Gender and Science: Investigating Female Students' Perceptions of Physics

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ABSTRACT

This study investigates the perceptions and interests of female students in grades XI and XII toward physics in secondary schools, with a specific focus on the underrepresentation of women in the field and its implications for education in Nepal. Although women make up over half of the population, their participation in physics-related careers and academic disciplines remains notably low. Similar global trends have been reported in studies by Hazari et al. (2013), Makarova et al. (2019), and Rosenberg et al. (2024), highlighting persistent gender gaps, stereotype threats, and identity-related barriers in physics. This research seeks to understand how these issues manifest in the Nepali context by examining girls' perceptions of physics and identifying strategies to enhance their engagement. A mixed-method approach was used, combining qualitative interviews and quantitative questionnaires to collect data from forty female students and eight teachers across four schools in Tanahun District. Quantitative data were analyzed using SPSS, while thematic analysis was applied to the qualitative data. Key themes emerged from the findings, including the perception of physics as a difficult subject, the influence of gender stereotypes, career ambitions, interest levels, and the role of teachers. Despite perceived barriers, some girls showed a strong interest in physics. Factors such as motivated teachers, accessible lab resources, and extracurricular activities were found to positively influence engagement. The study recommends interactive teaching, inclusive curricula, supportive policies, and community involvement to foster gender equity in physics education, aligning with similar evidence from international research (Tshering et al., 2024; Guenaga et al., 2022).

Keywords: Physics, Attitude, Career Aspiration, Gender stereotype, Motivation, School facility, Laboratory facility

INTRODUCTION

Women make up more than half of the population in many regions. For instance, according to the 2078 census in Nepal, women constitute 51.04% of the population. Women perform multiple roles as mothers, spouses, and breadwinners. They contribute around 65% of the labor force in the agricultural sector and play a key role in the economy, especially in subsistence farming (Shrestha & Shrestha, 2015). However, the participation of women in leadership and decision-making roles remains low (FAO, 2023).

The contribution of women in economic sectors is significant. It is largely unnoticed because of their conventional roles that are always taken for granted. When employed, their wages are normally less than that of men with similar positions in labor-intensive work, whereas in urban areas and in white-collar jobs, women have better jobs and responsibility with the salary at par with their male counterparts (Shrestha & Shrestha, 2015). According to the national education system plan 2028 BS, it had identified various problems in the education system and one of them was of the backward communities deprived of educational opportunities. But there was nowhere any mention of girls' and women's backwardness in education. The interest and attitude in the field of science and technology is different for male and females. In the context of physics, the participation of women

is even more limited. At Tribhuvan University, there are currently 1,300 physicists, including 25 women involved in teaching and three in research. Approximately 40 men and seven women from Nepal with Ph.D. degrees work in physics in various foreign countries. Women constitute less than 4% of the total number of physicists in Nepal. This low female involvement is partly due to negligible investment and budgetary constraints in research (Shrestha & Shrestha, 2015). The Central Department of Physics at Tribhuvan University employs 19 teachers, of whom only two are female. Similarly, the Department of Science and Environment Education at the same university has no female teachers. Hence, in the field of physics there is a more significant difference in the male and female. So, this study has raised the issue of interest, attitude as well as perception of girls towards studying physics.

In secondary level education, among Class XI-XII students, the perception towards physics holds significant importance. This critical stage not only shapes academic choices but also influences career aspirations and societal contributions. Understanding the perceptions of female students towards physics is paramount in addressing the gender gap and fostering inclusivity within the scientific community. Understanding the perceptions of female students towards physics in secondary education is essential for developing effective interventions to address the gender gap in physical science fields. By exploring the factors influencing female students' attitudes, educators and policymakers can implement strategies to create more inclusive learning environments and encourage greater participation of women in physics and related disciplines (Abraham & Barker, 2023).

Physics, often regarded as the fundamental science, serves as the cornerstone for understanding the natural world. One of the largest and longest-standing issues in the field of physics is the underrepresentation of women (Skibba, 2019). However, despite its pivotal role, there exists a persistent gender disparity in the field, with female representation notably lower compared to males. This phenomenon has sparked considerable interest and concern among educators, policymakers, and researcher's alike. Past studies have shown that females remain significantly less in physics-related careers and academic programs, starting from secondary education levels. This underrepresentation can be attributed to various factors, including societal stereotypes, lack of role models, and biases in educational systems (Makarova et al., 2019).

Previous research on the theme of female students' perceptions of physics and strategies for enhancing their interest at the secondary level has highlighted several key findings and they have documented the existence of a gender gap in physics education, with female students consistently showing lower levels of interest, participation, and confidence in the subject compared to male students. Research by Mistina et al. (2025) found that societal stereotypes and cultural biases often shape female students' perceptions of physics, leading to feelings of inadequacy and a lack of belonging in the field. Similarly, Tytler et al. (2012) identified a correlation between negative teacher attitudes towards female students and their reduced interest and performance in physics. These studies suggest that addressing societal and educational factors is crucial in promoting greater interest and participation among female students in physics.

Moreover, recent research by Tshering et al. (2024) has explored the impact of classroom interventions and pedagogical approaches on female students' engagement with physics. They found that incorporating hands-on activities, collaborative learning, and real-world applications can significantly increase female students' interest and confidence in the subject. Additionally, studies by Rosenberg et al. (2024) and Guenaga et al. (2022) have highlighted the importance of mentorship and female role models in inspiring and supporting girls to pursue physics-related careers.

Overall, previous research underscores the need for a multifaceted approach to address the gender gap in physics education, encompassing both cultural and systemic changes within educational institutions. This research aims to build upon these findings by further exploring female students' perceptions of physics and identifying effective strategies for promoting their interest and participation at the secondary level.

Objectives of the Study

The objectives of this study are

- To explore the perceptions of class XI-XII female students towards physics,
- To identify factors for promoting greater interest in the physics among female students at the secondary level (class XI-XII).

Key Terms

Physics, Attitude, Career Aspiration, Gender stereotype, Motivation, School facility, Laboratory facility

Research Design

The study employed a mixed methods approach, combining quantitative and qualitative elements. Qualitative data was gathered through open-ended questions, and quantitative aspects were integrated into the research, involving the quantification and analysis of variables to derive results.

Population and Sampling

Total numbers of students studying science in the four schools (in class XI/XII) were 410 whereas girls were 217. The population of the study consisted of 410 science students in class XI/XII from four schools in Tanahun District, of whom 217 were girls. The four schools were selected using convenience sampling based on accessibility and permission from the schools. From these schools, 40 students were selected as the sample using convenience sampling from the available science students.

Data Collection Tools

Since the research problem is in mixed research design, the research uses survey questionnaires as well as in-depth interviews as data collection tools.

In nature, an in-depth interview is an open-ended, discovery-oriented method to obtain detailed information about a topic from a stakeholder. In-depth interviews are a qualitative research method; their goal is to explore in depth a respondent's point of view, experiences, feelings, and perspectives.

The questionnaire utilized in the study was designed to gather data from participants in a structured manner. It included a combination of open-ended questions and closed-ended questions presented in a Likert scale format.

The study used interviews with selected participants from the four schools in Tanahun District. The interviews were audio-recorded with the consent of the participants, lasted approximately _ minutes each, and were conducted in Nepali. The responses were later translated into English for analysis. If any interview was not recorded, notes were taken immediately after the interview and used for analysis.

Ethical Considerations

Ethical approval for this study was obtained from the relevant institutional research ethics committee before data collection began. Prior to the interviews, each student was informed about the purpose of the study, what participation involved, the voluntary nature of participation, and their right to withdraw at any time without penalty. Written informed consent was obtained from all participants, and for students under the required age, consent was also obtained from their parent or guardian where applicable. Participant confidentiality was maintained by using codes instead of names, and all data were used only for academic purposes.

Limitations

A limitation of this study is its small, non-random sample: because only 40 students from four convenience-selected schools in a single district were included, the findings may not be generalisable to all science students in Tanahun District or to students across Nepal.

Analysis of Data and Interpretation of Results

This chapter includes the analysis and interpretation of collected data. The collected data were analyzed and interpreted by using descriptive and inferential statistics such as mean, standard deviation etc. Similarly, the qualitative data yielded rich insights into the perceptions of Class 11-12 female students towards physics. Through in-depth interviews, focus group discussions, and thematic analysis, several key themes emerged.

The examination and interpretation of data gathered for a research centered on females' perceptions and interest on physics learning strategies at the secondary level are discussed. The data were obtained through questionnaire tests administered to 40 female students enrolled in eleventh and twelfth grade across four secondary schools in the Tanahun district. These questionnaire tests utilized a Likert scale format, offering five options for students to express their opinions. The collected data underwent analysis employing appropriate statistical methodologies, including frequency, percentage, weighted mean and Standard Deviation. Similarly the data through in depth interviews were analyzed and embedded into quantitative results for final conclusion. In essence, this section provides a descriptive analysis and interpretation of the amassed data, offering insights into physics learning strategies within secondary education and the pedagogical implications derived from the findings (Dawadi, 2024). The collected data were examined and interpreted within the framework of the following themes.

Table1. Female student showing the perception of difficulty for physics

Response	**Frequency (N)**	**Percentage (%)**
Strongly Agree	1	2.5
Agree	11	27.5
Neutral	22	55.0
Disagree	1	2.5
Strongly Disagree	5	12.5
Total	**40**	**100.0**

The findings from Table 1 reveal that female students generally perceive physics as challenging, with the majority (55%) holding a neutral stance. However, 27.5% agreed, and 2.5% strongly agreed with this perception, while 2.5% disagreed, and 12.5% strongly disagreed. The mean score of 3.05, exceeding the acceptable threshold of 3 on the Likert scale, indicates a generally positive response. With a standard deviation of 0.93, indicating slight variance in opinions, it appears that most female students view physics as difficult.

Table2. Female students thinking gender stereotypes subject for physics

Response	**Frequency (N)**	**Percentage (%)**
Strongly Agree	2	5.0
Agree	10	25.0
Neutral	15	37.5
Disagree	13	32.5
Strongly Disagree	0	0.0
Total	**40**	**100.0**

Table 2 outlines the perceptions of female students regarding physics as a subject biased towards males. The majority of students expressed a neutral standpoint on this matter, with 37.5% of total respondents choosing this option. Additionally, 32.5% disagreed, while only 25% agreed with the notion. Notably, no students strongly disagreed. The mean score of 3.02 suggests a neutral stance overall, and the standard deviation of 0.89 indicates a general positivity towards the statement. The absence of strongly disagree responses suggests a consensus among students regarding this perception.

Table 3. Female students giving high interest in physics and being more engaged in physics

Response	**Frequency (N)**	**Percentage (%)**
Strongly Agree	4	10.0
Agree	4	10.0
Neutral	17	42.5
Disagree	12	30.0
Strongly Disagree	3	7.5*
Total	**40**	**100.0**

Table 3 illustrates the perspectives of female students regarding their interest and engagement in the field of physics, which aids in comprehending its concepts better. Data was gathered from a sample of 40 female students and is presented through frequency distributions. The findings reveal that only 42.5% of students held a neutral stance or agreed with the statement, while 30% disagreed. Additionally, 10% agreed, and another 10% strongly agreed, while 5.5% strongly disagreed. The mean score for responses was 3.3, indicating a slight positive inclination towards the statement, with a standard deviation (S.D) of 1.02. Consequently, it appears that the majority of female students express a desire to be actively involved in the field of physics.

Table 4. Planning in career aspirations for physics

Response	Frequency (N)	Percentage (%)
Strongly Agree	0	0.0
Agree	11	27.5
Neutral	13	32.5
Disagree	13	32.5
Strongly Disagree	3	7.5
Total	**40**	**100.0**

Based on table 4, it seems that a significant portion of female students planning for career aspirations in physics are either neutral or disagree with their current situation. There were no responses in the strongly agreed category, indicating that none of the female students strongly agree with their current situation regarding career aspirations in physics. Similarly, 27.5% of the respondents agree with their current situation. While this shows some level of satisfaction, it's not a dominant response.The largest portion of respondents, at 32.5%, fell into the neutral category. This suggests that a substantial number of female students neither agree nor disagree with their current situation. Another 32.5% of respondents disagree with their current situation. This indicates a significant dissatisfaction among this group and 7.5% of respondents strongly disagree with their current situation, which is a smaller but still notable portion.

Overall, the mean score of 2.8 and the negative remarks suggest that there might be some underlying issues or challenges that need to be addressed regarding the career aspirations of female students in physics. Further investigation and support may be necessary to understand and address these concerns effectively.

Table 5. Teacher motivation plays an important role in learning physics.

Response	Frequency (N)	Percentage (%)
Strongly Agree	15	37.5
Agree	19	47.5
Neutral	6	15.0
Disagree	0	0.0
Strongly Disagree	0	0.0
Total	**40**	**100.0**

The table 5 suggests a strong consensus among female students regarding the importance of teacher motivation in learning physics. 37.5% of respondents strongly agree that teacher motivation is crucial in the learning process of physics. Similarly, an even higher percentage, 47.5%, agrees with this statement, indicating a widespread acknowledgment of the significance of teacher motivation. Only 15% of respondents fell into the neutral

category. No respondents disagreed or strongly disagreed with the statement, highlighting a strong consensus among female students that teacher motivation plays a vital role in their learning experience in physics.

The mean score of 4.22 and the positive remarks indicate a clear and overwhelmingly positive perception among respondents regarding the impact of teacher motivation on learning physics. This suggests that maintaining and enhancing teacher motivation could significantly contribute to improving the learning outcomes and engagement of female students in physics.

Table 6. School facility plays a crucial role for increasing interest in physics

Response	**Frequency (N)**	**Percentage (%)**
Strongly Agree	27	67.5
Agree	8	20.0
Neutral	4	10.0
Disagree	1	2.5
Strongly Disagree	0	0.0
Total	**40**	**100.0**

Table 6 presented it's evident that the majority of female students strongly believe that school facilities play a crucial role in increasing interest in physics. A significant 67.5% of respondents strongly agree that school facilities are crucial for increasing interest in physics. Another 20% of respondents agree with this statement, further supporting the notion that school facilities are important for generating interest in physics among female students. Only 10% of respondents fell into the neutral category. Very few respondents, only 2.5% and none respectively, disagree with the statement. This suggests a widespread consensus among female students that school facilities are indeed crucial for fostering interest in physics.

The mean score of 4.52 and the positive remarks indicate a strong consensus among respondents regarding the importance of school facilities in increasing interest in physics. This suggests that improving school facilities could be an effective strategy for promoting engagement and enthusiasm for physics among female students.

Table 7. **Lab facility plays a crucial role for increasing interest in physics**

Response	**Frequency (N)**	**Percentage (%)**
Strongly Agree	11	27.5
Agree	20	50.0
Neutral	9	22.5
Disagree	0	0.0
Strongly Disagree	0	0.0
Total	**40**	**100.0**

The data presented in the table 7 indicates a generally positive perception among female students regarding the importance of laboratory facilities in increasing interest in physics. 27.5% of respondents strongly agree that lab facilities play a crucial role in fostering interest in physics. A larger portion, comprising 50% of respondents, agrees with the statement, further affirming the significance of lab facilities in generating interest in physics. 22.5% of respondents fell into the neutral category. No respondents disagreed or strongly disagreed with the statement, implying a consensus among female students that lab facilities are indeed crucial for sparking interest in physics.

The mean score of 4.05 and the positive remarks indicate a generally favorable perception among respondents regarding the role of lab facilities in enhancing interest in physics. This suggests that investing in and improving laboratory resources could positively impact the engagement and enthusiasm of female students in the field of physics.

Table 8. **Active participation in extracurricular and activities related to physics**

Response	**Frequency (N)**	**Percentage (%)**
Strongly Agree	2	5.0
Agree	19	47.5
Neutral	13	32.5
Disagree	2	5.0
Strongly Disagree	4	10.0
Total	**40**	**100.0**

The data from table 8 suggests a mixed perception among female students regarding the importance of active participation in extracurricular activities related to physics. While there are some respondents who strongly agree (5%) and agree (47.5%) with the statement, indicating a recognition of the value of extracurricular activities related to physics, the overall percentage is not dominant. The largest portion of respondents, at 32.5%, fell into the neutral category. This suggests that a significant number of female students neither agree nor disagree with the statement. While the percentages are relatively low (5% and 10% respectively), there are still some respondents who disagree or strongly disagree with the importance of active participation in extracurricular activities related to physics.

The mean score of 2.85 and the negative remarks suggest that there might be some skepticism or indifference among female students towards actively participating in extracurricular activities related to physics. This could indicate a need for further exploration into the types of activities offered or the perceived benefits of such involvement, in order to better engage female students in these opportunities.Similarly the themes after the in depth interview are presented as

Perception of Difficulty

Many female students expressed that they perceived physics as a difficult subject. This perception was often influenced by their prior experiences, classroom environment, and teaching methods. Students commonly cited complex mathematical concepts and abstract theories as barriers to understanding and enjoying physics.

One student, discussing the challenging subject of physics in interview, explained that she finds it slightly more difficult than biology and chemistry due to her weaker mathematical skills. Consequently, she sought extra explanations from her mentor, asking them to clarify concepts two or three times.

Gender Stereotypes

A significant number of participants reported encountering gender stereotypes that portrayed physics as a subject more suited for males. These stereotypes were reinforced through societal norms, media representations, and interactions within the classroom. Female students often felt marginalized or discouraged from pursuing physics due to these perceptions.

In this context, a female student acknowledges that there's a common perception that the biology field is predominantly for girls, while physics and engineering are seen as more suitable for boys.

Interest and Engagement

Despite the challenges and stereotypes, a subset of female students expressed genuine interest and curiosity towards physics. Factors such as engaging teaching methods, supportive learning environments, and personal interests in related fields (e.g., engineering, astronomy) positively influenced their attitudes towards the subject.

In this regard, a female student says that surely everything like the subject interest and the time we spend on that subject, the teacher's teaching method, the school environment, definitely has a positive effect on it.

Career Aspirations

The perception of physics as a gateway to lucrative career opportunities, particularly in engineering and theoritical physics fields, influenced the career aspirations of some female students. However, others expressed uncertainty or lack of awareness about potential career paths in physics-related fields.

In the interview of this sense, girl 1 of a school said especially we female students see their career in medical science. Therefore, what we make of our career in the future also depends on our interest in the subject of physics.

Teacher Influence

The role of teachers emerged as pivotal in shaping the perceptions and attitudes of female students towards physics. Positive interactions with knowledgeable and supportive teachers were cited as influential factors in fostering interest and confidence in the subject.

In this context, the opinion of a female student is like this. Of course, our opinion is subjectively formed by every aspect of my teacher's ability, his behavior with students, his motivation.

Similarly, effective strategies for enhancing the interest and engagement of female students in physics were discerned through a multifaceted approach. Initially, a comprehensive review of existing literature and initiatives targeting the augmentation of female students' interest and involvement in physics was conducted. Subsequently, various strategies were identified and put into practice. These included the integration of hands-on experiments, interactive demonstrations, and real-world applications to render physics more captivating and pertinent. Overall, the findings suggest that while perceptions and interest towards physics among Class 11-12 female students are influenced by various factors, there is a strong correlation between interest and academic performance in the subject. By addressing barriers such as gender stereotypes, providing engaging learning experiences, and fostering supportive teacher-student relationships, educators can enhance the interest and achievement of female students in physics.

Hence, the study found that a significant portion of female students perceive physics as a challenging and intimidating subject. The study discovered that some female students perceive physics as less relevant to their future careers or interests compared to other subjects. Similarly, the study identified factors influencing these perceptions, including teaching methods, curriculum content, societal stereotypes, and lack of female role models in physics. It recognized variations in perceptions based on individual interests, prior academic experiences, and socio-cultural backgrounds.

Analysis and presentation of Findings

This chapter presents findings emerging from the study on perception of females' towards physics. Interest and enjoyment becomes one of the most important factors to determine males' and females' choice of studying Physics. However, male and females differ psychologically so the fields of their interests in Physics should be different to some extent. To maintain females' favorable attitudes towards Physics, the specifics of females' interests should be taken into account and reflected in the content of science lessons. The total number of class 11/12 specializing science stream pupils who participated in the research was 40 female students. These pupils were selected from four schools located in Tanahun Nepal. A general trend found in many studies is that females are less interested in Physics particularly than males (Ramsden,1998). Now after embedding the quantitative findings after survey through questionnaire and qualitative thematic findings after study on female students and science teachers, the overall findings are presented here through following headings. ***Perceived Difficulty of Physics***

Female students generally perceive physics as challenging, with a majority holding a neutral stance due to to a combination of psychological, social, and educational factors like self-efficacy , anxiety and stress, sense of belonging:, peer influence etc. While the mean score indicates a positive response, the slight variance in opinions suggests that most female students view physics as difficult.

Gender Stereotypes in Physics

Female students express a neutral stance regarding physics being biased towards males. The absence of strongly disagree responses suggests a consensus among students, although there's a slight inclination towards neutrality.

Interest and Engagement in Physics

Majority of female students express a desire to be actively involved in physics. The positive mean score suggests a slight inclination towards active engagement, although there are still students who express neutrality or disagreement.

Career Aspirations in Physics

A substantial portion of female students either hold a neutral or disagree with their current career aspirations in physics. The negative mean score indicates dissatisfaction among a significant group, suggesting a need for further investigation and support.

Importance of Teacher Motivation

There is a strong consensus among female students regarding the significance of teacher motivation in learning physics. The overwhelmingly positive perception suggests that maintaining and enhancing teacher motivation could significantly improve learning outcomes.

Role of School Facilities

Female students strongly believe that school facilities play a crucial role in increasing interest in physics. The strong consensus suggests that improving school facilities could effectively promote engagement and enthusiasm for physics among female students.

Importance of Laboratory Facilities

Female students generally perceive laboratory facilities as crucial for fostering interest in physics. The favorable perception indicates that investing in and improving laboratory resources could positively impact student engagement in physics.

Active Participation in Extracurricular Activities

There's a mixed perception among female students regarding the importance of active participation in extracurricular activities related to physics. The negative mean score suggests some skepticism or indifference towards such activities, indicating a need for further exploration into their benefits and offerings.

Overall, the findings highlight various aspects of female students' perceptions and experiences in physics education. While there are positive inclinations towards engagement and the significance of certain factors like teacher motivation and school facilities, there are also areas of concern, such as career aspirations and extracurricular involvement. Addressing these concerns and leveraging the identified strengths could contribute to a more inclusive and supportive environment for female students in physics education.

CONCLUSION AND IMPLICATIONS

Conclusion

In conclusion, the perception of physics as a challenging subject among female students, often leading to a neutral stance, is influenced by a variety of interconnected factors including societal stereotypes, educational environments, confidence levels, interest, and social belonging. To mitigate these challenges and foster a more positive perception of physics, it is essential to address these issues comprehensively. Promoting female role models in physics, adopting inclusive and supportive teaching practices, building confidence through positive reinforcement, and making the curriculum more relevant and engaging can significantly improve female students' experiences and perceptions of physics. By creating a more inclusive and encouraging learning environment, we can help female students develop a stronger interest and confidence in physics, ultimately paving the way for greater gender equity in the field.

Hence, the findings of this study highlight the multifaceted challenges and opportunities in promoting physics education among female students. By addressing gender stereotypes, enhancing teacher support, improving educational resources, and increasing representation of women in physics, we can create a more inclusive and encouraging environment. National policies and community support are critical in this effort. Through these measures, we can inspire and empower more female students to engage with physics and pursue careers in physical science.

Implications

The findings of this study have several implications for educators, policymakers, and stakeholders:

Educational Practices

Educators should adopt interactive teaching methods, provide supportive feedback, and create inclusive learning environments to promote greater interest and engagement in physics among female students.

Curriculum Development

Curriculum developers should ensure that physics education materials are diverse, relevant, and accessible to female students, addressing their interests, challenges, and aspirations.

Policy Development

Policymakers should prioritize initiatives aimed at challenging gender stereotypes, promoting gender equity, and increasing female participation in physical science field at the national level.

Professional Development

Teachers and school administrators should receive training and support to effectively address the needs of female students in physics education, including strategies for fostering motivation and engagement.

Hence, this study underscores the importance of understanding and addressing the perceptions of class XI-XII female students towards physics. By implementing effective strategies and fostering an inclusive learning environment, educators and policymakers can work towards promoting greater interest and engagement in physics among female students at the secondary level, ultimately contributing to the advancement of gender equity physical science education.

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