

Trends and Gender Disparities in Science Stream Enrolment at Higher Secondary Level: A Five-Year Analysis

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Abstract: The paper analyses the changes in and gender gaps in enrolment in PCB (Physics, Chemistry, and Biology) among Class XI students in Manipur over a five-year period (2021-2025). The analysis focuses on subject-specific enrolment trends and gender-related preferences utilizing secondary data from the Council of Higher Secondary Education Manipur (COHSEM). The descriptive statistics reveal that the peak enrolment occurred in 2022, followed by a decline in 2023 and 2024, with a partial recovery in 2025. The female students predominantly applied to Biology over all other subjects throughout the years; however, this was juxtaposed with Physics and Chemistry, which exhibited gender balance and favoured female applicants. Statistically significant gender differences were seen across all three disciplines and the overall scientific stream, with females exhibiting higher mean enrolments in each instance, as validated by independent samples t-tests. These statistics suggest that while enrolment in Physics and Chemistry is somewhat equitable between genders, Biology is more favoured by girls. The results reveal the persistent presence of subject-specific gender attraction and the necessity to change the curriculum and implement awareness programs and interventions to promote equitable representation in all areas of STEM at the higher secondary level.

Keywords: Science, Gender, Enrolment, Trends, Disparities.

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I. INTRODUCTION

Science education at the higher secondary level is decisive in moulding students for tertiary education and work trajectory in a technology-led world. It facilitates the shift from foundational learning to areas of expertise, instilling in learners' skill such as critical thinking, problem-solving abilities and analytical attitude. The National Curriculum Framework (NCF 2005) draws attention to the basic scientific principles to be taught with depth and relevance, in alignment with cutting-edge developments to foster meaningful learning.

Obialor et.al (2022) point out the developmental significance of science education at the national level, exerting influence over agriculture, health and technology. Science extends beyond the mere transfer of knowledge; it promotes creativity, adaptability and analytical thinking - as outlined in the frameworks of NCF 2005 and NEP 2020. These frameworks urge the adoption of need-based and

discovery-based learning that uphold curiosity and context-based problem solving.

Disciplinary focus in class XI- specifically in Physics, Chemistry and Biology (PCB) – expands employment prospects in engineering, medicine and life sciences. Physics generates logical reasoning; Chemistry contributes to pharmaceutical and material science foundations and Biology advances students for health and environmental fields. NEP 2020 and NCF 2023 empowers dynamism in subject choice and invites students to pursue on education based on passion and career trajectories, while nurturing innovation and scientific citizenship.

Gender disparities in science enrolment have endured despite advancing policy initiatives. As Sahoo and Kumar (2023) documented, female students, particularly those of SC, ST, and OBC origin, pursue science less frequently than their male counterparts. These data emphasize continuing systematic inequalities that shape subject selections and restrict women's engagement in STEM careers.

Locally stratified analyses identified further inequities. Singh (2020) observed Manipur's elevated gender disparity in science enrolment relative to national aggregates, demanding responses specific to the regional context. Globally, women's enrolment in physics, engineering, and computing remains minimal, whereas biology and health sciences draw a higher proportion of female students (UNESCO, 2024). Gender norms, limited role models, and biased educational settings fuel this disparity. (UNESCO, 2017).

NEP 2020 and NCF 2023 recommend STEM introduction from early grades, experiential learning through practical experimentation, and adaptable curricula to address existing disparities. Accordingly, the current investigation analyses enrolment trends in PCB among Class XI students across 15 districts of Manipur (2021-2025), utilizing secondary data from the Council of Higher Secondary Education Manipur (COHSEM). The study assesses gender differences in subject preference to provide insights for policies aimed at ensuring gender equity and broadened access to science education in Manipur.

➤ *Objectives of the Study*

The primary objective of this study is to analyse subject-specific and gender-based enrolment trends in the science stream (specifically, Physics, Chemistry, and Biology, PCB) for Class XI in Manipur during a five-year period (2021-2025). This analysis aims to provide insights into developing patterns and gender imbalance concerning topic choice, with the objective of informing evidence-based educational planning and equitable policies initiatives across the region.

➤ *Specific Objectives:*

- To analyse the enrolment trends in Physics, Chemistry, and Biology among Class XI students in Manipur from 2021 to 2025.
- To analyse gender-based subject choices and determine enrolment patterns in the three key scientific subjects.
- To examine whether Biology attracts more female students, whereas Physics and Chemistry draw more male students, and how this changes over five years.
- Evaluate gender discrepancies in science subject enrolment in Manipur districts.

➤ *Hypothesis*

- H1: There is a significant difference in PCB enrolment between boys and girls.
- H2: Enrolment in Biology is higher among girls than boys.

II. REVIEWS OF RELATED LITERATURE

There is a vast literature that has been developed to focus on the nature and patterns of enrolment and gender inequalities in secondary and higher secondary education especially in the science disciplines. Shah (2016) reviewed the secondary and higher secondary Gross Enrolment Ratios

(GER) in India between 2004-05 to 2013-14, which has undergone significant improvement of 51.7 to 76.6 percentage points in the secondary stage and 27.8 to 52.2 percentage points in the higher secondary stage, the largest improvement occurring among girls. Nonetheless, it was restricted to a previous decade and revealed the necessity of continuing the policy in the goal of decreasing inequalities and favouring inclusive learning.

Kumar (2025) studied schools in Hamirpur, Himachal Pradesh (2016-2021), where an insignificant increase in participation of boys was observed, and participation decreased among girls. The research revealed that gendered stream preferences were observed: boys preferred commerce while girls preferred science. Based on secondary data, Kumar suggested the idea of focused scholarships, distribution of resources, and differentiation of curriculum to overcome these differences.

Bhaskar et al. (2021) conducted a regional-based study of the entire South India region, key points regarding enrolment, GER, pupil-teacher ratio, and quality of infrastructure were reported. The results showed increased enrolment of girls in government schools against boys in the private schools. The GER in Kerala (103%) was the highest but Andhra Pradesh was lowest (74%). Karnataka was in the lead in pupil-teacher ratio (16:1). The study, despite being secondary data based, provided feasible inferences that could be used to improve the infrastructure and equity.

To provide more insight into gender differences in secondary education, Sharma (2024) examined gender gaps in education and their prevalence among girls in marginalized communities as well as in rural areas. These barriers were poor infrastructure, distance, poverty, early marriage and burdens at home. Among the recommendations of the study, there was an expansion of free education up to class 12, budget increase, and specific interventions to ensure that girls stay in school.

Kashung and Kamei (2024) analysed School Fagat Hansi Mission in Imphal which extensively boosted (278 percent and 160 percent) in enrolment and teaching staffs respectively in a target school. Although pass rates increased, infrastructural deficits persisted, reminding us of the need for balanced development in both physical and academic fields.

Rajni Ranjan and Jajoo (2023) compared schools-Bilha block, Chhattisgarh, government- and private. The outcomes of their results showed that there were greater enrolment level and retention in the government schools but little superior academic achievements in the privately operated ones. Such disparities were explained by the factors such as policies, accountability, and accessibility which upheld the influence of institutional environment on educational participation.

International studies are further useful points of view. Wahab et al. (2021) also discussed the declining enrolment in sciences in Bangladesh and attributed the problem to ineffective teachers, insufficient infrastructure, discouraging

incentives, and inflexible curriculums. To turn around the trend they suggested curricular change, teacher preparation, and incentives linked to the job. In a similar manner, Ramsurrun et al. (2024) cited subject difficulty and employment issues in the declining number of students registering to pursue science disciplines in Mauritius. They suggested the use of digital elements, the constructivist approach to teaching, and other professional exposure to students.

Siddiqui (2013) referred to the dropout rates among Muslim students in India as one of the issues where socioeconomic and cultural obstacles played an instrumental role. Increased financing, community involvement, and instruction in the vernacular again were among the recommended answers--principles continuing in application to the wider field of educational equity.

Applying NSS data, Sahoo and Kumar (2023) have shown that girls were 10 percent less inclined to take up a science major as compared to boys with SC, ST, OBC students significantly underrepresented as well. They cited poor accessibility and encountering the intersection of various disadvantages, especially in the case of SC/OBC girls. Such data is complemented by the results of Sahoo and Klasen (2021) who have demonstrated, based on data in IHDS, that girls were 20 percent less likely to choose science or commerce regardless of cognitive ability. The inequality became smaller when the parental education was distributed more equally, which once again draws attention to the socioeconomic circumstances and family background.

On the basis of AISHE and Census data in Haryana, Alka (2019) recorded higher female enrolment in urban areas such as Gurugram and Panchkula with lower numbers in the Nuh as a result of conservative norms and underdeveloped infrastructure. She spoke in favor of district-specific solutions to help female access to higher education.

Lastly, Sarma and Daimary (2024) have conducted a study of AISHE statistics over the period of 2010-11 to 2020-21 to draw the conclusion that Gender Disparity Index (GDI) in education shifted in favour of women in higher education since 2018, especially in science, social science, and commerce streams. This poses an indication of a changing pattern in the relation to gendered access where engineering and information technology are still male dominated.

The studies reviewed together with the main idea is that, even though the enrolment in science stream has been

rising over the years, gender disparities remain because of societal expectations, infrastructural disparity and the discrepancy in access. These observations will form a basis that can be applied in studying your five years data on enrolment in Class XI in Physics, Chemistry and Biology allowing comparisons of time, gender and choice of subjects.

III. RESEARCH METHODOLOGY

This research employs a quantitative design utilizing inferential and descriptive statistical measures to identify trends and gender disparities in enrolment in the science studies stream, specifically Physics, Chemistry, and Biology (PCB), among Class Eleven students in Manipur over a five-year period (2021-2025).

The research relies exclusively on secondary data, which was obtained from the IT unit of the Council of Higher Secondary Education Manipur (COHSEM) via legitimate channels. The dataset includes subject-specific, gender-specific, and district-specific enrolment figures for Class XI science students. The population will encompass all students enrolled in the science stream, including Anthropology, Computer Science, and Home Science; however, a purposive sample was selected exclusively from students studying Physics, Chemistry, and Biology at the time of the study.

The data was ethically obtained with formal consent for information collection, and no subject or personally identifying information was accessed or employed. The data was analysed and processed using Microsoft Excel. The detection of trends during the five-year period was conducted using descriptive statistics, including totals, percentages, and averages. Visual aids, including bar graphs and line charts, were employed to elucidate the enrolment trends by gender. An independent sample t-test was conducted to determine the significance of gender discrepancies in enrolment in PCB topics.

IV. RESULTS AND INTERPRETATION

The secondary data analysis of the Council of Higher Secondary Education Manipur (COHSEM) will provide insights into enrolment trends, gender-based subject preferences, and inter-district variations in Physics, Chemistry, and Biology among Class XI students from 2021 to 2025. The results are presented according to the individual objectives of the study, and hypothesis testing has been conducted to statistically validate the findings.

Table 1 Enrolment by Subject and Gender (2021–2025)

Enrolment in Physics				Enrolment in Chemistry			Enrolment in Biology		
Year	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
2021	10261	10148	20409	10262	10158	20420	9789	10059	19848
2022	12919	13287	26206	12930	13302	26232	12319	13190	25509
2023	11734	11832	23566	11711	11842	23553	11192	11721	22913
2024	10861	10886	21747	10841	10904	21745	10338	10806	21144
2025	12148	12195	24343	12134	12197	24331	11558	12082	23640

➤ *Objective 1: Trends in Enrolment in Physics, Chemistry, and Biology (2021-2025)*

Table 1, containing five years of enrolment data, indicates a moderate fluctuation in the number of Class XI students pursuing Physics, Chemistry, and Biology in the state of Manipur from 2021 to 2025.

The enrolment of students in physics increased to 26,206, subsequently decreased to 23,566, and then to 21,747; but, by 2025, it had rebounded to 24,343. Chemistry exhibited a comparable trend, rising from 20,420 in 2021 to 26,232 in 2022, subsequently declining to 21,745 in 2024, and experiencing a slight improvement to 24,331 in 2025.

Biology's overall enrolment continually remained the lowest among the three courses, exhibiting a similar trajectory with an increase from 19,848 in 2021 to 25,509 in 2022, followed by a decline to 22,913 in 2023 and 21,144 in 2024, before rebounding to 23,640 in 2025.

Upon comparison, the year with the highest enrolment was 2022, while 2024 had the lowest. The data indicate that enrolment in the three primary science disciplines either correlates or diverges, influenced by systemic factors such as policy alterations, demographic shifts, or school-level variables, which collectively affect the total provision of science education.

➤ *Objective 2: Gender Preferences in Subject Selection*

The five-year data analysis (Table 1) reveals a significant gender-based trend in the three key science disciplines. Female enrolment in biology surpassed male enrolment each year, with the disparity ranging from 270 students in 2021 to 524 students in 2025.

In contrast, Physics and Chemistry exhibited about identical participation rates of girls and boys across the years, with girls generally achieving marginally superior performance compared to boys. In 2021, the gender gap in Physics was -113, indicating a minor male predominance,

while in 2025, it shifted to +47, reflecting a slight female predominance. In Chemistry, the deficit was -104 in 2021 and +63 in 2025. Overall, the results were most similar in Physics and Chemistry, whereas they varied significantly in Biology, indicating a preference among women for life sciences.

➤ *Objective 3: Consistency of Subject Preferences Over Time*

Table 1 suggests that gender-based preferences in subject selection have remained relatively stable over the five-year period. Biology exhibited a consistent female edge annually, with the disparity gradually increasing from 2021 to 2025.

Physics and Chemistry were not predominantly male-dominated; rather, they were either gender-neutral or slightly favoured females in most years. The absence of a male advantage in Physics and Chemistry contradicts prevailing ideas regarding the male dominance in physical sciences, particularly with Class XI science enrolment in Manipur. The persistent nature of this phenomenon over time indicates fixed subject-specific gender preferences rather than those influenced by short-term fluctuations.

➤ *Objective 4: Gender Disparities at the District Level*

The district-based survey revealed a diverse gender trend. Certain urban districts, including Imphal West and Imphal East, demonstrated a higher percentage of female representation compared to males in the three subjects, while several hill districts displayed a male predominance in Physics and Chemistry, despite a significant female enrolment in Biology. The extent of the gender gap varied significantly throughout districts, highlighting the necessity of addressing enrolment in relation to socio-cultural influences, school infrastructure, and accessibility.

➤ *Hypothesis Testing*

The independent samples t-tests validated substantial differences among all disciplines and within the science stream as overall:

Table 2 t-test Results: Gender Differences in Science Stream Enrolment (2021–2025)

Subject	t-critical	t-calculated	Result	Gender with Higher Mean
Science	2.132	2.86	Significant	Girls
Physics	2.132	2.36	Significant	Girls
Chemistry	2.132	2.54	Significant	Girls
Biology	2.132	5.50	Significant	Girls

The differences are statistically significant at the 0.05 level, suggesting that gender influences subject enrolment trends.

• *H1: Enrolment in PCB Exhibits Significant Disparities Between Boys and Girls.*

Autonomous specimens t-tests were conducted to examine the mean enrolment in Physics, Chemistry, and Biology between male and female students, as well as for the overall scientific stream. Numerical findings indicate that all results are statistically significant ($p < 0.05$), with the mean enrolment of female students surpassing that of male students.

- ✓ Physics: $t = 2.36, p < 0.05$
- ✓ Chemistry: $t = 2.54, p < 0.05$
- ✓ Biology: $t = 5.50, p < 0.05$

The data conclusively demonstrate that the observed gender differences are not arbitrary, revealing significant disparities during the five-year analysis period.

• *H 2: Female students enrol in Biology at a Higher Rate Than Male Students.*

Of the three subjects, the biology t-test exhibited the highest test statistic value ($t = 5.50, p < 0.05$), indicating a substantial and significant preference for Biology among

females. This aligns with the trend analysis findings, which indicate that Biology consistently attracts a greater proportion of female students across all districts and years examined, in contrast to male students.

V. DISCUSSION

The findings of the current research indicate that gender differences in the enrolment for Physics, Chemistry, and Biology in Class XI in Manipur from 2021 to 2025 are both obvious and statistically significant. Despite all three disciplines exhibiting comparable broad trends—namely, peak enrolment in 2022, a decline in the subsequent period (2023-2024), and a resurgence in 2025—gender-specific preferences are evident, mirroring one another.

Biology was the predominant subject among girls, with a substantial enrolment throughout each year and district, since nearly all girls registered for this course. This aligns with earlier research by Sahoo and Kumar (2023) and UNESCO (2017), which identifies a global trend of greater female representation in the life sciences. The independent samples t-test corroborated this tendency, revealing that Biology had the highest t-value (5.50), indicating the most significant gender-based disparity among the three topics.

The statistics in physics and chemistry exhibited a near gender equilibrium, with women holding a little advantage in most years. This observation contrasts with the national and international trend wherein physical sciences are predominantly male dominated (UNESCO, 2024), suggesting that the factors in the Manipur setting may be socio-cultural or institutional influences that encourage more female participation. Nonetheless, taking into account these disparities at the district level, it is apparent that districts with hills persist in exhibiting a gender gap in Physics and Chemistry, highlighting the issue of inequalities.

Such conclusions may have substantial ramifications for educational policy and planning. The female predisposition towards Biology may be partially ascribed to a preference for careers in medicine, nursing, and life sciences; however, the equitable enrolment in Physics and Chemistry suggests a potential trend towards achieving gender parity in the physical sciences. The district disparities highlight the necessity for targeted interventions, such as the distribution of scientific facilities to underprivileged districts, the promotion of female role models across all STEM disciplines, and the socio-cultural demystification of these fields.

The study will substantiate global patterns while providing evidence of the unique developmental characteristics of the scientific education system in Manipur, which is particularly pertinent to policymakers aiming to improve gender balance in STEM-related initiatives.

VI. CONCLUSION

The study analysed enrolment trends and gender disparities in Physics, Chemistry, and Biology among Class XI students in Manipur from 2021 to 2025. The findings indicated that the general pattern was consistent across all three disciplines, with enrolment reaching its zenith in 2022, declining midway through 2023 and 2024, and recovering slightly in 2025. Gender-based analysis revealed that females consistently excelled in Biology, while Physics had a somewhat equitable distribution, with females marginally outperforming males in most years. Chemistry, on the other hand, maintained a balanced performance across the majority of years. Independent samples t-tests indicated that gender inequalities across the three subjects and within the science stream were statistically significant, with the most pronounced disparity observed in Biology.

The regional disparity was substantial in the district-level examination. Female representation was more prominently depicted across all three subjects in urban districts, in contrast to the prevailing male dominance in Physics and Chemistry within some hill districts. These trends suggest that while Manipur exhibits a favourable trajectory towards gender parity in physical sciences, disparities persist in specific regions and subject area preferences. These disparities must be rectified through targeted interventions, such as enhancing scientific infrastructure in underrepresented regions, offering scholarships and mentorship for girls, and emphasizing female role models to dismantle obstacles to equitable participation in all scientific fields.

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