Perception of Engineering Among Girls in India: Implications on Career Decisions

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Abstract: India is witnessing a steady growth in the enrolment of girls into engineering education. There has been a change in the enrolment status from 9% in 2012 to almost 20% in 2023. This positive movement may be attributed to the affirmative actions taken by the Indian government in promoting engineering education among girls. These actions were conceived with a hope to reach critical mass to maintain the momentum. The vision thus is to facilitate participation of girls in technical domain as an organic movement. Taking this development into cognizance, this study examines the current perception of engineering among female science students (those opted for Physics, Mathematics, Chemistry in senior secondary classes) and their intended direction of higher education. Senior high school female science students from seven different high schools (n=150) were administered an open-ended question seeking their understanding on engineers and engineering. 137 students responded. The responses were analysed using content analysis. The analysis resulted in four categories viz., 'Impression of engineers', 'Impression of engineering career', 'Association of utilitarian value, and 'Association of income'. The theme which ran across these categories was 'relate, recognize and requirement'. The study revealed that largely female students have expressed their intention of higher education, without exploring or seeking more clarity on the image which they hold to be correct. It could also be seen that there was no explicit mention of the gendered nature of engineering although it was implicit in their perception. We, thus propose interventions aiming at providing a comprehensive view on engineering field making it as an attractive and possible career option for female science students.

Keywords: Women Engineers, Engineering Education, Perception of Engineering, Belonging

1. Introduction

Inclusivity of women in STEM education and career has been a concern across the world. The under representation of women has been attributed to factors like self-efficacy beliefs (for example, de las Cuevas, García-Arenas and Rico, 2022), interest (for example, Sadler et al, 2012; Weisgram, Bigler and Liben, 2010), gender-role beliefs (for example, Dicke, Safavian and Eccles, 2019; Obura and Ajowi, 2012; Zhang. Kong and Wang, 2023) belongingness, and identity (Joshi et al, 2020; Wofford, Smith, and Branch, 2024). In addition, preferences to work with people was found as a positive influence (Eccles and Wang 2016; Su, Rounds and Armstrong, 2009). It could be seen that the factors themselves are outcome of constant interplay between the images which person holds about the occupation and what she sees/ experiences in the external world. However, around the globe, continued efforts are on from the policy makers to encourage and facilitate women's contribution into engineering. In India, under representation of women is seen specifically in engineering and not in health sciences. India has achieved gender parity with respect to enrolment in higher education as per the latest survey on higher education (Ministry of Education [MoE], 2021). However, the choices made by girls in higher education is not uniform across disciplines. The enrolment of girls into engineering education has remained around 26% for a decade plus. India experienced gender-gap in the enrolment of engineering, especially in the Institutes of National Importance (INI) like IITs (Indian Institute of Technology) and NITs (National Institute of Technology). Studying in these institutes meant access to quality education at affordable fees and promising careers with a significantly higher compensation package. Entrance to these institutes is through national level Joint Entrance Examinations (JEE). Qualifying in these examinations would generally require rigorous preparations, beginning as early as class 9. And this would generally require the students to attend coaching institutes outside the school hours. The phenomenon of lower enrolment of girls, despite qualifying in JEE, intrigued the government and hence a committee was set up. The committee came up with the recommendation of introduction of supernumerary quota for girls (Gonsalves 2017) in INIs and There has been a change in the enrolment status from 9% in 2012 to almost 20% in 2023 (Ministry of Education [MoE], 2024). In addition, the report stressed the need to take up interventions at high school levels to ensure sustained participation of girls. The report also highlighted the importance of organic growth, meaning participation of girls in technical domain as an internally driven phenomenon. To ensure sustained participation of women in engineering field, we need to address the phenomena holistically. It is important to instill the confidence in young women so that they can inspire their juniors by being role models. A study by Gupta (2020) shares that the experiences of the young women students, in elite institutions, are still evolving to be positive.

The study underscores the need to have healthy social relations within these elite institutes. Also, whether the positive wave has reached the next level of aspirants needs to be investigated. Towards this, a larger study aimed at understanding the factors influencing the choice of higher education among senior high school students was taken up. A part of the study was to capture their perception about engineering education along with their intention to take up engineering education as their choice for higher education. This paper presents the analysis of the perception of girls about engineering and about engineers and its association with their intention to take up engineering education.

2. Perception and Decision Making

Luthans (2012) describes perception as the interpretation of a situation which is unique to individual and that it may not be the exact representation of the situation. How an individual makes the meaning of a situation depends on a complex process, rendering a unique image of the surroundings. The external world offers same visuals, actions to everyone, however, it is the individual who applies different filters in registering and organizing the sensory information to arrive at some conclusions which are meaningful to them. For example, associating working with machines to engineering may be common across the genders, but whether one can relate to that profession depends on the socially constructed roles acting as filter. The assumed suitability of individual to a career is a result of implicit and explicit messages they gather during their growing years. Further, social perception is the constant interaction of the perceiver and the perceived. Robbins and Judge (2015) share that "the world as it is perceived is the world that is behaviourally important". Hence, perception plays a significant role in decision making, either at individual level or at group level. The rational way of making decision involves careful evaluation of each alternative. It assumes little or no relevance to difference in filters used in elimination of alternatives. It is natural for human beings to prefer simplicity over complexity, which makes them adopt some generalized notions. However, this also brings in the danger of stereotypical evaluation of alternatives. Individuals use tried and tested methods and the one which they are familiar with, in making choices (Robbins & Judge: 176-177, 2015). For example, if a child sees men working on machines more often than women, she may understand that working with machines belong to men. Similarly, in growing years, when one sees the direct help offered by doctors to the needy through their profession, or through a nurse, medicine field appears to be more connected with people than engineering. Hence, understanding how girls perceive engineering field can give one of the important angles to work on solutions. This is also evidenced in the recent study by Batz-Barbarich, Strah and Tay (2024). Therefore, our focus was to understand how girls perceive engineers and engineering career.

3. Methods and Materials

3.1 Participants

The study used two primary criteria for the selection of sampling population: the schools selected must have student-representation from most of the regions of India and follow the same system of education (Central Board of School Education). A questionnaire was administered to Senior high school science students (Class 11) as part of a large project aimed at identifying the factors influencing their higher education choice. Of the total 342 respondents, 150 were girls. As part of the questionnaire, a free text question - what comes to your mind when you think of engineers or engineering?' was asked. 137 girls responded to the free text question. Majority of them (54%) were from south, 20% from North, 6% from East, and 4% from West. 15% of the girls had not taken Mathematics. Around 38% of the mothers and 40% of the fathers had education graduation and above. Around 18% of the students had seen a female engineer in the family, which included mother, sister, cousin and aunt. 41 students (out of 150) expressed their intention to take up engineering education as their higher education choice.

3.2 Data Analysis

Qualitative content analysis (QCA) was adopted as a method to understand the responses. Schreier (2012) explains how this method is suitable when there is certain amount of interpretation needed. It can be applied to data gathered by variety of techniques, say interviews, television programmes, social media responses etc. it is especially recommended when the data is rich. The advantage of using QCA is that it helps in selecting the data with respect to the question and hence reduces the data. All other information not relevant to the question are not considered. It focuses on context and meaning of the text rather than the frequency of occurrence of certain word as in content analysis. Another important difference is that QCA focuses on the latent meaning of

the text. QCA was combined with coding to arrive at categories, sub-categories and theme. The coding procedure was adopted as per Saldana's (2013) coding manual. The first cycle of coding yielded fifteen sub-categories Further, four categories were formed, grouping the sub-categories. The lead author did the first set of coding, which was subsequently reviewed and discussed with co-authors to arrive at the final set. Finally, a primary theme 'Recognize, relate, and requirement' emerged out of the data. Our sensing from the data was that girls perception of engineering could be captured by these three parameters. While the categories explained the content of perception, the theme captured the essence of the data (Morse 2008). Table 1 gives example responses, codes, subcategories and categories.

4. Findings

4.1 Categories and Subcategories

Figure 1 shows the relationship between categories and subcategories. A brief explanation of the categories and the theme is given in the discussion section.

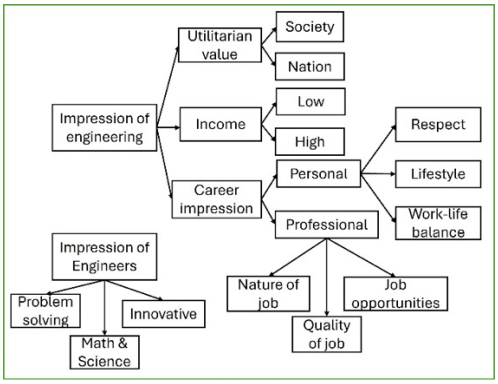

Figure 1: Categories and subcategories

Table 1: Example responses, codes, subcategories and categories

Responses (verbatim)	Codes	Subcategories	Categories
'…building block of our country, … good job opportunities, timely promotion, salary hikes and the best facilities. …math person in the engineering jobs.'	Useful to the country, job opportunities, good working conditions, high income, Academic excellence in Math, perseverance	Useful to country, job opportunities, quality of job, high income, math, hard working	Utilitarian value, Career impressions, Income, Impressions of engineers
'A man standing wearing yellow cap with a pen and paper, study hard, especially math'	Man with yellow cap, studious, Academic excellence in Maths, study hard	Gender association Construction site (nature of job), Math excellence	Impression of engineers, Career impression, Impression of engineers
'I can only imagine people working on their jobs 24/7, insufficient time of rest for themselves or their family. I feel engineering as draining and with no purpose'	Working hard, no time for family, engineering is draining, no purpose	Lifestyle, work-life balance, lack of purpose	Career impressions
'Engineers are found everywhere, …computers, actors, govt jobs, start-up companies, businesses, industries etc. can't think about one particular picture for engineers, it's vast field and engineering students pursue things other than engineering'	Engineers everywhere	Lack of respect, recognition	Impressions of engineers, Career impressions
'machines, tools etc',	Machines, Work-life balance	Nature of work, Lifestyle	Career impressions

'first thing that I can think of is working with machines and people unable to give proper time to family members'			

4.1.1 Impression of Engineers

The overall impression of engineers was positive. Engineer was seen as someone who is proficient in Mathematics and Physics. In addition, traits such as being innovative and having an aptitude for problem solving were attributed to engineers.

4.1.2 Impression of Engineering

This category captures participants' understanding on engineering career in terms of perceived personal life and professional life. Under personal life, they shared their understanding on presence or absence of work-life balance, lifestyle, and perceived respect in the society while 'nature of job', 'quality of job', and 'job opportunities' were cited under professional aspects.

4.1.3 Association of Income

Engineering was seen as a career with a scope for decent earnings. It was believed that only those who qualify from premium engineering colleges have more scope to earn than graduates from tier-2 or tier-3 colleges.

4.1.4 Association of Utilitarian Value

The responses highlighted the understanding of the usefulness of engineering careers to society and country.

4.1.5 Theme –, Relate, Recognize and Requirement

'Relate' refers to seeing alignment of personal goal with engineering career and the lifestyle. For example, visualizing oneself in the areas like - construction, IT, automobile, etc. This includes implicit gender association as well. 'Recognize' is the perceived respect and recognition from the society which involves pride association with engineering career; 'requirement' refers to the perceived utilitarian value of engineering education or job to people, society, country and the like.

5. Discussion

Scholars have explained 'recognize and relate' under the concept of Identity and goal congruence and 'requirement' is akin to communal affordability that an engineering career can offer. Gee's (2000) in his work on identity, shares four ways in which identity can be viewed – first one is 'nature-identity' which is a state, developed by natural forces (like genetic); second is 'institution or position identity' which the institute authorizes, third is 'discourse identity' that which is recognized by others in interaction and the fourth on is 'affinity identity', which is shared in the affinity groups. The classification is to help understand what it means to be "certain kind of person". He also shares that a person's identity is a combination of all the four and that there can be no boundary experienced. For this study, discourse identity seems to be more relevant. It could be seen that students perceived engineering careers as those which are respected in the eyes of society. This might be due to the association of position, income level and the intelligence associated with the degree. However, unless they see the alignment of this type of career with their own intended lifestyle, relating to engineering becomes challenging, evidenced by the response from a participant who does not wish to go for engineering education below:

> *engineer is building block of our country, …I see good job opportunities, timely promotion, salary hikes and the best working facilities. I visualize a math person/brain in the jobs related to Engg. Even with tough working conditions, they give best performance, i see my mother slogging every day in hot climate*

While the participant acknowledges the positive aspects of engineering field, the choice of words like -*slogging* can be inferred as not the lifestyle participant wishes to go for. In addition, when engineers are recognized as math-competent, a higher self-efficacy can only facilitate considering engineering education. Joshi et al (2020) found that the scope for helping the community becomes the deciding factor for women while choosing career. For example, if helping people is the goal and if they perceive engineering career to offer that possibility, then the person has a positive inclination towards engineering education. It is important to note here that most girls related helping people to a doctor not an engineer. Engineering was more associated with helping society grow

through technological advancements. Similarly, Eccles (2009) in her work found that women are less likely to opt for engineering as they want occupations which directly help people. This translates into education in the medical field. Weisgram et al (2010) found that occupational values are recognized differently between male and female genders. It is evidenced in this work as well that a career in engineering is recognized more with machines by girls. Similarly, Capobianco et al (2011) found in their study that children of elementary schools form the conceptualization of engineer as masculine. This notion further gets amplified by the social roles they witness and hence distances them from the path. Eidlin-Levy et al (2023) in their work with primary and high school students, found that the girls preferred less-Math intensive fields. In another study by Tandrayen-Ragoobur (2022), it is found that despite the affirmative actions, the probability of women choosing engineering education is lesser.

It is of noteworthy observation that there is difference in processing of the same information between young women who wish to take up engineering education vis-à-vis who do not wish to take up. The general notion about engineering among both the groups is that it is a career which is Mathematics intensive and that it involves working with machines and technology. The significant deterrent factors were perception of non-availability of good jobs, and non-association of utilitarian value with the engineering career. Those who expressed their intention to pursue it saw it as an opportunity to help society and the presence of work-life balance. This means the perception is formed based on here say or the exposure they get through their family and around. There was no evidence showing awareness on available opportunities for girls who want to pursue engineering. No one mentioned the availability of supernumerary quota which offers additional seats for young women in INIs but mentioned the difficulty of getting into INIs (E.g. quote -*The path to become engineer is very difficult because they have to clear exam called JEE, Jee advance which is considered the most difficult exam*). It can be inferred that the option of studying in INIs remains filtered out despite the efforts by the policy makers. There was no evidence to show that they considered the possibility of studying engineering in these institutes, which could enhance their career opportunities. Censoring self from such available opportunities suggests lack of awareness and lack of belonging. This study hence accentuates the necessity of interventions that can bring in gender-neutral image of engineering career and necessary awareness to empower them to make informed career-decisions. The significance of interventions and proposed interventions are discussed in the next section.

5.1 Significance of Interventions

In India, one of the significant steps was the introduction of supernumerary quota for girls in IITs and NITs. However, this study found minimal or no awareness of such a policy existing among girls. This suggests that interventions should start much earlier in middle schools. Jiang et al (2024) found in their study that increased awareness on Math-intensive careers significantly increased the intention among high school girls to pursue STEM careers. Sadler et al (2012), in their longitudinal study on high school boys and girls, found that there is a significant decrease in interest in pursuing engineering education career among girls during high school. Colvin et al (2013) experimented with middle school girls by making them do hands-on activities such as constructing bridge, water purification etc., as part of civil engineering. They found that there was change in the perceptions of girls about engineering with respect to engineering career's usefulness to people and society. A study of the influence of social networking on the decision to pursue engineering revealed that women attributed it to the school counsellor. Furthermore, the study found that the decision to higher education in engineering occurs during high school or pre-college levels (Wao et al, 2023). Capobianco (2011) conducted qualitative longitudinal study of undergraduate female engineering students to understand how they construct engineering identity. They found that involving them more in real-life engineering tasks strengthens their professional engineering identity and hence their intention to pursue engineering careers. Despite decades of study on the subject, there is no direct solution to trigger interest. Verdin (2021), found that there is interaction of interest, belongingness and engineering identity and that it is the interest which is more significant than the other two. Schools need to really change the paradigm on how Math and Science are made interesting and inclusive. A design thinking workshop as intervention was found to have increased girls' positive evaluation of STEM subjects by means of better perception and self-image (Kijima et al, 2024).

5.2 Proposed Interventions

Thus, this study proposes the interventions focusing on the theme that emerged – 'Relate, recognize, and requirement', at high school level. First one is to hold interactive sessions for female students with women engineers, aimed at communicating the significance and importance of engineers' role in the society. The session should also highlight the contribution of engineering in medical sciences. Since it was evidenced that female

students perceive medical sciences as a socially recognized profession, this awareness has the potential make engineering an attractive option. The second type of intervention should focus on creating a sense of belonging (relate) among girls. Possible interventions can be in the form of exposure to all possible careers, which are gender-neutral in nature. These interventions should be in the form of small projects, which focus on attributes like -problem solving and creativity. This can boost the self-efficacy of the children, which in turn can make them view engineering as a possible career option. The third type of intervention should focus on the need (requirement) for engineers, especially on the need to have diversity in offering solutions. These can be in the form of workshops for the students with activities where real-life challenges of society are presented, and they are encouraged to come a wide variety of engineering solutions. Witnessing themselves as part of the solution has the potential to not only boost their self-esteem but also trigger a sense of responsibility. The aim is to make these young girls feel responsible for contributing to the engineering field. The significance of their contribution should be conveyed. A recent study by Batz-Barbarich, Strah and Tay (2024) supports the strengths of such interventions which can potentially change the perception of young women on engineering. Furthermore, a study by Casad et al, (2018) accentuates the strength of psychological interventions, addressing the need to work the theme that emerged in that study. To achieve gender-parity in engineering, it is not enough if only students are encouraged but the atmosphere in which they grow should also be considered. In their growing up years, the children spend the maximum amount of time in their schools and the most influencing person would be the schoolteacher. Evidence shows that educating teachers through interventions has significant effects on teaching and learning of STEM students (Baker et al, 2007).

5.3 Limitations

The study presents the analysis of only girl students. However, similar analysis of boys' perception might bring in different dimensions. Understanding the reasons for such perception through select interviews will add value to the findings and interventions. Influence of culture on perception is not considered, which is crucial factor in India, being a home for diverse cultures, practices and value systems.

6. Conclusions

The solutions to problems in society should consider the benefits of all the stakeholders. To achieve that it is essential that women participate in designing and developing engineering products and services. This might bring in a paradigm shift in the way products are designed and developed. Being part of the technology creation and drive not only empowers women but also contributes to innovative solutions. A good half of society, not taking part in the development of technology, is akin to depriving society of benefitting from alternate possibilities. The study revealed that it is not the lack of potential but lack of awareness that keeps young girls away from engineering education. Although planned interventions at school levels have proven beneficial, the implementation and the follow-up have not been effective. Unless the eco-system is convinced of the cause, stand-alone interventions may not serve the purpose. Moreover, conviction in the cause needs to be expressed by all the concerned - parents, teachers, and employers. Children will gather information from their surroundings in their growing years and understand that as reality. The onus of providing an informed ambience lies with the surrounding eco system.

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References

Baker, D., Krause, S., Yaşar, Ş., Roberts, C. and Robinson-Kurpius, S. (2007) "An intervention to address gender issues in a course on design, engineering, and technology for science educators", *Journal of Engineering Education*, Vol 96, No. 3, pp 213-226. Available at: 10.1002/j.2168-9830.2007.tb00931.x

Batz-Barbarich, C., Strah, N. and Tay, L. (2024) "The impact of changing engineering perceptions on women's attitudes and behavioral intentions towards engineering pursuits", *International Journal of STEM Education*, Vol 11, No. 1, pp 23. Available at: 10.1186/s40594-024-00476-5.

Belanger, A.L., Joshi, M.P., Fuesting, M.A., Weisgram, E.S., Claypool, H.M. and Diekman, A.B. (2020) "Putting belonging in context: Communal affordances signal belonging in STEM", *Personality and Social Psychology Bulletin*, Vol 46, No. 8, pp 1186-1204. Available at: 10.1177/0146167219897181

Capobianco, B.M., Diefes-dux, H.A., Mena, I. and Weller, J. (2011) "What is an engineer? Implications of elementary school student conceptions for engineering education", *Journal of Engineering Education*, Vol 100, No. 2, pp 304-328. Available at: 10.1002/j.2168-9830.2011.tb00015.x

Casad, B.J., Oyler, D.L., Sullivan, E.T., McClellan, E.M., Tierney, D.N., Anderson, D.A., Greeley, P.A., Fague, M.A. and Flammang, B.J. (2018) "Wise psychological interventions to improve gender and racial equality in STEM", *Group Processes & Intergroup Relations*, Vol 21, No. 5, pp 767-787. Available at: 10.1177/1368430218767034

Colvin, W., Lyden, S. and León de la Barra, B.A. (2013) "Attracting girls to civil engineering through hands-on activities that reveal the communal goals and values of the profession", *Leadership and Management in Engineering*, Vol 13, No. 1, pp 35-41. Available at: 10.1061/(ASCE)LM.1943-5630.0000208

De las Cuevas, P., García-Arenas, M. and Rico, N. (2022) "Why not STEM? A study case on the influence of gender factors on students' higher education choice", *Mathematics*, Vol 10, No. 2, pp 239. Available at: 10.3390/math10020239

Dicke, A.L., Safavian, N. and Eccles, J.S. (2019) "Traditional gender role beliefs and career attainment in STEM: A gendered story?", *Frontiers in psychology*, Vol 10, pp 1053. Available at: 10.3389/fpsyg.2019.01053

Eccles, J. (2009) "Who am I and what am I going to do with my life? Personal and collective identities as motivators of action", *Educational psychologist*, Vol 44, No. 2, pp 78-89. Available at: 10.1080/00461520902832368

Eccles, J.S. and Wang, M.T. (2016). "What motivates females and males to pursue careers in mathematics and science?". *International Journal of Behavioral Development*, Vol 40, No. 2, pp 100-106. Available at 10.1177/0165025415616201

Eidlin-Levy, H., Avraham, E., Fares, L. and Rubinsten, O. (2023), "Math anxiety affects career choices during development", *International Journal of STEM Education*, Vol 10, No. 1, pp 49. Available at: 10.1186/s40594-023-00441-8

Gee, J.P. (2000), "Identity as an analytic lens for research in education", In: *Review of research in education*, Vol 25, No. 1, pp 99-125. Available at: 10.3102/0091732X025001099

Gupta, N., 2020, "Patriarchy reinforced or challenged? A study of engineering students in an elite Indian institute", *Gender, Technology and Development*, Vol 24, No. 2, pp 250-270. Available at 10.1080/09718524.2020.1772187

Jiang, H., Zhang, L. and Zhang, W. (2024) "Influence of career awareness on STEM career interests: examining the roles of self-efficacy, outcome expectations, and gender", *International Journal of STEM Education*, Vol 11, No. 1, pp 22. Available at: 10.1186/s40594-024-00482-7

Kijima, R., Yang-Yoshihara, M. and Maekawa, M.S. (2021) "Using design thinking to cultivate the next generation of female STEAM thinkers", *International Journal of STEM Education*, Vol 8, pp 1-15. Available at: 10.1186/s40594-021-00271-6

Kong, L., Wang, J. and Zhang, X. (2023) "How Gender Stereotypes Impact the Career Choice of High School Students", *Journal of Education, Humanities and Social Sciences*, Vol 12, pp 254-265. Available at: 10.54097/ehss.v12i.7649

Luthans, F. (2012) *Organizational Behavior*, McGraw-Hill/Irwin, New York.

Ministry of Education (2021) "All India Survey on Higher Education", Government of India, Vol 353, 2021-22. [Online]. Available: https://aishe.gov.in/aishe/viewDocument.action?documentId=353

Ministry of Education (2023) "National Institute Ranking Frame", Government of India, Vol 8, 2023. [Online]. Available at: https://www.nirfindia.org/Rankings/2024/EngineeringRanking.html

Morse, J.M. (2008) "Confusing categories and themes". *Qualitative health research*, Vol 18, No. 6, pp 727-728.

Obura, C.A. and Ajowi, J.O. (2012) "Gender and students' perceptions of career aspirations in secondary schools", *Academic Journal of Interdisciplinary Studies*, Vol 1, No. 2 pp 149-164. Available at: 10.5901/ajis.2012.v1n2p149

Robbins, S.P., Judge, T.A. and Vohra, N. (2019) "*Organizational behaviour",* Pearson Education, India.

Sadler, P.M., Sonnert, G., Hazari, Z. and Tai, R. (2012) "Stability and volatility of STEM career interest in high school: A gender study", *Science education*, Vol 96, No. 3, pp 411-427. Available at: 10.1002/sce.21007

Saldana, J. (2013) *The Coding Manual for Researchers.* Sage Publications, California, USA.

Schreier, M. (2012) *Qualitative Content Analysis in Practice*. Sage Publications, City Road, London.

Su, R., Rounds, J. and Armstrong, P.I. (2009) "Men and things, women and people: a meta-analysis of sex differences in interests". *Psychological bulletin*, Vol 135, No.6, p.859. Available at 10.1037/a0017364

Tandrayen-Ragoobur, V. and Gokulsing, D. (2022) "Gender gap in STEM education and career choices: what matters?", *Journal of Applied Research in Higher Education*, Vol 14, No. 3, pp 1021-1040. Available at: 10.1108/JARHE-09-2019-0235

Verdin, D. (2021) "The power of interest: minoritized women's interest in engineering fosters persistence beliefs beyond belongingness and engineering identity", *International Journal of STEM Education,* Vol 8, No.1, pp 33. Avaiable at: 10.1186/s40594-021-00292-1

Wao, H., Kersaint, G., Smith, C.A., Campbell-Montalvo, R., Puccia, E., Skvoretz, J., Martin, J.P., Lee, R. and MacDonald, G. (2023) "Examining how social networks influence women and under-represented minority students' pursuit of engineering in university: when, who, and how?", *International Journal of STEM Education,* Vol 10, No. 1, pp 25. Available at: 10.1186/s40594-023-00415-w

Weisgram, E.S., Bigler, R.S. and Liben, L.S. (2010) "Gender, values, and occupational interests among children, adolescents, and adults", *Child Development*, Vol 81, No. 3, pp 778-796. Available at: 10.1111/j.1467-8624.2010.01433.x

Wofford, A.M., Smith, K.N. and Branch, B.L. (2024) " "I found my home there": Women's engineering identity in STEM student organizations". *Journal of Student Affairs Research and Practice*, Vol 61, No. 3, pp 336-350. 10.1080/19496591.2023.2181085