

Lived Experiences Of Female Learners In South African Grade 12 Physical Sciences Classrooms

Elisa Sebina Mphasha¹, Prof Mahlapahlapana Themane²
(Corresponding author)

¹Department of Education, University of Limpopo, Private Bag
X1106, Sovenga, 0727, South Africa Email:
sebinachuene@yahoo.com PhD student.

²Department of Education, University of Limpopo, Private Bag
X1106, Sovenga, 0727, South Africa Professor at the University
of Limpopo Email: Mahlapahlapana.themane@ul.ac.za

Abstract

Despite South Africa having achieved gender parity in enrolment numbers for science-related subjects, challenges such as exclusion and lack of support persist, affecting girls' engagement in STEM fields. The aim of this study was to explore the experiences of female learners in South African Grade 12 Physical Sciences classrooms. A qualitative research approach and phenomenological research design were adopted. A total of 12 participants were selected from four schools through purposive sampling. To be eligible, learners had to be at least 18 years old and enrolled in Physical Sciences. Ethical clearance was obtained from Turfloop Ethics Research Committee (TREC). Data was constructed through individual open-ended interviews, observations, and document analysis. Data was analysed using thematic data analysis. Four themes emerged from the data: lack of confidence in learning Physical Sciences, work overload, a lack of role models in STEM in society, and learners' experience with teachers. This emphasises the need for inclusive teaching strategies, teacher training and mentorship to improve learning and close the gender gap in STEM education.

Keywords: female learners, physical sciences, experience.

1. Introduction and Background

Female learners have historically been underrepresented in science-related fields, often facing systemic barriers that limit their participation (Wade-Jaimes & Schwartz, 2021). The long-standing perception that female learners are not "fit enough" for science subjects has resulted in their exclusion from subjects such as Physical Sciences. However, in recent years, governments worldwide have introduced policies and

initiatives to bridge this gender gap (Wang, Li, Ou-Yang, Wan, Wang, Zhang & Yi 2024; Oliveira, Tenorio & Siqueira 2022). In South Africa, gender parity in science enrolment has been achieved, a milestone widely celebrated by gender equity advocates. However, despite this progress, numerous challenges continue to hinder female learners' engagement and retention in science classrooms, including a lack of parental support (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2018), teacher support (Msambwa, Daniel, Lianyu & Fute, 2024), and peer support (Watkins & Mensah, 2019), as well as learners' own lack of self-efficacy (Falco & Summers, 2019) and motivation (Msambwa et al., 2024).

While existing studies have explored barriers to female participation in science, limited research has captured the lived experiences of female learners within Physical Sciences classrooms, particularly in underrepresented contexts. Christidou (2011) argues that understanding the perspectives of female learners is essential to addressing their challenges and improving retention in STEM fields. Interventions, such as out-of-school science programmes (Chambers & Schreiber, 2004), metacognitive self-management strategies (Ayazgök & Yalçin, 2014), gender-exclusive study groups (Bennett, Hogarth, Lubben, Campbell & Robinson, 2010), and attitude-improving didactic interventions (Aguilera & Perales-Palacios, 2020), have been implemented to enhance female learners' experiences in Physical Sciences have been attempted, but with minimal success. The effectiveness of these interventions in South African classrooms remains underexplored. This study, therefore, sought to highlight the experiences of girls in Physical Sciences within the Capricorn South District, with the intent of offering a deeper understanding of their challenges and resilience.

Many female learners still experience exclusion, bias, and negative learning environments that deter them from continuing in science-related disciplines (Hazari, Sonnert, Sadler & Shanahan, 2010). By focusing on their direct experiences, this study aims to provide insights into how gender dynamics influence their learning of science and propose context-specific solutions to foster a more inclusive science education environment. To this end, the researcher sought to answer the following research question: What are the lived experiences of female learners in South African Grade 12 Physical Sciences classrooms?

Experiences of girls in Physical Sciences classrooms

Learning experiences of female learners in Physical Sciences classrooms are shaped by numerous factors, including positive reinforcement, supportive learning environments, engagement, and social belonging (Spearman & Watt, 2013).

Research has shown that mentorship and role modelling significantly enhance female participation in STEM (González-Pérez, Mateos de Cabo, & Sáinz, 2020; Kricorian, Seu, Lopez, Ureta & Equils, 2020). When female learners receive encouragement from their teachers, parents, and peers, their confidence and motivation in science improve (Rumfola, 2017). Additionally, creating gender-inclusive learning environments, promoting STEM clubs, and ensuring access to female mentors have been identified as effective strategies for supporting female learners (Guerrero & Guerrero Puerta, 2023).

However, many female learners still face gender biases, societal barriers, and resource limitations that hinder their progress (Islam & Asadullah, 2018; Galsanjigmed & Sekiguchi, 2023). Liani, Nyamongo & Tolhurst, (2020) highlight the persistent challenges faced by women in science, including societal expectations, limited institutional support, and cultural stereotypes. While some female learners develop a strong interest in Physical Sciences, others experience exclusion and alienation due to negative perceptions of their capabilities (Rainey, Dancy, Mickelson, Stearns & Moller, 2018). The disparity between these experiences underscores the need for targeted interventions to create an equitable learning environment.

One of the critical reasons for the underrepresentation of women in science is the negative experiences they face in the classroom (Shirazi, 2017). Studies indicate that female learners often perceive science as difficult due to discouraging learning environments (Jones, Howe & Rua, 2000). Gender bias in classrooms, perpetuated by both teachers (Chávez & Mitchell, 2020) and male peers (Grunspan, Eddy, Brownell, Wiggins, Crowe & Goodreau, 2016), further discourages female participation in STEM subjects.

The "leaky pipeline" phenomenon describes how female learners, despite initially enrolling in science subjects in primary and secondary school, gradually shift away from STEM disciplines as they advance to higher education and the workforce (Almukhambetova Torrano & Nam, 2021). Many female learners change their majors from natural sciences to social sciences due to the challenges they encounter in science classrooms (Biewen & Schwerter, 2022). These findings highlight the urgent need to address gender biases and create a more inclusive and supportive learning environment for female learners pursuing Physical Sciences, especially from their own lived experiences.

Feminist Science Theory

The researchers used the Feminist Science Theory (FST) to frame our study. The FST is an interdisciplinary framework that

critiques how gender influences the production of scientific knowledge, research methodologies, and representation within science disciplines (Bluhm, 2015). As a branch of feminist thought, FST challenges traditional objectivity in science, advocating for reflexivity to mitigate biases and ensure inclusivity (Harding, 1986). The theory is particularly relevant in understanding the lived experiences of girls in Physical Sciences classrooms, as it amplifies historically marginalised voices in scientific inquiry. Ethical considerations in applying FST include the need to avoid reinforcing stereotypes and marginalisation, while promoting transparency, reflexivity, and participant dignity (Oladoyinbo, Olabanji, Olaniyi, Adebisi, Okunleye & Ismaila Alao, 2024). Furthermore, FST encourages transformative research that prioritises inclusivity and collaboration, addressing historical biases in science education (Parry, 2020). Despite its critics, who argue that it overemphasises androcentric biases in knowledge production (Davis, 2021), FST remains a valuable tool in interrogating gender dynamics in science classrooms and advocating for equity-driven interventions. In a study by Roy (2004) FST was used to illustrate how a practical transformation in methodology can change molecular biology-based research in the reproductive sciences.

Since the researchers sought to explore the lived experiences of girls in Physical Sciences by examining both their challenges and resilience, the FST was deemed appropriate. By understanding these experiences, teachers and policymakers could design more effective interventions that go beyond enrolment parity. This could ensure retention, success, and long-term participation of women in STEM. They considered that these findings would provide valuable insights into the socio-cultural and institutional factors influencing female learners' engagement in science and contribute to the development of gender-responsive educational policies.

2. Methodology

Research approach and design

This study employed a qualitative, interpretive phenomenological design to explore the lived experiences of female Grade 12 learners in Physical Sciences classrooms. By focusing on personal narratives, the researchers were enabled to capture in-depth insights into the learners' challenges and perspectives. In-depth interviews allowed participants to freely share their experiences, providing a richer understanding that might not have been achieved through structured surveys.

Participants, setting, and sampling

A purposive sampling strategy used to select participants based on their direct experiences with Physical Sciences. Four quantile one schools from the Capricorn South District, Limpopo Province, South Africa, were selected to participate in the study. This decision was meant to enable the researchers to gain an insider perspectives of the participants' experiences.

A total of 20 participants were selected from four schools through a purposive sampling strategy as follows: four Grade 12 teachers, one from each of the four schools; four Grade 12 male learners from each of the four schools and twelve, Grade 12 female learners, three learners from each of the four schools.

Data collection

Three methods of data collection were used for the study, namely open-ended interviews, observations and document analysis. Prior to the interviews, the learners completed a brief sociodemographic profile form to provide relevant background information. To minimise bias, the researchers employed reflexivity and bracketing throughout the process, ensuring that personal experiences and preconceptions did not influence data interpretation. Semi-structured interviews offered the researchers flexibility to probe in order to gain deeper insights. All the interviews were audio-recorded after receiving permission from the participants. This allowed the researchers to capture data accurately. Data collection took place in a private, distraction-free space within the schools to create a comfortable and confidential environment for participants.

Interviews were primarily conducted in Sepedi, allowing participants to express themselves freely in their preferred language. Each interview lasted approximately 30 minutes, providing ample time for meaningful discussions.

Document analysis proceeded the interview process. Documents reviewed included classwork books of the selected learners to check their performance in the subject. The researchers also looked at the Curriculum Assessment Policy Statement (CAPS), focusing particularly on the examples or illustrations used in the Physical Sciences textbooks and teachers' workbooks.

Data analysis

Qualitative data analysis was conducted using a thematic analysis approach, as outlined by Creswell & Poth (2016). The data, originally collected in Sepedi, were first translated into English for analysis. The process began with familiarisation, where the researcher transcribed and reviewed interview recordings multiple times to gain an in-depth understanding of participant responses. The coding process involved creating a

data matrix, where sentences and paragraphs were fragmented into meaningful units and assigned specific codes. These codes were then grouped into themes reflecting the participants' experiences. To ensure rigour and trustworthiness of the data, an independent coder was engaged to review the coded data, and a consensus meeting was held to finalise the themes. Participants' direct quotations were used to support the findings, illustrating their experiences and perspectives. The final themes were then interpreted in relation to the study's research objectives and the existing literature.

Trustworthiness

To enhance the study's credibility, transferability, confirmability, and dependability, were applied. Credibility was ensured through prolonged engagement, with interviews lasting 30 to 60 minutes, and member checking, where participants were given the opportunity to validate their responses. Transferability was achieved by providing thick descriptions of the study setting, participant demographics, and research methodology, allowing the findings to be applied to similar contexts. Confirmability was strengthened through independent coding, where the researcher initially coded the data, and an independent coder verified the accuracy of the codes. An audit trail was also maintained to document all research steps, ensuring transparency. Dependability was ensured by providing a detailed and replicable methodology. To maintain consistency, the researcher utilised voice recordings, field notes, and supervisor oversight throughout the study.

Ethical considerations

The study received ethical approval from the Turfloop Research Ethics Committee (TREC) (Approval Number: TREC/643/2022). Additional permission was granted by the Limpopo Department of Education and the School Principals and Management Teams of the participating schools. For ethical compliance, only learners aged 18 and older were included, and written assent was obtained from their parents. Participants were thoroughly informed about the study's purpose as well as their right to withdraw their participation at any time without having to provide a reason. Furthermore, steps were taken to ensure participants' privacy and confidentiality by pledging not to divulge any information that was deemed personal. Additionally, anonymity was preserved by removing all identifying information, and data will be securely stored for five years to adhere to ethical research standards. All participants were protected from harm by ensuring the use of sensitive and respectful language is carried out throughout the study.

3. Results

Four themes emerged from the data analysis: lack of confidence by female learners to study Physical Sciences, heavy workloads, a lack of role models in STEM in society, and experiences with their teachers.

Theme 1: Lack of confidence in learning Physical Sciences

Some female learners indicated a lack of confidence in themselves towards learning Physical Sciences. This stems from them not understanding the subject and getting poor results in the subject since Grade 10. Some learners blamed their peers for refusing to assist them with content knowledge, this is evident through the following quotes: Remaking on her results which were obtained from their mid-year examinations. PFL4: "I got level three (with a sad face) and no I am not satisfied. I need level five so that I can pass with a bachelor's level. Level three is a pass, but it is not a good pass. I do not think that I will be able to go to university with level 3."

Another learner, PFL1 said: "I got level one (with a sad face). No, I am not satisfied, some of my classmates were laughing at us that got level one. They laughed because they got level two and some level 3. It is not nice to be laughed at."

The researchers then asked the learners whether they were enjoying Physical sciences, in class when it is taught. PFL2 replied thus,

"Yes. Only if I am enjoying the topic. Because I get irritable if I do not understand in class. I mean, you would also not enjoy it if you spent the whole hour listening to something you do not understand, knowing very well that you will be required to write homework tasks based on it. And then you will struggle even more to write the homework, and then tomorrow another linking topic will come that builds on top of that question you did not understand. And then the cycle continues again and again, then I lose confidence in the subject (PFL2)."

This citation reveals that the learners found the classes of Physical Sciences torturous.

Theme 2: Work overload

The learners in the study indicated that they faced academic pressures when compared to their male counterparts. Some learners found the content unmanageable as they struggled with the pace and volume of assignments, leading to stress and disengagement. This problem was attributed to the fact that they had other responsibilities like family chores (cooking, fetching water, cleaning). One learner had this to say,

"They should stop giving me too many chores and stop suffocating me. When I get home, they should stop telling me

to wash the dishes and cook when I have too much schoolwork. My mom does not do anything (PFL10)."

Learners in Physical Sciences classrooms experienced a range of emotions, from motivation and excitement to frustration and discouragement. While some learners enjoyed the subject and found it engaging, others struggled due to fast-paced teaching, lack of individualised support, and classroom dynamics. The paradox is evident in how different learners interpret their experiences, with some relying on external resources such as YouTube or extra classes to cope. This is reflected in the following participant quotes:

"Yes, I do have. For Physical Sciences, I have a teacher that teaches here at school, Mr (surname). I feel like he is more patient, he gives every learner special attention and if you don't understand anything, he comes and explains. So, I take what the teacher taught me at school and when I get there, I merge the information. Then if there is something I do not understand, I tell him, please explain this to me so that I can understand. If I missed something at school I go like, "whoo okay" at least I still have Mr (surname). It gives me hope."

The female learners indicated that they need someone that they are not entirely used to as an extra teacher. Some extra classes are beneficial, and others are not.

"I ask my dad for data so that I can watch YouTube videos. My parents cannot afford to pay for a tutor because I must travel and pay for his fees. But the videos are immensely helpful as they sometimes show us the real experiment for the chemistry part, unlike when a teacher just explains without us seeing anything."

Theme 3 Learners' experience with teachers

The female learners have provided both positive and negative responses regarding the relationships and treatment from their Physical Sciences teachers. Some believed that the relationship they had with their teachers was normal, while some thought it was not good, as some of the learners' moods changed as the teacher approached the class. This is reflected through the following quotes:

"I would honestly rather become invisible to her, so that I can get all the

content. But if she spots me and says something which is positive, then no

problem. It is just a normal teacher and learner relationship" (PFL11).

In another instance, a probing question was asked to the female learner after she had said that her teacher favoured

boys. The question was: How do you see that? The following is her response:

Sometimes he chases us out of class. You see here at school; they have shared teachers amongst us. They are like our parents. So those who are his children, he does not chase out of the class. If there is something that they did today, he does not chase them out. But if someone else does the same thing tomorrow, he will chase them out. (Participant FL7).

Another one said:

When the teacher enters, the behaviour is different, so there are some changes whereby we are not open with him. Even when we do have questions, we cannot ask him (PFL5).

These quotes indicate the varied experiences that learners in the study sample experienced in the learning of Physical Sciences in their classrooms. From these quotes, the researchers observed that learners lacked adequate support for their learning. In the next section, the researchers expand more on this observation.

Discussion

The aim of this study was to explore the lived experiences of female learners in Grade 12 Physical Sciences classrooms. To this end, the researchers employed a qualitative research approach, where they adopted a phenomenological research design to answer the research question. The findings show that the learners had a visceral dislike of the subject because they lacked an enabling environment comprising support from their teachers and male counterparts. This finding becomes clearer when examining each theme individually:

Theme 1: Lack of confidence in learning Physical Sciences

On the lack of confidence by learners to study Physical Sciences, the researchers found that the learners in the study sample did not express any happiness about their experiences in their classrooms. This result is consistent with findings from studies conducted elsewhere in the world. In a study by Atherton (2015) where the results for male and female students were compared, it was found that lack of confidence in learning sciences arises predominantly in females with little educational experience and a distant educational background. Thompson-Krug (2014) in a study which sought to determine whether authentic learning experiences improve female students' perceptions of STEM and confidence in attaining a STEM career, found that the confidence of female learners was low. Cheryan, Ziegler, Montoya & Jiang (2017) also found that there is a large gender imbalance in the science, technology, engineering, and mathematics workforce deriving from a leaky

pipeline where women start losing interest and confidence in science and engineering as early as primary school. These and other studies confirm the findings that female learners face challenges in science classrooms, if the following citation is anything to go by:

“I got level one (with a sad face). And no, I am not satisfied, some of my classmates were laughing at us that got level one. They laughed because they got level two and some level 3. It is not nice to be laughed at.”

One can conclude that these learners’ goal to attain results at level 3 and not above, reveals a low confidence level.

Using the FST to critique how gender influences the production of scientific knowledge. It is apparent that these learners’ experiences of Physical Sciences were shaped by their societal structures of knowledge production. For instance, some learners had a lingering feeling of being not good enough for Physical Sciences. These structural barriers contribute significantly to the study of the subject by female learners.

Theme 2: Workload

The learners indicated that they had difficulties with studying Physical Sciences due to an unbearable load of house chores. This finding is concord with other studies elsewhere, including in the higher education sector. A study by Gerrand & Variawa (2018) cited both structural and cultural challenges in undergraduate STEM programmes. overwhelmed by their transition from secondary school to first-year tertiary studies. Baloyi, Muremela, Makhwanya, Kutame, Gamede & Ajani (2023) revealed that Physical Science educators in Vuwani grapple with various challenges. This challenge has a ripple effect on female learners as reflected by a learner who said:

They should stop giving me too many chores and stop suffocating me. When I get home, they should stop telling me to wash the dishes and cook when I have too much schoolwork. My mom doesn’t do anything ((PFL10).

These challenges encompass resource scarcity, excessive workloads, inadequate support from school management teams (SMT), These studies underscore the importance of fostering collaborative partnerships between schools, local communities, and business sectors. Such collaborative efforts can elevate the plight of girls. When considering the major concepts of FST, like socio-cultural reproduction and to a lesser extent acceptance of and resistance to gender-based patterns persist. Radical feminists in education have concentrated mainly on the monopolisation of knowledge and culture and on sexual politics in schools, putting women’s and girls’ concerns first through separate and dedicated programmes.

Theme 3: Learners' experience with teachers

Gleaning from the analysis of the results, the findings showed that the learners experienced a lack of sense of belonging in Physical Sciences classrooms because of stereotypes and biases about the role of women in STEM subjects, which were evident both in classroom discourses and lack of recognition by teachers and male peers. Secondly, the intersection of gender and Physical Sciences served as a barrier to participants' perceived recognition from their teachers as competent science persons as well as their sense of belonging in science classes. Participants pointed to the lack of role-models, specifically women, in academia (Herrmann, Adelman, Bodford, Graudejus, Okun & Kwan 2016).

Conclusion

This study concurs with Bottia, Stearns, Mickelson, Moller & Parler (2015) who argues that experiences of female learners in secondary school needs to be documented so that there may be an increase in the number of female learners retained in STEM subjects. The increase may stem from policies made by the government due to awareness of the experiences of female learners in Physical Sciences classes. Additionally, experience in science subjects in secondary school may either encourage or discourage female learners to pursue STEM subjects at tertiary level, which may increase or decrease the "leaky pipeline" in science (Clark Blickenstaff, 2005). This solidifies the need to document female learners' experiences in Physical Sciences in grade 12 classes.

Acknowledgements

The researchers would like to thank the following individuals and institutions: the participants, for their time and for agreeing to share their experiences during the data collection period; colleagues who workshopped the researcher on different aspect of article-writing; the ULWASA (University of Limpopo Women' Academic Solidarity Association) for their support in providing a mentor and writing retreats, and aspecial thank you to Dr Mphasha M.H for the emotional support offered during the writing of this article.

Bibliography

1. Almukhambetova, A., Torrano, D. H., & Nam, A. (2021). Fixing the leaky pipeline for talented women in STEM. *International Journal of Science and Mathematics Education*, 1-20.
2. Aguilera, D., & Perales-Palacios, F. J. (2020). What effects do didactic interventions have on students' attitudes towards science? A meta-analysis. *Research in Science Education*, 50(2), 573-597.
3. Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2018). 'Not girly, not sexy, not glamorous':

- primary school girls' and parents' constructions of science aspirations 1. In *Pedagogical Responses to the Changing Position of Girls and Young Women* (pp. 171-194). Routledge.
4. Atherton, M. (2015). Measuring confidence levels of male and female students in open access enabling courses. *Issues in Educational Research*, 25(2), 81-98.
 5. Ayazgök, B., & Yalçın, N. (2014). The investigation of the metacognitive awareness and the academic achievement about simple machine in 7th grade students in primary education. *Procedia-Social and Behavioral Sciences*, 141, 774-780.
 6. Baloyi, M. S., Muremela, M. G., Makhwanya, N. T., Kutame, A. P., Gamede, B. T., & Ajani, O. A. (2023). Challenges confronting rural physical science educators in enhancing Grade 12 Performance S* crossref. *International Journal of Research in Business and Social Science*, 12(9), 450-459.
 7. Bennett, J., Hogarth, S., Lubben, F., Campbell, B., & Robinson, A. (2010). Talking science: The research evidence on the use of small group discussions in science teaching. *International Journal of Science Education*, 32(1), 69-95.
 8. Biewen, M., & Schwerter, J. (2022). Does more maths and natural sciences in high school increase the share of female STEM workers? Evidence from a curriculum reform. *Applied Economics*, 54(16), 1889-1911.
 9. Bluhm, R. (2015). Feminist philosophy of science and neuroethics. In *Handbook of Neuroethics* (pp. 1405-1419). Springer, Dordrecht.
 10. Bottia, M. C., Stearns, E., Mickelson, R. A., Moller, S., & Parler, A. D. (2015). The relationships among high school STEM learning experiences and students' intent to declare and declaration of a STEM major in college. *Teachers College Record*, 117(3), 1-46.
 11. Chambers*, E. A., & Schreiber, J. B. (2004). Girls' academic achievement: varying associations of extracurricular activities. *Gender and education*, 16(3), 327-346.
 12. Chávez, K., & Mitchell, K. M. (2020). Exploring bias in student evaluations: Gender, race, and ethnicity. *PS: Political Science & Politics*, 53(2), 270-274.
 13. Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others?. *Psychological bulletin*, 143(1), 1.
 14. Christidou, V. (2011). Interest, Attitudes and Images Related to Science: Combining Students' Voices with the Voices of School Science, Teachers, and Popular Science. *International journal of environmental and science education*, 6(2), 141-159.

15. Clark Blickenstaff*, J. (2005). Women and science careers: leaky pipeline or gender filter?. *Gender and education*, 17(4), 369-386.
16. Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.
17. Davis, A. C. (2021). Resolving the tension between feminism and evolutionary psychology: An epistemological critique. *Evolutionary Behavioral Sciences*, 15(4), 368.
18. Falco, L. D., & Summers, J. J. (2019). Improving career decision self-efficacy and STEM self-efficacy in high school girls: Evaluation of an intervention. *Journal of Career Development*, 46(1), 62-76.
19. Galsanjigmed, E., & Sekiguchi, T. (2023). Challenges women experience in leadership careers: an integrative review. *Merits*, 3(2), 366-389.
20. Gerrard, D., & Variawa, C. (2018, June). Bridges and barriers: A multi-year study of workload-related learning experiences from diverse student and instructor perspectives in first-year engineering education. *American Society for Engineering Education*
21. 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.
22. Grunspan, D. Z., Eddy, S. L., Brownell, S. E., Wiggins, B. L., Crowe, A. J., & Goodreau, S. M. (2016). Males underestimate academic performance of their female peers in undergraduate biology classrooms. *PloS one*, 11(2), e0148405.
23. Guerrero, M. A., & Guerrero Puerta, L. (2023). Advancing gender equality in schools through inclusive physical education and teaching training: a systematic review. *Societies*, 13(3), 64.
24. Harding, S. G. (1986). *The science question in feminism*. Cornell University Press.
25. Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of research in science teaching*, 47(8), 978-1003.
26. Islam, K. M. M., & Asadullah, M. N. (2018). Gender stereotypes and education: A comparative content analysis of Malaysian, Indonesian, Pakistani and Bangladeshi school textbooks. *PloS one*, 13(1), e0190807.
27. Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science education*, 84(2), 180-192.
28. Kricorian, K., Seu, M., Lopez, D., Ureta, E., & Equils, O. (2020). Factors influencing participation of

- underrepresented students in STEM fields: matched mentors and mindsets. *International Journal of STEM Education*, 7, 1-9.
29. Liani, M. L., Nyamongo, I. K., & Tolhurst, R. (2020). Understanding intersecting gender inequities in academic scientific research career progression in sub-Saharan Africa.
 30. Msambwa, M. M., Daniel, K., Lianyu, C., & Fute, A. (2024). A systematic review of the factors affecting girls' participation in science, technology, engineering, and mathematics subjects. *Computer Applications in Engineering Education*, 32(2), e22707.
 31. Oladoyinbo, T. O., Olabanji, S. O., Olaniyi, O. O., Adebisi, O. O., Okunleye, O. J., & Ismaila Alao, A. (2024). Exploring the challenges of artificial intelligence in data integrity and its influence on social dynamics. *Asian Journal of Advanced Research and Reports*, 18(2), 1-23.
 32. Oliveira, G. M. M. D., Tenorio, M., & Siqueira, A. D. S. E. (Eds.). (2022). *Science Gender Gap: Are We in the Right Path?*. *International Journal of Cardiovascular Sciences*, 35(2), 148-151.
 33. Parry, B. (2020). Feminist research principles and practices. *Online readings in research methods*, 1-28.
 34. Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International journal of STEM education*, 5, 1-14.
 35. Roy, D. (2004). Feminist theory in science: Working toward a practical transformation. *Hypatia*, 19(1), 255-279.
 36. Rumfola, L. (2017). Positive reinforcement positively helps students in the classroom. Thesis, State University of New York. Retrieved on April, 15, 2019.
 37. Shirazi, S. (2017). Student experience of school science. *International journal of science education*, 39(14), 1891-1912.
 38. Thompson-Krug, M. E. (2014). The effects of authentic learning experiences on female students' perceptions of science and confidence in attaining a STEM career. Master of Science Education Dissertation, Montana University
 39. Spearman, J., & Watt, H. M. (2013). Perception shapes experience: The influence of actual and perceived classroom environment dimensions on girls' motivations for science. *Learning Environments Research*, 16, 217-238.
 40. Wade-James, K., King, N. S., & Schwartz, R. (2021). "You could like science and not be a science person": Black girls' negotiation of space and identity in science. *Science Education*, 105(5), 855-879.

41. Wang, Y., Li, J., Ou-Yang, X., Wan, M., Wang, Y., Zhang, G., & Yi, H. (2024). Bridging the gap: advancing gender equality in medical research. *Postgraduate Medical Journal*, qgae161.
42. Watkins, S. E., & Mensah, F. M. (2019). Peer support and STEM success for one African American female engineer. *Journal of Negro Education*, 88(2), 181-193.