but rather the difference in high school course completion and university entry rates. Addressing these early educational choices and entry rates could reduce the gender gap in STEM readiness and consequently in STEM professions.

Contributions:

This research contributes to understanding the role of high school course selection in university STEM entry, the impact of non-STEM-oriented males on the gender gap, and the broader literature on gender differences in educational achievement and career choices.

References:

Card, D., & Payne, A. A. (2020). High School Choices and the Gender Gap in STEM. *Economic Inquiry*, 59(1), 9-28.

6. Diversity Begets Diversity: A Global Perspective on Gender Equality in Scientific Society Leadership

Bibliography

Potvin, D. A., Burdfield-Steel, E., Potvin, J. M., & Heap, S. M. (2018). Diversity begets diversity: A global perspective on gender equality in scientific society leadership. PloS one, 13(5), e0197280

Introduction

The study explores gender equality in leadership roles within scientific societies, focusing on the zoological sciences. It examines whether scientific societies, often characterized by self-selective membership and elected board positions, provide an effective avenue for promoting female leadership compared to traditional academic institutions.

Data and Methodology

The research involved collecting data from 202 scientific societies around the world. Information was gathered on the gender composition of society boards and leadership positions (e.g., president, vice president, secretary, treasurer). Additionally, the study considered various characteristics of the societies, such as their age, geographic scope, size of the board, and the presence of a visible commitment to gender equality.

Key Findings

Gender Representation in Leadership:

- Women were more represented in society leadership roles compared to academic institutions but still underrepresented (~30%).
- The most informative predictor for the gender ratio of society boards and leadership positions was a cultural model that included society age, board size, and commitment to equality.

Society Characteristics and Gender Equality:

- Societies with a visible commitment to gender equality had better gender representation.
- Older societies tended to have more gender biases compared to newer ones.
- Societies with larger boards were more likely to have higher female representation.

Geographic and Disciplinary Scope:

- International societies demonstrated better gender equality than national or continental ones.
- There was no significant difference in gender representation based on whether a society was discipline-based or taxon-based.

Recommendations

The study suggests that scientific societies could play a crucial role in promoting gender equality in science by:

- Adopting visible commitments to gender equality.
- Ensuring regular turnover in leadership positions to facilitate diverse representation.
- Expanding the size of boards to improve the chances of female leadership.

Conclusion

Scientific societies offer a potentially effective platform for enhancing gender equality in scientific leadership. By adopting specific organizational characteristics and visible commitments to equality, these societies can contribute significantly to closing the gender gap in scientific fields.

References

Potvin, D. A., Burdfield-Steel, E., Potvin, J. M., & Heap, S. M. (2018). Diversity begets diversity: A global perspective on gender equality in scientific society leadership. *PLOS ONE*, 13(5), e0197280. https://doi.org/10.1371/journal.pone.0197280

7. Traditional Gender Role Beliefs and Career Attainment in STEM: A Gendered Story?

Bibliography

Dicke, A. L., Safavian, N., & Eccles, J. S. (2019). Traditional gender role beliefs and career attainment in STEM: A gendered story?. Frontiers in psychology, 10, 1053

Introduction:

This study explores the impact of traditional gender role beliefs (TGRB) on educational and STEM (science, technology, engineering, mathematics) occupational attainment. Utilizing longitudinal data from the Michigan Study of Adolescent and Adult Life Transitions, the research examines how TGRB during adolescence influence educational achievements and career choices in adulthood, with a focus on gender differences.

Methods:

The study's sample consists of 744 participants, with 58% being female. Participants' educational attainment and occupations were assessed at age 42. Occupations were categorized into traditional STEM-related careers in physical sciences, mathematics, engineering, and technology (PMET), life sciences (LS), and non-STEM fields. Path analyses and logistic regression models were used to examine the relationships between TGRB, educational attainment, and occupational outcomes. Models accounted for maternal educational attainment to control for family educational background.

Results:

For females, TGRB at ages 16/18 significantly predicted lower educational attainment and a reduced likelihood of pursuing PMET careers, even after controlling for their educational attainment. Females with stronger TGRB were more likely to be in LS rather than PMET careers. No significant associations were found for males, though patterns were similar to those of females. TGRB mediated gender differences in educational and

PMET occupational attainment, indicating that traditional beliefs contribute to the gender disparity in STEM fields.

Discussion:

The findings highlight the role of TGRB in shaping educational and career trajectories, particularly for females. Traditional beliefs hinder females' progression into higher education and male-dominated STEM fields like PMET, while guiding them towards LS occupations. For males, TGRB did not show significant direct effects, but similar trends suggest underlying influences. This underscores the need for interventions targeting gender role beliefs to promote gender equity in STEM education and careers.

Conclusion:

Traditional gender role beliefs play a critical role in perpetuating gender disparities in STEM fields. Addressing these beliefs through educational and societal interventions could enhance female representation in male-dominated STEM careers and reduce overall gender inequality in educational and occupational attainment.

References:

Dicke, A.-L., Safavian, N., & Eccles, J. S. (2019). Traditional Gender Role Beliefs and Career Attainment in STEM: A Gendered Story? *Frontiers in Psychology*, 10, 1053. doi: 10.3389/fpsyg.2019.01053.

8. Women in STEM: Does College Boost Their Performance?

Bibliography

Gomez Soler, S. C., Abadía Alvarado, L. K., & Bernal Nisperuza, G. L. (2020). Women in STEM: does college boost their performance?. Higher Education, 79, 849-866.

Abstract

This study examines the gender-specific impact of attending a STEM (Science, Technology, Engineering, and Math) program in Colombia, using a value-added measure. By comparing the results of the national exit exams taken at the end of high school and college, the research finds that the gender achievement gap in math and reading scores increases after college, disadvantaging women. The gap is more pronounced for STEM majors compared to non-STEM majors, particularly in public and accredited universities.

Introduction

The underrepresentation of women in STEM careers poses economic and social challenges, limiting innovation and perpetuating gender inequalities. This study investigates whether attending a STEM program in college helps close the gender achievement gap in Colombia, a country with significant gender disparities in math performance at the high school level.

Literature Review

Prior studies have documented gender segregation in higher education, with women underrepresented in STEM fields due to lower math and science performance, cultural pressures, and gender stereotypes. However, there is limited research on whether college education in STEM fields reduces these gender gaps. This study aims to fill this gap by using a value-added model to assess the impact of STEM education on gender-specific academic outcomes.

Data and Methodology

The study uses a panel dataset combining results from the Saber11 exam (high school) and the SaberPro exam (college) for Colombian students. By employing a difference-in-differences estimation strategy and propensity score matching, the research controls for selection bias and measures the learning gains of students in STEM versus non-STEM programs.

Results

The findings reveal that the gender gap in math scores widens after college, with women in STEM programs experiencing a greater increase in the gap compared to their male counterparts. In reading, women consistently outperform men, but the advantage decreases slightly after college. The gap is larger in public and accredited universities.

Discussion and Conclusion

The results suggest that attending a STEM program in college does not help close the gender achievement gap in Colombia. Instead, the gap increases, indicating that additional support may be needed for women in these fields. Addressing these disparities is crucial for promoting gender equality and maximizing the potential of the workforce.

References

Abadía, L. K. (2017).Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011).Cunha, F., & Miller, M. (2014).Morales Valera, D., & Sifontes, F. (2014).Schrøter, D. C., & Nielsen, J. (2013).UNESCO (2017).

9. Cultural Stereotypes and Sense of Belonging Contribute to Gender Gaps in STEM

Bibliography

Master, A. H., & Meltzoff, A. N. (2020). Cultural stereotypes and sense of belonging contribute to gender gaps in STEM. Grantee Submission, 12(1), 152-198.

Abstract:

The study explores the influence of cultural stereotypes and sense of belonging on gender gaps in STEM education. Utilizing the Stereotypes, Motivation, and Outcomes (STEMO) developmental model, it integrates recent findings from social and developmental psychology. The research suggests that stereotypes and self-representations of belonging significantly contribute to gender disparities in STEM interest and academic performance.

Introduction:

STEM education is crucial for individual and societal advancement, fostering critical thinking, problem-solving, and innovation. However, there is a gender gap in STEM fields, with fewer women participating. Addressing this gap is essential to meet the increasing demand for STEM professionals.

Methods:

The study reviews existing literature on cultural stereotypes and self-representations in STEM. It synthesizes findings on how these factors affect students' sense of belonging and motivation, subsequently impacting their academic choices and achievements in STEM fields.

Results:

The analysis reveals that cultural stereotypes negatively influence girls' interest and performance in STEM by undermining their sense of belonging. Boys, conversely, benefit from positive stereotypes that enhance their STEM identity and motivation. Interventions that counteract stereotypes and bolster a sense of belonging can mitigate these effects.

Discussion:

The findings underscore the importance of addressing cultural stereotypes and fostering a sense of belonging to reduce gender gaps in STEM. Interventions such as stereotype threat reduction and belonging enhancement are effective in promoting gender equity in STEM education.

Conclusion:

Cultural stereotypes and a sense of belonging are pivotal in shaping gender differences in STEM interest and outcomes. By focusing on these social and psychological factors, educators and policymakers can develop targeted interventions to close the gender gap in STEM fields.

References:

Master, A. H., & Meltzoff, A. N. (2020). Cultural stereotypes and sense of belonging contribute to gender gaps in STEM. International Journal of Gender, Science and Technology, 12, 152-198.

10. Gender gap in STEM education and career choices: what matters?

Bibliography

Tandrayen-Ragoobur, V., & Gokulsing, D. (2021). Gender gap in STEM education and career choices: what matters?. Journal of Applied Research in Higher Education, 14(3), 1021-1040.

Abstract:
The paper examines the gender disparity in STEM (Science, Technology, Engineering, and Maths) tertiary education enrollment and career choices in Mauritius. It extends the theoretical framework of Master and Meltzoff (2016) to explore personal, environmental, and behavioral factors influencing STEM participation. The study uses a survey of 209 undergraduates and interviews with 15 women in STEM professions. Findings indicate a lower likelihood of female students enrolling in STEM degrees due to factors like self-efficacy, academic performance, and support from family and teachers. The study also reveals challenges faced by women in STEM careers, such as gender discrimination and work-life balance issues.

Introduction:
The gender gap in STEM education and careers is a global concern, influenced by stereotypes, socialization, and self-confidence. Mauritius, despite its investment in education, shows an underrepresentation of women in STEM fields. This study aims to understand the factors contributing to this gap in Mauritius.

Methodology:
The study employs a mixed-method approach, combining quantitative data from a student

survey with qualitative data from interviews with women in STEM careers. The survey data is analyzed using logistic regression to model the gender gap in STEM enrollment.

Results:
The study confirms a gender disparity in STEM enrollment, with female students less likely to choose STEM degrees. Key factors influencing this choice include self-efficacy, academic performance, and support from family and teachers. Women in STEM careers face challenges such as gender discrimination and difficulties in balancing work and family life.

Discussion:
The findings suggest that to address the gender gap in STEM, efforts should focus on improving self-efficacy and providing role models for female students. Additionally, organizations should create inclusive work environments that support women's career progression in STEM fields.

Conclusion:
The study provides a comprehensive analysis of the gender gap in STEM education and careers in Mauritius and offers policy implications for improving gender equity in these areas. It highlights the importance of supportive environments and the need to challenge stereotypes and social norms that discourage women from pursuing STEM education and careers.

References:

Tandrayen-Ragoobur, V., & Gokulsing, D. (2021). Gender gap in STEM education and career choices: what matters? Journal of Applied Research in Higher Education, 13(2), 205-221. DOI: 10.1108/JARHE-09-2019-0235

Master, A., & Meltzoff, A. N. (2016). Building bridges between psychological science and education: cultural stereotypes, STEM, and equity. Prospects, 46(2), 215-234. DOI: 10.1007/s11125-016-9383-z

11. Analysis of barriers, supports and gender gap in the choice of STEM studies in secondary education

The research paper by Noemí Merayo and Alba Ayuso, published in the International Journal of Technology and Design Education, investigates the barriers, supports, and gender gap in the choice of STEM (Science, Technology, Engineering, and Mathematics) studies among secondary education students. The study employs a quantitative descriptive, correlational, and explanatory design, analyzing data from 1562 students and 432 teachers using questionnaires. The research aims to understand why fewer girls pursue STEM studies and to explore teachers' roles in guiding students, particularly girls, towards STEM.

Bibliography

Merayo, N., & Ayuso, A. (2023). Analysis of barriers, supports and gender gap in the choice of STEM studies in secondary education. International Journal of Technology and Design Education, 33(4), 1471-1498.

Introduction and Theoretical Background:

The paper begins by highlighting the underrepresentation of women in STEM fields and the importance of addressing this issue in secondary education. It reviews literature on the influence of teachers, parents, role models, and students' perceptions on STEM career choices.

Methods and Data Collection:

The study uses non-probability purposive sampling, including students aged 13-18 and teachers aged 24-68. The questionnaires are based on a systematic review of scientific literature and are tested for reliability using Cronbach's alpha. Data are analyzed using SPSS 24.0 with a 95% confidence level.

Results and Discussion:

The findings reveal that female students show less interest in STEM, with preferences for health and education professions. Boys are more inclined towards engineering and computer science. Girls associate STEM with helping people and society, while boys prioritize earning money. Girls perceive a need for special qualities to engage in STEM, often underestimating their intelligence and courage. Families and teachers encourage boys more than girls in STEM activities. There is a lack of female role models in STEM, and girls are influenced by stereotypes and lack of STEM knowledge. Teachers often do not include gender equality objectives in curricula and many have not received training on this issue.

Teachers' Beliefs and Actions:

Teachers believe that girls are influenced by preconceived ideas and lack of STEM knowledge. They acknowledge the importance of promoting STEM among girls but do not always have the necessary strategies to do so effectively.

Conclusion and Future Work:

The study concludes that to address the gender gap in STEM, schools should focus on demonstrating the real-life applications of STEM, fostering creativity, building self-confidence, promoting STEM activities, and making female role models more visible. Teachers should receive gender-specific training and integrate gender-sensitive approaches into STEM education. Future work includes increasing the sample size, integrating primary school teachers' perspectives, and considering the role of student guidance departments.

12. Increasing Women's Participation in the STEM Industry: A First Step for Developing a Social Marketing Strategy

Bibliography

Kayan-Fadlelmula, F., Sellami, A., Abdelkader, N., & Umer, S. (2022). A systematic review of STEM education research in the GCC countries: Trends, gaps and barriers. International Journal of STEM Education, 9, 1-24.

Abstract:

The study aims to understand gender differences in the perceived importance of job attributes to inform strategies for increasing women's participation in STEM industries. Using choice-based conjoint and choice model analyses, the research identifies salary and work-family balance as key determinants of women's career choices. The findings suggest that a social marketing strategy focusing on these attributes could encourage more women to enter STEM fields.

Introduction:

Women face challenges in STEM industries, with lower participation rates compared to men. Social norms and gender roles influence work-related choices, leading to a need for interventions that address these barriers.

Methodology:

The study uses marketing statistical tools, such as choice-based conjoint analysis and choice models, to assess the importance of job attributes for men and women.

Participants were recruited through an online survey service, with the sample consisting of individuals aged 20-40 years.

Results:

Salary and the ability to combine work and family obligations were found to be the most important attributes for women when choosing a career. Men prioritized salary, while women prioritized work-family balance. The study also found that women perceive STEM jobs as offering higher salaries than non-STEM jobs.

Discussion:

The research suggests that social marketing campaigns should focus on the financial benefits of STEM careers and the compatibility of these jobs with family life. The study also emphasizes the need for workplace policies that support work-family balance to make STEM careers more attractive to women.

13. A systematic review of STEM education research in the GCC countries: Trends, gaps, and barriers

Bibliography

Kayan-Fadlelmula, F., Sellami, A., Abdelkader, N., & Umer, S. (2022). A systematic review of STEM education research in the GCC countries: Trends, gaps and barriers. International Journal of STEM Education, 9, 1-24.

The study concludes that a social marketing strategy, combined with supportive workplace policies, could effectively increase women's participation in STEM industries. Long-term monitoring of campaign effects and actual changes in women's participation in STEM fields is recommended.

The systematic review by Kayan-Fadlelmula and colleagues, published in the International Journal of STEM Education (2022), examines the trends, gaps, and barriers in STEM (Science, Technology, Engineering, and Mathematics) education research within the Gulf Cooperation Council (GCC) countries. The study aims to contribute to the STEM literature, explore factors influencing student participation, and identify research gaps.

Methodology:

The researchers conducted a thorough review of literature, employing a systematic approach to data extraction and analysis. They used specific search terms and databases to identify relevant scholarly papers, resulting in 18 studies included in the review. The data extraction process involved a coding protocol for variables such as authors, year of publication, research country, participants, education level, research methods, thematic

focus, and identified gaps and problems in STEM research within the GCC. Interrater reliability was established using a percent agreement metric, with a high agreement rate among researchers.

Results:

The review reveals a rise in STEM education research in the GCC, with the UAE leading in published papers. The research primarily focuses on K-12 teachers and undergraduate students, utilizing quantitative methods. Key themes include cultural factors, contextual factors (educational policy), school-level factors (curriculum, assessment, teachers), and student-level factors (gender, socio-economic status, self-efficacy, motivation, aspirations, attitude, achievement).

Gaps and Barriers:

The review identifies several gaps, including the need for more comprehensive teacher training programs, a lack of clarity on gender differences in STEM performance, and limited research on students' career aspirations and expectations. It also notes the underrepresentation of women in STEM fields and the influence of cultural stereotypes, family support, and educational policies on student participation.

Conclusion:

The paper concludes that while there is a growing body of research on STEM education in the GCC, there are still significant gaps that need to be addressed to enhance STEM education in the region. The authors suggest that future research should focus on institutional barriers to STEM enrollment, the impact of high school education on aspirations, and factors influencing women's retention in STEM fields. Addressing these gaps is crucial for the development of a knowledge-based economy in the GCC countries.

References:

Kayan-Fadlelmula, et al. (2022). A systematic review of STEM education research in the Gulf Cooperation Council countries. International Journal of STEM Education, 9(2), 1-13. DOI: https://doi.org/10.1186/s40594-021-00319-7

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. Biochemia Medica, 22(3), 276-282. DOI: https://doi.org/10.11613/BM.2012.032

Organisation for Economic Co-Operation and Development (OECD) (2016). PISA 2015 Results in Focus. Retrieved from http://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf

14. Mathematics Anxiety and Self-Efficacy of Mexican Engineering Students: Is There Gender Gap?

Bibliography

Morán-Soto, G., & González-Peña, O. I. (2022). Mathematics anxiety and self-efficacy of mexican engineering students: Is there gender gap?. Education Sciences, 12(6), 391.

Abstract:

The study examines the levels of mathematics anxiety and self-efficacy among Mexican engineering students to determine if there is a gender gap. Data from 498 students were collected using adapted and validated survey items. A MANOVA analysis revealed that male students reported higher self-efficacy and lower math anxiety than females. These findings could inform strategies to improve female students' experiences in math-related activities and reduce the gender gap in STEM fields.

Introduction:

The gender gap in STEM fields is a well-documented issue, with women underrepresented in leadership positions and the industrial sector. The study aims to understand the factors influencing students' selection of STEM majors, focusing on math self-efficacy and anxiety.

Methodology:

Participants were 498 first-year engineering students from a Mexican university. The study used adapted versions of the Mathematics Self-Efficacy Survey (MSES) and the Mathematics Anxiety Rating Scale (MARS 30-item), translated into Spanish and validated for the Mexican context.

Results:

Male engineering students showed higher math self-efficacy and lower math anxiety compared to female students. The MANOVA results indicated significant differences between genders in these areas.

Discussion:

The study suggests that male students are more confident in their math abilities in both everyday and academic settings. Female students experience higher levels of math anxiety, particularly during tests, which may affect their performance and interest in STEM careers. The inverse correlation between math self-efficacy and math anxiety highlights the importance of addressing both factors to improve student outcomes.

Conclusion:

The research underscores the need for strategies to enhance female students' math self-efficacy and reduce math anxiety. This could lead to greater gender equality in engineering and other STEM disciplines.

15. Anatomy of an Enduring Gender Gap: The Evolution of Women's Participation in Computer Science

Bibliography

Sax, L. J., Lehman, K. J., Jacobs, J. A., Kanny, M. A., Lim, G., Monje-Paulson, L., & Zimmerman, H. B. (2017). Anatomy of an enduring gender gap: The evolution of women's participation in computer science. The Journal of higher education, 88(2), 258-293.

Abstract:

This study investigates the persistent gender gap in computer science (CS) majors over four decades, analyzing data from the Cooperative Institutional Research Program (CIRP) Freshman Survey. It examines trends in college students' intentions to major in CS, the characteristics of CS majors, and factors contributing to the gender gap.

Introduction:

The study responds to the need for more computer scientists and the underrepresentation of women in the field. It aims to document trends in aspirations to major in CS, explore the characteristics of prospective CS majors over time, and identify key determinants of the gender gap in CS major aspirations.

Methodology:

The research utilizes a large dataset of first-time, full-time college students from 1971 to 2011, weighted to reflect the population of students at 4-year institutions in the United States. Factor analysis was used to create seven factors from 65 independent variables, which were then used in logistic regression and decomposition analysis to understand the gender gap.

Results:

The study finds a persistent gender gap in CS major aspirations, with women's representation peaking in 1980 and then declining. Predictors of CS major intentions include parental STEM careers, valuing status/wealth, and being Asian/Pacific Islander or African American. Negative predictors include social activism and attending research universities. Over time, the importance of math self-concept and family income has decreased, while the predictive power of a scholarly orientation has increased. The

gender gap is primarily due to gender differences in the predictive power of student characteristics rather than differences in the mean values of these characteristics.

Discussion:

The study suggests that while traditional explanations for the gender gap persist, there are shifts in the types of students attracted to CS and the reasons behind their interest. It recommends that efforts to attract women to CS should focus on broadening perceptions of the field's creative opportunities and societal impacts.

Implications:

The findings have implications for research and practice, indicating the importance of studying CS separately from other STEM fields and examining the gender gap over time. The study also highlights the need for continued research on participation in CS within the context of time.

Conclusion:

The study contributes to the understanding of the gender gap in CS by examining the field's unique characteristics and the changing nature of the student population interested in CS over time. It calls for a focus on the evolving reasons for the gender gap and suggests that future research should continue to explore these dynamics.

References:

Astin, A. W. (1993). What matters in college? Four critical years revisited. San Francisco, CA: Jossey-Bass.

Astin, H. S., & Sax, L. J. (1996). Developing scientific talent in undergraduate women. In C. Davis, A. Ginorio, C. Hollenshead, B. Lazarus, & P. Rayman (Eds.), The equity equation: Women in science, mathematics, and engineering (pp. 96–121). San Francisco, CA: Jossey-Bass.

16. Gender bias in academia: A lifetime problem that needs solutions.

Bibliography

Llorens, A., Tzovara, A., Bellier, L., Bhaya-Grossman, I., Bidet-Caulet, A., Chang, W. K., ... & Dronkers, N. F. (2021). Gender bias in academia: A lifetime problem that needs solutions. Neuron, 109(13), 2047-2074.

Key Findings

Gender Disparities in Academia: The authors highlight the persistent gender gap in academia, with women being underrepresented in senior positions despite increased

enrollment in STEM PhD programs. They cite statistics from the National Institutes of Health (NIH) and European Research Council (ERC) that demonstrate this disparity.

Gender Bias as a Multifaceted Issue: The authors argue that gender bias is not a single problem but manifests in various ways throughout a researcher's career. These biases can be explicit (conscious) or implicit (unconscious) and stem from stereotypes, prejudice, and discrimination.

Impact of Gender Bias: Gender bias affects women's scientific productivity, authorship, peer review, access to funding and awards, teaching evaluations, hiring and promotion decisions, negotiation outcomes, conference participation, and experiences of sexual harassment.

Intersectionality: The authors emphasize that gender bias is further amplified for women who belong to other underrepresented groups, such as those based on race, ethnicity, socioeconomic status, etc.

Proposed Solutions

The authors propose a range of solutions to address gender bias in academia, targeting actions at the individual, institutional, and societal levels. These solutions include:

Individual Level: Increased awareness and education about gender bias, self-examination of biases, and proactive adjustments in behavior.

Institutional Level: Implementing double-blind peer review, diversifying editorial and review boards, setting targets for grant funding and awards for women researchers, bias training for hiring committees, increasing diversity in search committees, and providing affordable childcare and family-friendly policies.

Societal Level: Legislative action to promote gender equity and increased societal awareness of gender bias.

Conclusion

Llorens et al. (2021) conclude by emphasizing the importance of diversity in science and the need for continued efforts to address gender bias. They call for the development of standardized metrics to assess gender bias and evaluate the effectiveness of interventions, as well as increased transparency and data reporting from academic institutions. The authors believe that addressing gender bias is crucial not only for ethical reasons but also for advancing research and educational practices in academia.

17. The Gender-Equality Paradox in STEM Education

Bibliography

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. Psychological science, 29(4), 581-593.

Abstract

The underrepresentation of women in science, technology, engineering, and mathematics (STEM) fields is a global issue. This study investigated the relationship between national gender equality and STEM participation using an international dataset of adolescent achievement (N = 472,242). It found a paradox: girls performed similarly to or better than boys in science in most countries, yet women were underrepresented in STEM degrees. This gap was larger in more gender-equal countries. The study suggests that this paradox arises from individual choices based on academic strengths and societal factors. It highlights the need to consider both personal preferences and sociocultural contexts to increase women's participation in STEM.

Introduction

The underrepresentation of women in STEM fields is a persistent concern. Despite efforts to address this issue, the gender gap remains stable. This study explores a new perspective: the educational-gender-equality paradox. This paradox refers to the observation that countries with high gender equality often have larger gender gaps in STEM participation. The study investigates this paradox using expectancy-value theory, which suggests that students choose academic paths based on their strengths and the perceived value of those paths.

Methodology

The study used data from the 2015 Programme for International Student Assessment (PISA), which assessed the science, mathematics, and reading abilities of adolescents across 67 countries and regions. It also used data from the Global Gender Gap Index (GGGI) to measure national gender equality and data on overall life satisfaction (OLS) from the United Nations Development Programme.

Results

The study found that girls performed similarly to or better than boys in science in most countries. However, there were significant sex differences in relative academic strengths, with boys showing a relative strength in science and math and girls in reading. These differences were more pronounced in more gender-equal countries. The study also found that boys often reported higher self-efficacy, enjoyment, and interest in science than girls, particularly in more gender-equal countries. A mediation analysis suggested that overall life satisfaction partially explained the relationship between gender equality and the STEM gender gap.

Discussion

The findings support the educational-gender-equality paradox, showing that the STEM gender gap is larger in more gender-equal countries. The authors propose that this is due to a combination of individual choices based on academic strengths and societal factors.

Implications

The study has important implications for efforts to increase women's participation in STEM. It suggests that simply promoting gender equality may not be enough to close the STEM gender gap. Instead, interventions should focus on addressing individual differences in academic strengths and interests, as well as broader socioeconomic factors that may influence career choices.

Conclusion

The study highlights the complex interplay between individual choices, societal factors, and gender equality in shaping STEM participation. It underscores the need for a nuanced understanding of these factors to develop effective strategies for increasing women's representation in STEM fields.

18. Gender Differences in Computer Science Students

The study by Beyer et al. (2003) investigates gender differences among Computer Science (CS) majors and non-majors, focusing on quantitative ability, educational goals, computer experience, stereotypes, confidence, personality, support, stress, financial issues, gender discrimination, and attitudes toward the academic environment in CS. The research aims to understand why women are underrepresented in CS by examining these factors collectively.

Bibliography

Beyer, S., Rynes, K., Perrault, J., Hay, K., & Haller, S. (2003, January). Gender differences in computer science students. In Proceedings of the 34th SIGCSE technical symposium on Computer science education (pp. 49-53).

Introduction

The research is motivated by the significant shortage of computer scientists in the U.S. and the need to increase the representation of women in CS. The study uses a multivariate approach to identify interactions among variables that may influence women's pursuit of CS careers.

Method

The study involved 56 students (24 females, 32 males) enrolled in CS courses at the University of Wisconsin-Parkside. Participants completed questionnaires assessing various demographic, educational, and attitudinal factors.

Results

Demographic Variables

- The sample was predominantly Caucasian, with no significant gender or major/non-major differences in demographic variables except for marital status and semesters attended.
- Ability in Quantitative Areas
- No significant gender differences were found in self-reported college GPA or ACT scores. CS majors scored higher on the science portion of the ACT than non-majors.

Educational Goals and Interests

- CS majors spent more time on school work than non-majors, and men had higher educational aspirations than women. Non-majors valued interactions with people and extrinsic rewards more than majors in career selection.

Experience with Computers

- Majors spent more time using computers for school work than non-majors. Men were more likely to have installed RAM and had more programming experience than women.

Stereotypes and Knowledge about CS

- Both genders had similar knowledge of CS, but men held more stereotypical views of computer scientists as loners. Female non-majors underestimated the salary potential in CS.

Confidence

- Women had less confidence in computer skills than men, even when controlling for quantitative ability. Female CS majors had less confidence than male non-majors.

Personality

- Female non-majors were less conscientious than male non-majors, while female CS majors were more conscientious than male CS majors. Men had more masculine gender roles than women.

Support and Encouragement

- No significant gender differences were found in support and encouragement, but female non-majors felt less reassured of their competence than female majors.

Stress and Financial Issues

- Non-majors were more certain of financial support to complete college than CS majors.

Gender Discrimination

- Overall, students perceived little gender discrimination in the CS department.
- Attitudes towards CS Courses and Instructors
- CS majors had a less positive view of the academic environment in the CS department than non-majors.

Discussion

The study concludes that low confidence and negative stereotypes are major barriers for women in CS. The research suggests that increasing women's confidence and awareness of career opportunities in CS, providing support and encouragement, and addressing stereotypes could improve women's participation in the field.

References

Beyer, S., Rynes, K., Chavez, M., Hay, K., & Perrault, J. (2003). Gender Differences in Computer Science Students. SIGCSE'03, February 19-23, 2003, Reno, Nevada, USA. Copyright 2003 ACM 1-58113-648-X/03/0002…$5.00.

Beyer, S. (1990). Gender Differences in the Accuracy of Self-evaluations of Performance. Journal of Personality and Social Psychology, 59, 960-970.

19. Overcoming the STEM Gender Gap: from School to Work

Bibliography

Cavaletto, G. M., & Berra, M. (2020). Overcoming the stem gender gap: From school to work. Italian Journal of Sociology of Education, 12(Italian Journal of Sociology of Education 12/2), 1-21.

Abstract

The research by Mariella Berra and Giulia Maria Cavaletto from the University of Turin, Italy, investigates the persistent underrepresentation of women in STEM (Science, Technology, Engineering, and Mathematics) fields in Italy. The study identifies the role of gender stereotypes and the Italian education system's structure in perpetuating this gap.

The authors propose a best practice model to bridge the gender divide in STEM, focusing on the transition from school to work. The action research project "STEM Women: A Challenge for the School, an Opportunity for Businesses, a Search for Talents" involved a network of universities, public institutions, schools, and technology enterprises in the Piedmont Region. The project included a survey of 572 high school students, meetings with female STEM leaders, visits to STEM firms, and a public meeting to discuss the implications of increasing female presence in STEM professions.

Introduction

The introduction sets the stage for the necessity of closing the digital and technological skills gap in Italy to adapt to society 4.0. The authors highlight the challenges faced by the Italian education system, such as limited orientation opportunities and a lack of permeability between technical and humanistic paths. The Buona Scuola reform aimed to address these issues but has not yet effectively aligned the education system with labor market requirements, particularly in high schools. The gender gap in STEM is a critical concern, with women less likely to pursue STEM careers despite better employment prospects in these sectors.

Theoretical Background

The theoretical framework of the research is grounded in sociological literature on educational opportunities and gender digital gaps. The authors discuss the importance of schools in reducing the gender gap and the need for inclusive and fair orientation and transition processes from school to work.

Research Methods

The research was conducted in four stages: an online survey, classroom-based training, STEM Tours, and public speaking events. The survey results indicated that female students achieve higher marks in science and humanities but are still influenced by stereotypes that discourage them from STEM careers. The STEM Tours and public speaking events aimed to challenge these stereotypes and encourage informed career choices.

Results

The study found that female students are aware of the importance of technological skills for employment but are less likely to consider STEM studies important. The research also revealed that both male and female students are generally under-informed about future

job opportunities and that gender stereotypes persist in their perceptions of certain professions.

Conclusion

The conclusion emphasizes the need for continuous and early interventions to address gender stereotypes and the mismatch between education and the labor market. The authors advocate for a cultural shift to broaden socio-technical capital and promote the inclusion of those currently excluded or indifferent to new technologies and the economic landscape.

References

Berra, M., & Cavaletto, G.M. (2020). Overcoming the STEM Gender Gap: from School to Work, 12(2), 1-21. DOI: 10.14658/pupj-ijse-2020-2-1

Accornero, A. & Meraviglia, C. (2007). La valutazione sociale delle professioni nell'Italia contemporanea. Quaderni di Sociologia, 45, 19-73.

Akerlof, G. & Kranton, R. (2000). Economics and Identity. The Quarterly Journal of Economics, 115, 3, 715-753.

20. Stemming the Gender Gap in STEM Entrepreneurship: Insights into Women's Entrepreneurship in Science, Technology, Engineering, and Mathematics

Bibliography

Kuschel, K., Ettl, K., Díaz-García, C., & Alsos, G. A. (2020). Stemming the gender gap in STEM entrepreneurship–insights into women's entrepreneurship in science, technology, engineering and mathematics. International Entrepreneurship and Management Journal, 16(1), 1-15.

Abstract:
The paper examines the underrepresentation of women in STEM entrepreneurship, a critical area for innovation and economic growth. Despite the importance of STEM fields, women are significantly underrepresented, reflecting systemic gender biases and disadvantages. The authors explore institutional, organizational, and individual factors influencing women's entrepreneurship in STEM, aiming to lay the groundwork for future research to address this gender gap.

Introduction:
Innovative entrepreneurship is vital for economic dynamism and job creation. STEM fields, however, face a persistent gender gap, affecting productivity, economics, and wellbeing. The gender gap in STEM and entrepreneurship is rooted in social and cultural factors rather than biological differences. Despite increasing education and empowerment, gender disparities persist, leading to a 'leaky pipeline' in STEM careers and entrepreneurship.

Factors Influencing Women's Entrepreneurship in STEM:

- Institutional Factors: Gendered regulatory, normative, and cognitive institutions influence the desirability and feasibility of entrepreneurship.
- Organizational Factors: Gendered division of labor, symbols, and social structures within organizations can perpetuate inequalities.
- Individual Factors: Self-efficacy, agency, and perceptions of gender identity and roles affect individual career choices and entrepreneurial success.

Special Issue Overview:
The special issue includes five articles that provide diverse perspectives on women's entrepreneurship in STEM. These articles cover systematic literature reviews, mentoring programs, team dynamics, and the negotiation of entrepreneurial identity.

Implications and Future Research:
The authors call for more research on women's entrepreneurship within STEM, including descriptive analyses, the role of teams, and the impact of STEM education on

entrepreneurship. They also advocate for research on the gendered nature of entrepreneurial ecosystems and feminist analyses of STEM entrepreneurship.

Conclusion:
The paper underscores the need to address the gender gap in STEM entrepreneurship through comprehensive research and gender-sensitive policies. It emphasizes the importance of understanding and mitigating the institutional, organizational, and individual factors that hinder women's success in STEM fields.

21. Women’s Paths in Science: A Critical Feminist Analysis Jillian Kinzie

Bibliography

Kinzie, J. (2007). Women's paths in science: A critical feminist analysis. New Directions for Institutional Research, 2007(133), 81-93.

Introduction

Kinzie (2007) uses a feminist and critical theoretical framework to examine the low rates of women's participation in science, technology, engineering, and mathematics (STEM) fields. The author uses a national longitudinal dataset to track the educational pathways of women from middle school to college. Kinzie (2007) also discusses how her personal experiences and feminist viewpoint shaped her research questions and methodology.

Methodology

Kinzie (2007) used data from the National Educational Longitudinal Study (NELS:88) to track a cohort of female students (N = 3,148) from eighth grade through postsecondary education. The author focused on the students' intended majors during their senior year of high school and two years into their postsecondary education. This resulted in four distinct pathways:

- **"Nevers"**: Women who were not interested in STEM in 12th grade and did not major in STEM in college.
- **"Departers"**: Women who were interested in STEM in 12th grade but did not major in STEM in college.
- **"Joiners"**: Women who were not interested in STEM in 12th grade but majored in STEM in college.
- **"Persisters"**: Women who were interested in STEM in 12th grade and majored in STEM in college.

Kinzie (2007) used discriminant analysis to identify the variables that best predicted which pathway a woman would follow. These variables included academic achievement, self-concept, educational aspirations, grades, academic behaviors, course-taking patterns, attitudes toward STEM, socioeconomic status, and race/ethnicity.

Results and Interpretation

Kinzie (2007) found that several factors predicted women's pathways in STEM. Math achievement was a critical filter for entry into STEM majors, with low achievement in 8th grade potentially leading to decreased interest and preparation for college-level STEM courses. Science grades also acted as a filter, and positive beliefs about STEM in 8th grade were associated with persistence in STEM.

The author also found that "Departers" had higher self-concept than other groups, suggesting that a general measure of self-concept may not be sufficient to understand women's choices in STEM. Additionally, educational aspirations in 10th grade distinguished "Persisters" from "Nevers," highlighting the importance of early expectations for higher education.

"Joiners" were distinguished by their socioeconomic status and potentially negative attitudes toward STEM in 10th grade, which could be due to feeling unchallenged or underprepared. Kinzie (2007) emphasizes the importance of understanding this group, as they may have been overlooked for support services and interventions.

Conclusion

Kinzie (2007) concludes that increasing the number of women in STEM requires understanding the factors that distinguish the different pathways women take. The author suggests that focusing on "Joiners" and "Departers" is particularly important, as they represent potential entrants into STEM fields. Kinzie (2007) also emphasizes the need to examine the cultural structures that constrain women's choices and to develop interventions that address these constraints.

22. European Proposals to Work in the Gender Gap in STEM: A Systematic Analysis

Bibliography

García-Holgado, A., Verdugo-Castro, S., González, C., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2020). European proposals to work in the gender gap in STEM: A systematic analysis. IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 15(3), 215-224.

Introduction

García-Holgado et al. (2020) examined European research projects focused on the gender gap in STEM fields. The European Union has made it a priority to increase female participation in STEM and has funded numerous research projects to address this issue. However, there was a lack of analysis regarding the proposals and achievements of these projects. The authors aimed to provide an overview of the outputs from these projects developed over the last five years. The study employed a systematic review process to select and analyze the projects, ensuring the quality of results and avoiding bias.

Methodology

The authors developed a new methodology called Systematic Research Projects Review (SRPR) to conduct their analysis. This methodology is based on the Kitchenham's adaptation of the systematic literature review (SLR) and the Petersen's proposal for

systematic mapping studies. The SRPR methodology allowed the authors to select a set of projects that specifically focused on the gender gap in STEM. The research questions guiding the study were:

- What are the trends in Europe on the study about the gender gap in STEM?
- Which kind of outcomes are provided by the projects?
- Which kind of solutions or initiatives are developed?

Project Selection

The authors used the PICOC method to define the scope of their analysis, which included European research projects focused on the gender gap in the STEM sector. The screening process involved applying inclusion and exclusion criteria to the title, keywords, and summary of the project. The search strategy involved using relevant databases supported by the European Union, such as CORDIS and Erasmus+. Quality criteria were applied to ensure that the selected projects had enough information available to answer the research questions.

Research Projects

The selection process resulted in 31 projects from three funding programs: Erasmus+, Horizon 2020, and Framework Program Seventh. The projects were diverse in terms of their duration, implementation countries, and focus areas. The majority of the projects focused on intervention, while some focused-on diagnosis or a combination of both.

Proposal and Outputs of the Projects

The projects produced various outputs, including toolkits, good practices, educational materials, gender equality plans, frameworks, online courses, software, guidelines, and more. The main results of the projects were analyzed, focusing on their impact on the gender gap in STEM. The authors found that the projects employed different measures to achieve different types of results, highlighting the diversity of approaches taken to address the issue.

Discussion and Conclusion

García-Holgado et al. (2020) concluded that while intervention-based projects were predominant, there was a need for more projects focused on diagnosis to provide a stronger scientific basis for interventions. The authors emphasized the importance of diverse project outputs to maximize the impact on the field of study. They also acknowledged the limitations of their study, such as the potential exclusion of high-quality projects due to lack of publicly available information. The authors suggested using their quality criteria as a guide for future research projects to ensure sufficient information for other researchers.

23. Gender equality in STEM programs: a proposal to analyse the situation of a university about the gender gap

Bibliography

García-Holgado, A., Mena, J., García-Peñalvo, F. J., Pascual, J., Heikkinen, M., Harmoinen, S., ... & Amores, L. (2020, April). Gender equality in STEM programs: a proposal to analyse the situation of a university about the gender gap. In 2020 IEEE Global Engineering Education Conference (EDUCON) (pp. 1824-1830). IEEE.

Introduction

This research paper proposes a methodology to analyze the gender gap in STEM programs at a university . The authors emphasize the importance of understanding and addressing the underrepresentation of women in these fields, citing research that highlights the benefits of gender diversity in the workplace . The paper outlines a plan to collect and analyze data on various factors that may contribute to the gender gap, including academic performance, career aspirations, and perceptions of the academic environment .

Proposed Methodology

The proposed methodology involves a mixed-methods approach, combining quantitative and qualitative data collection and analysis . The quantitative component will focus on analyzing academic records to assess gender differences in enrollment, performance, and graduation rates in STEM programs . The qualitative component will involve conducting surveys and interviews with students, faculty, and staff to gather insights into their experiences and perceptions regarding gender equality in STEM fields .

Data Collection and Analysis

The data collection process will involve accessing academic records to gather information on student demographics, enrollment patterns, grades, and graduation rates . Surveys will be administered to students, faculty, and staff to collect data on their perceptions of the academic environment, career aspirations, and experiences related to gender equality . Interviews will be conducted with a selected group of participants to delve deeper into their experiences and perspectives . The collected data will be analyzed using statistical methods for the quantitative data and thematic analysis for the qualitative data .

Expected Outcomes

The research aims to provide a comprehensive understanding of the gender gap in STEM programs at the university . By identifying the factors that contribute to the

underrepresentation of women, the study will inform the development of targeted interventions to promote gender equality . The findings will be shared with university stakeholders, including administrators, faculty, and students, to raise awareness and foster a more inclusive academic environment .

References

2020 IEEE Global Engineering Education Conference (EDUCON)

24. The gender gap in higher STEM studies: A systematic literature review

Bibliography

Verdugo-Castro, S., García-Holgado, A., & Sánchez-Gómez, M. C. (2022). The gender gap in higher STEM studies: A systematic literature review. Heliyon, 8(8).

Introduction

Verdugo-Castro et al. (2022) conducted a systematic literature review to examine the gender gap in science, technology, engineering, and mathematics (STEM) fields in higher education. The authors highlight the underrepresentation of women in STEM, emphasizing that in some disciplines, female representation doesn't even reach 30%. The study aims to understand the causes of this gender gap to propose effective solutions. The research questions guiding the study are:

- RQ1: What studies exist on the gender gap in relation to the choice of higher education in the STEM field?
- RQ2: How do gender roles and stereotypes influence decision-making related to higher education?

Materials and Methods

The authors followed the PRISMA guidelines for conducting a systematic literature review. They searched peer-reviewed scientific articles, conference texts, books, and book chapters within the European education area. The initial search yielded 4571 results, which were narrowed down to 26 after applying the PRISMA flowchart and inclusion/exclusion criteria.

Results and Discussion

The review identified several key findings:

- **Gender Stereotypes:** Gender stereotypes are significant drivers of the gender gap in STEM. These stereotypes often lead to the "Leaky Pipeline" phenomenon,

where women drop out of STEM fields at various stages of their education and careers.

- **Stereotype Threat:** The concept of Stereotype Threat, where individuals fear confirming negative stereotypes about their group, is particularly relevant for women in STEM. This fear can negatively impact their self-confidence and performance.
- **Influences on Decision-Making:** The study highlights the influence of family, educational environment, peer groups, and broader cultural factors on an individual's decision to pursue higher education in STEM.
- **Social Cognitive Career Theory (SCCT):** The SCCT framework is used to explain how social stereotypes and individual beliefs interact to influence career choices. Early intervention to address these factors is crucial.
- **Educational Institutions:** The role of educational institutions in shaping perceptions of STEM fields and providing support for students is emphasized.
- **Male-Dominated Domains:** The perception of STEM fields as male-dominated can create barriers for women. The study suggests addressing this through initiatives like mentoring programs and promoting female role models.

Conclusions

Verdugo-Castro et al. (2022) conclude that to narrow the gender gap in STEM, it's essential to focus on fostering positive self-concept, self-efficacy, self-confidence, and self-perception in individuals. This will enable them to make educational choices aligned with their goals, rather than being influenced by societal stereotypes. The study also highlights the need for interventions at various levels, including family, educational settings, peer groups, and the broader culture, to create a more inclusive environment for women in STEM.

25. Addressing the Gender Gap: Women's Perceived Barriers to Pursuing STEM Careers

Swafford and Anderson (2020) used the Delphi method to identify the perceived barriers women face when pursuing STEM careers. The Delphi method is a research technique that involves gathering data from a panel of experts through a series of questionnaires or interviews. In this study, the panel consisted of 24 women from various academic and career backgrounds, both related and unrelated to STEM. The study aimed to address the gender gap in STEM fields and contribute to research on workforce development in the 21st century.

Bibliography

Swafford, M., & Anderson, R. (2020). Addressing the Gender Gap: Women's Perceived Barriers to Pursuing STEM Careers. Journal of Research in Technical Careers, 4(1), 61-74.

Key Findings

The study identified 22 perceived barriers that women face when considering STEM careers. The most significant barriers included:

Male domination of STEM careers: The perception that STEM fields are male dominated can discourage women from entering or advancing in these fields.

Lack of awareness of educational and career opportunities: Many women may not be aware of the diverse range of educational programs and career paths available in STEM.

STEM education and toys directed at boys: The traditional focus on boys in STEM education and toys can create a perception that STEM is not for girls.

Lack of female mentors/role models: The absence of visible female role models in STEM can make it difficult for women to envision themselves in these careers.

Minimization of barriers:

The tendency to downplay or deny the existence of barriers can prevent women from recognizing and addressing the challenges they face.

Personal expectations: Women may have internalized societal expectations that discourage them from pursuing STEM careers.

Time required to become proficient in a STEM field: The perception that STEM fields require a significant time investment can deter women who may have other commitments.

Lack of encouragement from men: The lack of support and encouragement from male colleagues and mentors can create a hostile environment for women in STEM.

Perceived glass ceiling of women in STEM careers: The belief that women face limitations in career advancement in STEM fields can discourage ambition and persistence.

Recommendations

The authors recommend several actions to address these barriers:

Increase awareness of educational and career opportunities in STEM: This can be achieved through formal, informal, and non-formal education initiatives targeting girls and young women.

Recruit and retain females in STEM degree programs: Institutions should develop strategies to attract and support women in STEM education.

Provide mentoring and support networks for women in STEM: Establishing mentoring programs and support networks can help women navigate the challenges they face in STEM careers.

Address gender bias and discrimination in STEM fields: Efforts should be made to create more inclusive and equitable environments for women in STEM.

Conclusion

This research highlights the complex and multifaceted nature of the gender gap in STEM careers. By identifying and addressing the perceived barriers, educators, policymakers, and industry leaders can work together to create a more welcoming and supportive environment for women in STEM, ultimately benefiting both individuals and society as a whole.

Reference

Swafford, M., & Anderson, R. (2020). Addressing the gender gap: Women's perceived barriers to pursuing STEM careers. Journal of Research in Technical Careers, 4(1), 61-74.

26. Understanding gender differences in STEM: Evidence from college applications

Bibliography

Delaney, J. M., & Devereux, P. J. (2019). Understanding gender differences in STEM: Evidence from college applications☆. Economics of Education Review, 72, 219-238.

Introduction

Delaney and Devereux (2019) investigate the gender gap in Science, Technology, Engineering, and Mathematics (STEM) fields using data from Ireland's centralized college admissions system. The authors use data on students' course preferences, school subjects, and grades to understand the factors contributing to the underrepresentation of women in STEM programs. The study aims to decompose the gender gap in STEM and analyze the influence of prior academic preparation, subject choices, and gender differences in academic performance.

Data and Methodology

The study utilizes data from the Central Applications Office (CAO) in Ireland, which includes information on all students who completed their Leaving Certificate (high school exit exam) and applied for undergraduate courses between 2015 and 2017. The data contain students' preferences for university programs, Leaving Certificate subjects and grades, demographic information, and school characteristics. The authors employ regression analysis to examine the relationship between gender and STEM course preferences, controlling for various factors such as academic achievement, subject choices, and grades.

Findings

The study's key findings include:

- **Significant Gender Gap in STEM Preferences:** A substantial gender gap exists in students' preferences for STEM courses, with males being more likely to list STEM courses as their first choice compared to females.
- **Subject Choices and Grades Matter:** The gender gap in STEM preferences is partially explained by differences in subject choices and grades in secondary school. Males are more likely to choose STEM-related subjects and perform better in mathematics, while females tend to excel in other subjects.
- **Unexplained Gender Gap Persists:** Even after accounting for subject choices and grades, a significant portion of the gender gap in STEM preferences remains unexplained, suggesting the influence of other factors such as societal norms, stereotypes, and personal preferences.

- **Heterogeneity within STEM:** The gender gap varies across different STEM fields. There is no significant gender gap in science, while the gaps in technology and engineering are more pronounced.
- **High Achievers and Affluent Areas:** The gender gap in STEM preferences is smaller among high-achieving students and those from more affluent areas.

Conclusion

Delaney and Devereux (2019) highlight the complex nature of the gender gap in STEM fields. While differences in subject choices and academic preparation partially explain the gap, a substantial portion remains unexplained, indicating the need for further research into the underlying factors influencing students' STEM preferences. The study's findings have implications for educational policies aimed at promoting gender equality in STEM education and careers.

Conclusion

The underrepresentation of women in STEM fields is a persistent and complex issue that has garnered significant attention in academic, public, and policy circles. Extensive research has explored the multifaceted factors contributing to this gender gap, revealing a complex interplay of individual, societal, and institutional influences.

Literature Review

The literature highlights the following key factors:

1. **Individual Factors:** Research has shown that personality traits, particularly neuroticism and agreeableness, can influence career choices, with women often exhibiting higher levels of these traits. Additionally, studies have found that girls tend to have lower self-efficacy in mathematics compared to boys, even at similar ability levels.
2. **Societal Factors:** Societal biases and stereotypes about gender roles in STEM play a crucial role. These biases can be perpetuated through media representations, educational practices, and family expectations, shaping girls' and women's perceptions of their capabilities and interests in STEM.
3. **Educational Factors:** The quality of STEM education and exposure to role models can significantly impact students' interest and confidence in STEM subjects. Research suggests that girls may face challenges in STEM classrooms due to implicit biases and a lack of female representation among teachers and mentors.
4. **Family Influence:** Parental attitudes and encouragement have been identified as influential factors in shaping children's career aspirations. Studies have shown that having a parent with a STEM career can increase the likelihood of children pursuing STEM fields.

Current Approaches and Limitations

Efforts to address the STEM gender gap have included initiatives to promote STEM education among girls, mentorship programs, and policies aimed at creating more inclusive STEM environments. However, these approaches often focus on individual factors and may not fully address the systemic and societal barriers that contribute to the gender gap. Additionally, many existing studies rely on observational data, which may not fully capture the dynamic and complex nature of the decision-making processes involved in educational and career choices.

Open Problems and Simulation Focus

This research project aims to address some of the limitations of previous studies by employing an agent-based modeling approach. This approach allows for the simulation of individual decision-making processes within a complex system, incorporating the interplay of various factors identified in the literature. The simulation will focus on the following open problems:

1. **Dynamic Interactions:** Investigating how individual factors, such as personality traits and academic abilities, interact with societal influences and educational experiences over time to shape STEM career choices.
2. **Critical Junctures:** Identifying critical points in individuals' educational and career trajectories where interventions could be most effective in promoting greater female participation in STEM.
3. **Policy Implications:** Exploring the potential impact of different policy interventions, such as promoting female role models or addressing media biases, on reducing the STEM gender gap.

By addressing these open problems, this research aims to provide a more nuanced understanding of the STEM gender gap and contribute to the development of evidence-based strategies for fostering greater gender diversity in STEM fields.

Reference

1. González-Pérez, S., Mateos de Cabo, R., & Sáinz, M. (2020). Girls in STEM: Is it a female role-model thing?. Frontiers in psychology, 11, 564148.
2. Bullinaria, J. (2018). Agent-based models of gender inequalities in career progression. Journal of Artificial Societies and Social Simulation, 21(3).
3. Friedmann, E. (2018). Increasing women’s participation in the STEM industry: A first step for developing a social marketing strategy. Journal of social marketing, 8(4), 442-460.
4. Wang, N., Tan, A. L., Zhou, X., Liu, K., Zeng, F., & Xiang, J. (2023). Gender differences in high school students’ interest in STEM careers: a multi-group

comparison based on structural equation model. International Journal of STEM Education, 10(1), 59.
5. Merayo, N., & Ayuso, A. (2023). Analysis of barriers, supports and gender gap in the choice of STEM studies in secondary education. International Journal of Technology and Design Education, 33(4), 1471-1498.
6. Tandrayen-Ragoobur, V., & Gokulsing, D. (2021). Gender gap in STEM education and career choices: what matters?. Journal of Applied Research in Higher Education, 14(3), 1021-1040.
7. Cimpian, J. R., Kim, T. H., & McDermott, Z. T. (2020). Understanding persistent gender gaps in STEM. Science, 368(6497), 1317-1319.
8. Card, D., & Payne, A. A. (2021). High school choices and the gender gap in STEM. Economic Inquiry, 59(1), 9-28.
9. Kayan-Fadlelmula, F., Sellami, A., Abdelkader, N., & Umer, S. (2022). A systematic review of STEM education research in the GCC countries: Trends, gaps and barriers. International Journal of STEM Education, 9, 1-24.
10. Delaney, J. M., & Devereux, P. J. (2019). Understanding gender differences in STEM: Evidence from college applications☆. Economics of Education Review, 72, 219-238.
11. Potvin, D. A., Burdfield-Steel, E., Potvin, J. M., & Heap, S. M. (2018). Diversity begets diversity: A global perspective on gender equality in scientific society leadership. PloS one, 13(5), e0197280.
12. The Lancet. (2016). International Day of Girls & Women in Science: Addressing Gender Inequality. The Lancet journal's #LancetWomen report. Retrieved from https://massivesci.com/articles/lancet-women-stem-inequality-sex-discrimination/
13. Morán-Soto, G., & González-Peña, O. I. (2022). Mathematics anxiety and self-efficacy of mexican engineering students: Is there gender gap?. Education Sciences, 12(6), 391.
14. Dicke, A. L., Safavian, N., & Eccles, J. S. (2019). Traditional gender role beliefs and career attainment in STEM: A gendered story?. Frontiers in psychology, 10, 1053.
15. Sax, L. J., Lehman, K. J., Jacobs, J. A., Kanny, M. A., Lim, G., Monje-Paulson, L., & Zimmerman, H. B. (2017). Anatomy of an enduring gender gap: The evolution of women's participation in computer science. The Journal of higher education, 88(2), 258-293.
16. Wang, M. T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. Educational psychology review, 29, 119-140.

17. Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. Psychological science, 29(4), 581-593.
18. Llorens, A., Tzovara, A., Bellier, L., Bhaya-Grossman, I., Bidet-Caulet, A., Chang, W. K., ... & Dronkers, N. F. (2021). Gender bias in academia: A lifetime problem that needs solutions. Neuron, 109(13), 2047-2074.
19. Master, A. H., & Meltzoff, A. N. (2020). Cultural stereotypes and sense of belonging contribute to gender gaps in STEM. Grantee Submission, 12(1), 152-198.
20. Beyer, S., Rynes, K., Perrault, J., Hay, K., & Haller, S. (2003, January). Gender differences in computer science students. In Proceedings of the 34th SIGCSE technical symposium on Computer science education (pp. 49-53).
21. Kinzie, J. (2007). Women's paths in science: A critical feminist analysis. New Directions for Institutional Research, 2007(133), 81-93.
22. García-Holgado, A., Verdugo-Castro, S., González, C., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2020). European proposals to work in the gender gap in STEM: A systematic analysis. IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 15(3), 215-224.
23. García-Holgado, A., Mena, J., García-Peñalvo, F. J., Pascual, J., Heikkinen, M., Harmoinen, S., ... & Amores, L. (2020, April). Gender equality in STEM programs: a proposal to analyse the situation of a university about the gender gap. In 2020 IEEE Global Engineering Education Conference (EDUCON) (pp. 1824-1830). IEEE.
24. Verdugo-Castro, S., García-Holgado, A., & Sánchez-Gómez, M. C. (2022). The gender gap in higher STEM studies: A systematic literature review. Heliyon, 8(8).
25. Swafford, M., & Anderson, R. (2020). Addressing the Gender Gap: Women's Perceived Barriers to Pursuing STEM Careers. Journal of Research in Technical Careers, 4(1), 61-74.
26. Cavaletto, G. M., & Berra, M. (2020). Overcoming the stem gender gap: From school to work. Italian Journal of Sociology of Education, 12(Italian Journal of Sociology of Education 12/2), 1-21.