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An Analysis of Gender and School-Type Differences in Secondary School Students' Attitudes Towards Learning Science in Longding District, Arunachal Pradesh

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Abstract

Background: People's views towards science learning are important for students' attitudes towards learning, their confidence, and their future study choices; however, district level data from hard-to-reach areas is limited. The aim of this study is to evaluate the level of students' attitudes towards science learning in Longding District, Arunachal Pradesh and identify differences between gender and school management. This study re-analyzed the aggregate data from a 2025-26 survey of 120 students in 8 schools using a different research framework. The sample included 60 male and 60 female students, and 60 students each from government and private schools. The instrument to measure attitudes towards science learning consisted of 20 statements, and was scored on a Likert scale from 0 to 80. Using published group statistics, we reconstructed two-sided independent samples comparisons, standardized mean differences and 95% confidence intervals. For both comparisons, respondent-level observations were not available. The mean overall score was 41.80, placing it in the moderate category. The mean for females (42.21) was greater than males (41.38), but the difference was small (males minus females = -0.83; t (118) = -0.76; p = 0.449; d = -0.14). The mean for private (42.37) was greater than government (41.23), and the difference was small (government minus private = -1.14; t (118) = -1.05; p = 0.297; d = -0.19). Neither comparison allowed us to reject the null hypothesis at the 5% level. Because of school clustering and missing microdata, strong claims about group differences were not justified.

Keywords: *attitudes toward science; secondary education; gender differences; school management; Longding District; Arunachal Pradesh; descriptive survey*

1. Introduction

Science education, at the secondary level, requires students to interpret observations and analyze the bases of conclusions. It also requires students to formulate scientific explanations for understanding phenomena, and to use scientific concepts and knowledge to solve problems. The Indian National Education Policy (2020) places a premium on experiential and inquiry-based learning, while the National Curriculum Framework for School Education 2023, focuses on competency, conceptual understanding, meaningful learning, and the application of knowledge. These policies argue for the evaluation of affective outcomes, in addition to those assessed on the basis of exams. Such an approach would stimulate the integration of motivational and self-efficacy constructs in the study of school achievement, as highlighted by Basileo et al. (2024).

Learner attitudes toward science represent the learners' evaluation of the discipline as a school subject. It needs to be distinguished from 'scientific attitude', which refers to intellectual habits of openness to evidence, scepticism, and integrity. Enjoyment, perceived utility, and self-efficacy in science, and a positive science identity, are constructs that may be related to attitude, but are distinct measures. Mackenzie et al. (2024) highlighted the role of classroom conditions as a means to develop

the value and self-efficacy toward senior science, and the role of motivation and affective engagement as a means to higher self-efficacy and academic values. Self-efficacy was also shown to play a key role in connection of several motivational variables.

Equity in education can be defined and assessed in various ways. The categories most often considered are gender and type of school. However, the impact of these categories is often uncertain and may not be causal. For instance, Iwuanyanwu (2022) noted differences in attitudes among Grade 9 students along lines of gender and organization of school. Kang (2023) reported on the effects of gender on the motivational aspects of students' inquiry work in science. On the other hand, Chan (2022) considered cultural attitudes and STEM aspirations. Similar differences among public and private schools may indicate how differences in instructional time, social class, teacher turnover, and school facilities may influence motivation.

The Longding District of Arunachal Pradesh is a case in point. The author of the dissertation focused on classes IX and X of the 2025–2026 school year and reported on 120 students in 4 public and 4 private secondary schools. Such studies fill relevant evidence gaps. Most of the research on the development of interest in science is focused on better-resourced urban or national samples. Research on lesser known districts is rarely included in national-level synthesis. However, inferring that teaching quality is low and infrastructure is inadequate due to lack of independent measurement is unwarranted.

The study asks three questions: What level of attitude toward science is reported for these students? Do boys and girls differ, on average, in attitude toward science? Do students of the different management types (i.e., private, government, etc.) differ, on average, in attitude toward science? The two null hypotheses, H01 and H02, stipulate no differences in attitude toward science, respectively, by gender and management type. This article aims to condense and summarize the author's dissertation and report what is reconstructible with aggregate values. If results of a statistical test do not show a statistically significant difference, it does not necessarily mean equal values.

2. Review of Related Literature

2.1 Attitude, motivation and science participation

Work predominantly published in the last few years considers attitudes toward science as consisting of multiple dimensions. Rosenzweig and Chen (2023) showed that among high school students, various types of motivation and STEM career preferences are related to different STEM career categories and are not the same for all. Mackenzie et al. (2024) found that in addition to environmental factors, self-concept, and academic values, the perceived utility of science subjects was an important factor in the plans of Grade 8-10 students to take and continue studying science subjects. Although students in post-interventions had higher science efficacy and STEM identity than their pre-intervention levels, Zhao et al. (2024) found that the two variables were postively impacted by, and influenced by, each other. Therefore, multi-dimensional attitudes toward science are applicable on a global scale. However, it may lead to concealment of specific areas and kinds of students' aspirations and confidence in science.

The practical experience of the classroom and anxiety related to science are other components that might be explored in the learning environment. Rozgonjuk et al. (2024) studied the relation between science anxiety and test performance based on gender in a large sample of Estonian secondary school students. Rogers and Fraser (2023) studied perceptions and attitudes of 431 middle school students in relation to practical work. Pont-Niclòs et al. (2024) examined creativity and engagement in relation to STEM attitudes and practical work. Tanti et al. (2021) studied students' science enjoyment and leisure interests. Collectively the studies indicate that similar appearance overall scores conceal internal variation, and that the inclusion of practical work may or may not improve overall scores, depending on the context.

2.2 Gender and Institutional Contexts

Different types of evidence about gender have been reported. For example, Iwuanyanwu (2022) reported differences based on single-sex versus co-educational settings. He showed attitudes depend on the definition of participation, enjoyment and confidence. Kang (2023) studied gendered inquiry in secondary science. Chan (2022) studied gendered STEM aspirations. Social and cultural factors affected secondary students' STEM study choices. The studies show that gender should be contextualized based on the type of science and classroom processes, rather than interpreted as an intrinsic stable characteristic of students.

Institutional types are often blunt proxies for management in the case of CRRS. In the study undertaken by Babu et al. (2025), scientific attitude, gender, and school management were analyzed. In the study conducted by Rajput et al. (2025), science results among Class IX students in Kathua district were analyzed. Their constructs, samples, and geographies, however, are different. A more general OECD (2023) synthesis states that performance and equity need to be assessed in relation to educational opportunity. Thus, variations across school sectors may be attributed to household resources, student achievement, proximity to school, teacher supply, and language of school instruction, among others, which were not measured in the Longding summary.

2.3 Pedagogy, Educational Policy and Research Gap

As mentioned by Urdanivia Alarcon et al. (2023) and Meulenbroeks et al. (2024), the use of inquiry-based lessons in science and physics, respectively, fosters student engagement and constructs positive attitudes towards science in general. However, several inquiries need to be undertaken on the constraints and obstacles faced by teachers in the use of such practices. Additionally, several policy-relevant studies need to be undertaken on the provision of teacher support and the right education-related materials to facilitate inquiry lessons for all students to engage and provide input. The UNESCO (2023) Global Education Monitoring Report cautioned that technology, media and communication interventions should be grounded on pedagogical justification and equity.

Contextual explanations fit better with the education-policy framework. NCERT (2023) places understanding, application, and inquiry at the core of the curriculum. UNESCO (2024) indicates that gender stereotypes remain pervasive and that girls and women have less access to the internet and digital technologies. The ASER Centre (2025) Report focuses on rural education in India. However, its measures cannot replace a district-specific secondary science-attitude survey. The main contribution of the analysis of Longding is clear: it documents local science-attitude distributions and two demographically balanced comparisons, while stating the limitations of drawing inference based on aggregate data.

3. Materials and Methods

3.1 Design, setting, and sampling

The source dissertation describes a cross-sectional descriptive survey conducted in Longding district, Arunachal Pradesh, India in 2025-26. The target population was students of Classes IX and X, in the sampled secondary schools. Out of the nine schools identified, eight were included in the study: four government and four private. It was reported that 60 student questionnaires were completed in each of the school categories. The final analytical sample comprised of 120 students, with 60 males and 60 females in each of the sectors (government and private). Each of the four gender by sector cells comprised of 30 students.

The sampling description describes stratification at the school level, and random selection of students within the sampled schools. Four schools each contributed 16 students, and four contributed 14 students, giving a total of 120. Randomness and coverage of the district are reported as described. It is not possible, without access to the records and frame of schools, to verify randomness. The analysis does not assume that all students of the district have the same likelihood of being included in the study.

3.2 Instrument and scoring

The 20-item Science Attitude Scale is attributed to Dr. (Mrs.) Avinash Grewal (2012) and includes 10 positive and 10 negative statements. Respondents are asked to indicate their level of agreement/disagreement using a five-point Likert scale, ranging from ‘strongly agree’ to ‘strongly disagree’. Favorable items are scored from 4 to 0, and items are reversed to score from 0 to 4 for negative items. Sum scores range from 0 to 80. The reported reliability of 0.75-0.86 was quoted from the instrument documentation cited in the source and not from an independent calculation for this sample. Without access to the actual responses, it was not possible to assess the instrument’s internal consistency and measurement invariance.

For interpretation, the total sum score of 0-80 has been grouped as 0-26 = ‘low’, 27-53 = ‘moderate’ and 54-80 = ‘high’. These score groups are considered as source defined descriptive groups. Due to grouped frequency intervals, straddling of these boundaries, the accuracy of percentage distribution for the groups is limited.

3.3 Data provenance and analytical procedure

We only used the aggregate tables and narrative results included in the dissertation supplied. No respondent-level data was generated and/or attributed to real students. The source reported 7 five-point frequency bands, group means and standard deviations, sample sizes, and two t statistics. Descriptive percentages were calculated from published counts. The recalculation of independent samples t statistics was performed using the traditional pooled-variance/independent groups formula for two equal-sized groups. Two-sided p-values were calculated using 118 degrees of freedom which was consistent with the degrees of freedom stated in the dissertation's reference test.

Standard errors for independent groups were calculated as $SE = \sqrt{(s_1^2/n_1 + s_2^2/n_2)}$. Confidence intervals of the mean difference were calculated as $(\bar{x}_1 - \bar{x}_2) \pm t_{0.99,118} \times SE$. Cohen's d was computed as the mean difference over the pooled within-group standard deviation. The direction of contrasts was fixed as male minus female, and government minus private; a negative contrast therefore implies the second group scored higher. Rounding in the source explains minor differences between some originally reported and computed statistics.

It is not possible to determine normality, outliers and other item characteristics, equality of group variances, and within-school correlations with aggregated data. As 120 students attended 8 schools, there may be correlations between students in the same school; therefore, the two sample t tests performed in this study should be considered as descriptive conventional comparisons. No new ethical approvals, field visits or consents have been performed, beyond what is reported in the dissertation.

4. Results and Statistical Analysis

4.1 Composition of the sample

Table 1. Gender-by-School-Type Distribution of Respondents

School type	Male	Female	Total	Share
Government	30	30	60	50.0%
Private	30	30	60	50.0%
Total	60	60	120	100.0%

Note. Source: demographic summary in the dissertation; shares recalculated as counts ÷ 120.

The balanced 2 × 2 allocation provides clear contrasts between the two specified binary classifications, without numerical dominance by either group. Gender and school type each divide the sample equally, but representativeness is not implied by balance alone. Equal group sizes also simplify the conventional standard-error calculation. The underlying number of sampled schools is four per sector, not 60; denominators must refer to pupils unless a school-level statistic is explicitly reported.

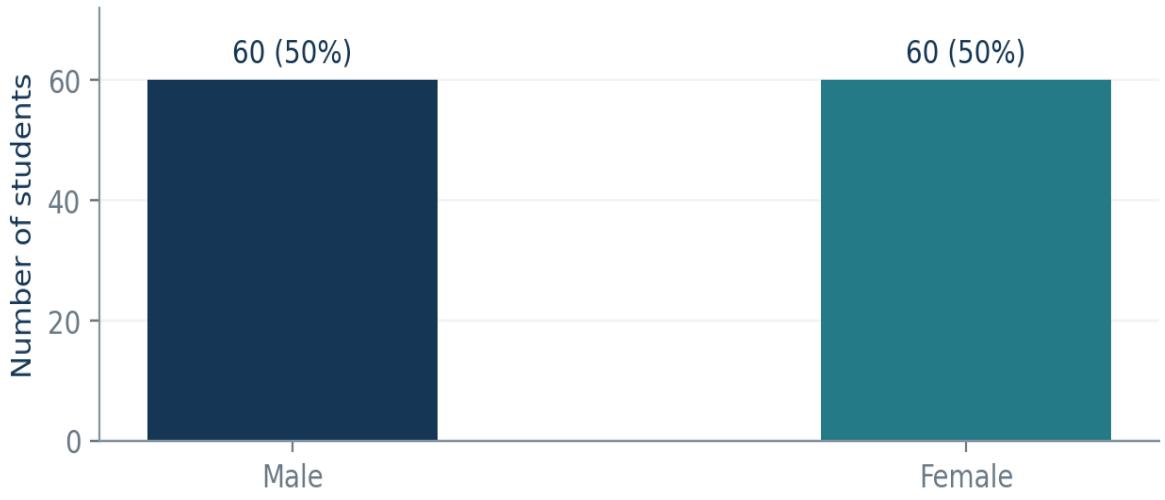


Figure 1. Gender distribution of the 120 surveyed pupils.

Figure 1 confirms that the reported respondents were divided evenly between male and female categories. The chart describes sample composition only; it does not establish anything about the gender distribution in Longding District as a whole.

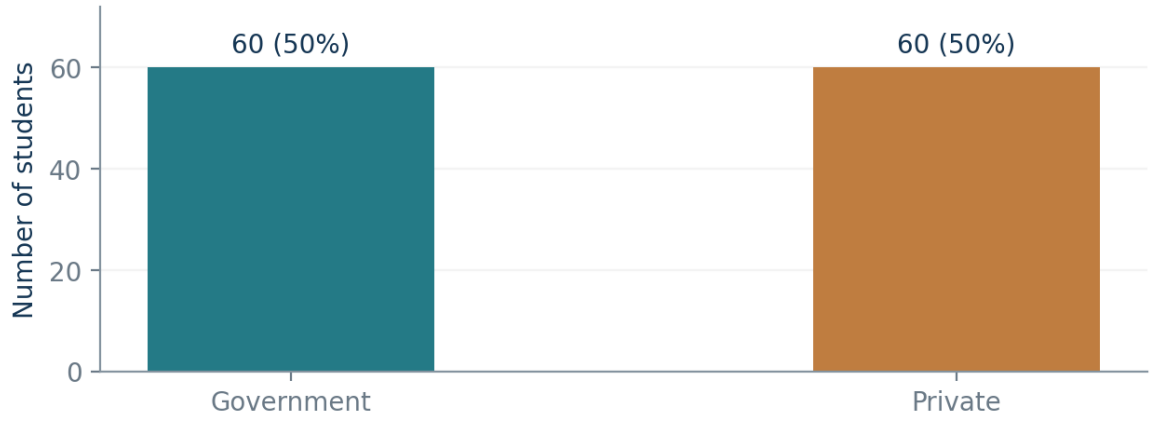


Figure 2. School-management distribution of respondents.

Figure 2 reports a second 50:50 split. Although four schools were selected from each management category, the bar heights display 60 pupils per category rather than 60 schools.

4.2 Overall score distribution

Table 2. Source-Reported Frequency Distribution of Science Attitude Scores

Score band	Frequency	Percentage
25–29	1	0.8%
30–34	12	10.0%
35–39	27	22.5%
40–44	46	38.3%
45–49	18	15.0%
50–54	12	10.0%
55–59	4	3.3%
Total	120	100.0%

Note. Class intervals and frequencies are from the dissertation; percentages were recomputed. The original raw scores are unavailable.

The modal group was 40–44 (46 pupils; 38.3%), followed by 35–39 (27 pupils; 22.5%). Together, these two adjacent bands account for 73 of 120 students (60.8%), suggesting a concentration around the low-forties on a scale with a possible maximum of 80. The reported overall mean score was 41.80, or 52.3% of the maximum attainable total. Under the source-defined cut-points, a score near this mean is categorized as moderate. The source histogram does not permit accurate counts in every attitude category because its lowest and upper bands overlap category thresholds.

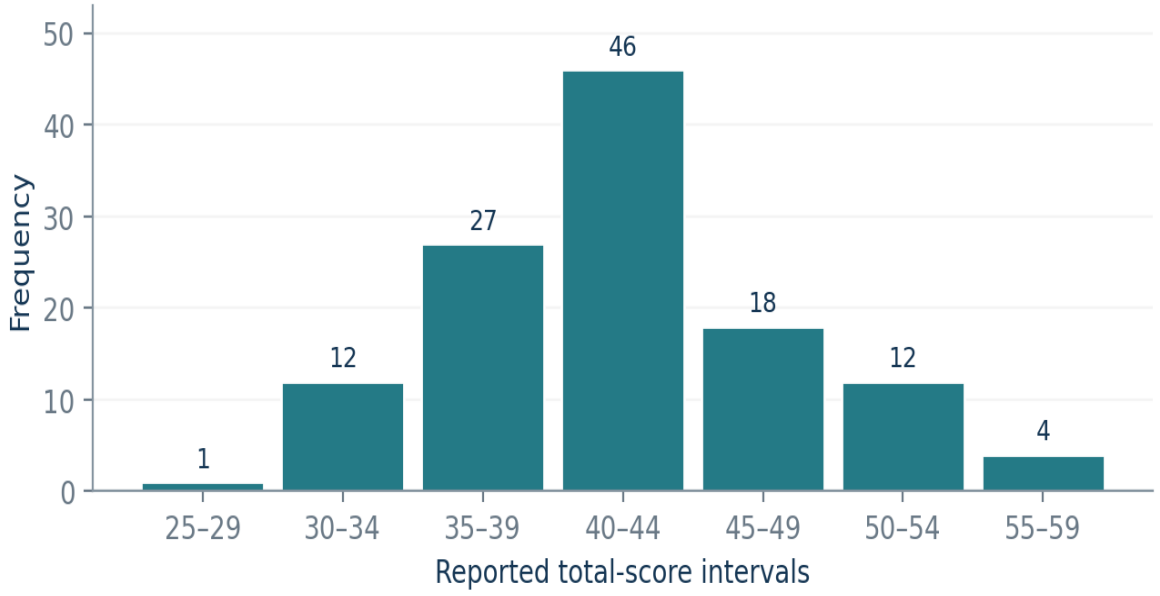


Figure 3. Frequency distribution of seven reported score intervals (n = 120).

The histogram-like grouped bar chart is drawn from the seven published frequency classes, not individual scores. Its peak at 40–44 is visible; detailed tail shape, skewness, or formal normality cannot be inferred reliably from these bins.

4.3 Descriptive comparisons

Table 3. Reported Means and Standard Deviations by Comparison Group

Group	n	Mean	SD	SE of mean
Male	60	41.38	6.17	0.80
Female	60	42.21	5.80	0.75
Government	60	41.23	6.64	0.86
Private	60	42.37	5.18	0.67

Note. Means and SDs are transcribed from the dissertation. SEs are calculated as SD/√60.

Female respondents had a mean score 0.83 points higher than male respondents, and students in private schools had a mean 1.14 points higher than those in government schools. These raw gaps correspond to approximately 1.0% and 1.4% of the scale maximum, respectively; however, a percentage of the scale range is not a substitute for a standardized effect size. The relatively close group means and overlapping spread suggest that much more variation occurs among pupils within each group than between the two group averages.

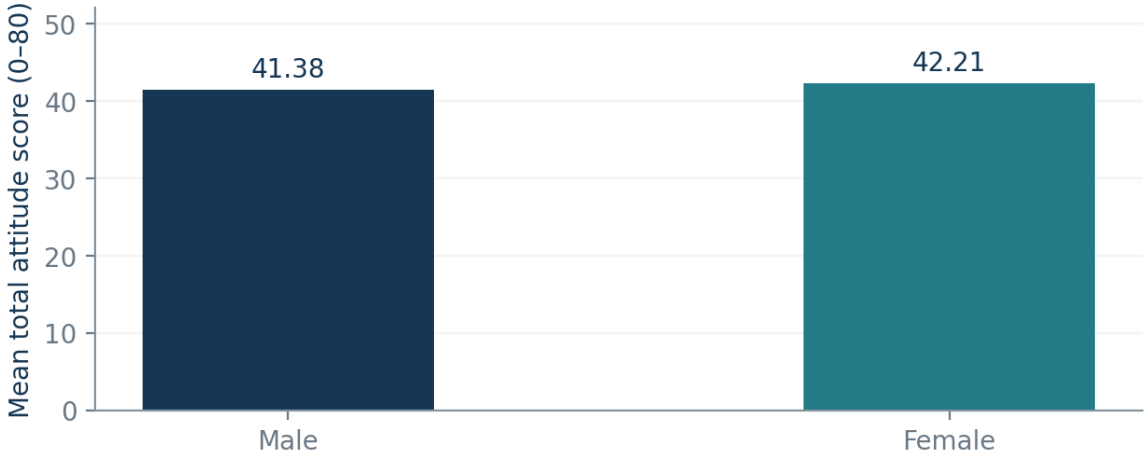


Figure 4. Science-attitude mean scores for male and female respondents.

The point-estimate gap shown in Figure 4 is small and favours female respondents. Statistical uncertainty is more informative than the visual height of the bars, which is examined explicitly in the confidence-interval figure.

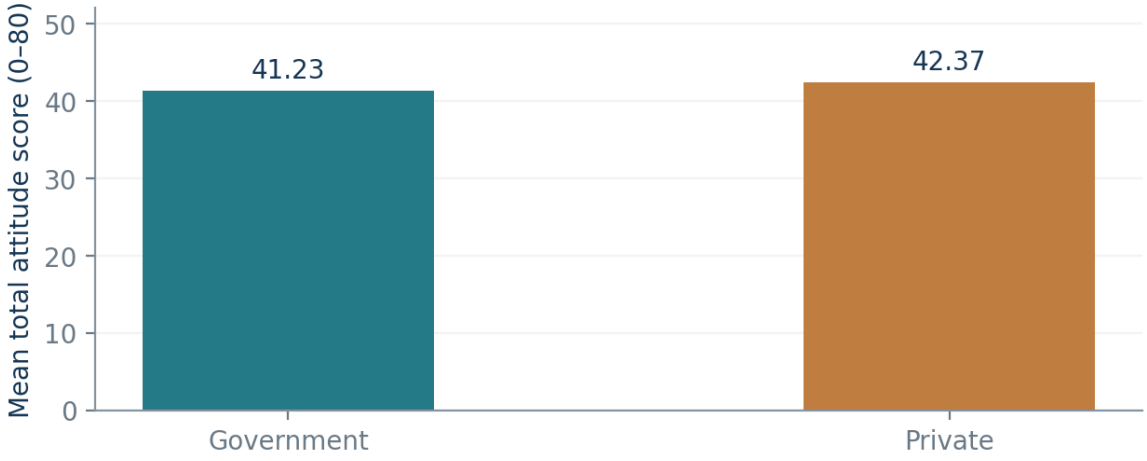


Figure 5. Science-attitude mean scores for government and private schools.

The source summaries place private-school respondents slightly higher on average, but the available evidence does not justify describing one management sector as educationally superior.

4.4 Hypothesis H01: Gender comparison

Table 4. Reconstructed Independent-Samples Test for Gender

Contrast	Mean diff.	SE diff.	t(118)	p, two-sided
Male – female	-0.83	1.093	-0.759	0.449

Note. Two-sided conventional student-level t test reconstructed using rounded group statistics; dissertation reported |t| ≈ 0.77.

The estimated male-minus-female difference was −0.83. The reconstructed t value was approximately −0.76 (df = 118; p = .449), close to the source-reported absolute t = 0.77. The 95% confidence interval extended from approximately −3.00 to +1.34 points. The test does not reject H01 at $\alpha = .05$. At the same time, the interval is compatible with both a modest female advantage and a smaller male advantage, so it would be incorrect to present the result as evidence that the two gender populations are equal.

4.5 Hypothesis H02: School-type comparison

Table 5. Reconstructed Independent-Samples Test for School Type

Contrast	Mean diff.	SE diff.	t(118)	p, two-sided
Government – private	-1.14	1.087	-1.049	0.297

Note. Rounded source means imply a difference of −1.14; the dissertation lists a mean difference of 1.13 and $|t| \approx 1.04$, an immaterial rounding discrepancy.

The reconstructed government-minus-private difference was −1.14; $t(118) \approx -1.05$, $p \approx .297$. H02 therefore was not rejected at the conventional 5% level. The corresponding confidence interval (approximately −3.30 to +1.02 points) includes zero and accommodates multiple underlying patterns. Because individual students were sampled within schools, uncertainty may be understated if members of the same school share unmeasured experiences or instructional conditions. Comparisons at the school level would have only eight primary sampling units.

4.6 Effect sizes and uncertainty

Table 6. Standardized Contrasts and 95% Confidence Intervals

Comparison	Cohen's d	Mean diff.	95% CI for diff.
Male – female	-0.14	-0.83	[-2.99, +1.33]
Government – private	-0.19	-1.14	[-3.29, +1.01]

Note. Negative values indicate higher means for the female or private-school group; CIs reflect conventional student-level independence.

Both Cohen's d values have small absolute magnitudes (about 0.14 and 0.19), and both confidence intervals overlap the no-difference value. Small standardized contrasts do not automatically establish educational equivalence: a properly planned equivalence test requires a justified smallest meaningful effect and an uncertainty interval narrow enough to assess that margin. No such equivalence margin was specified in the source. These contrasts should instead be interpreted as small differences in the observed sample under considerable uncertainty.

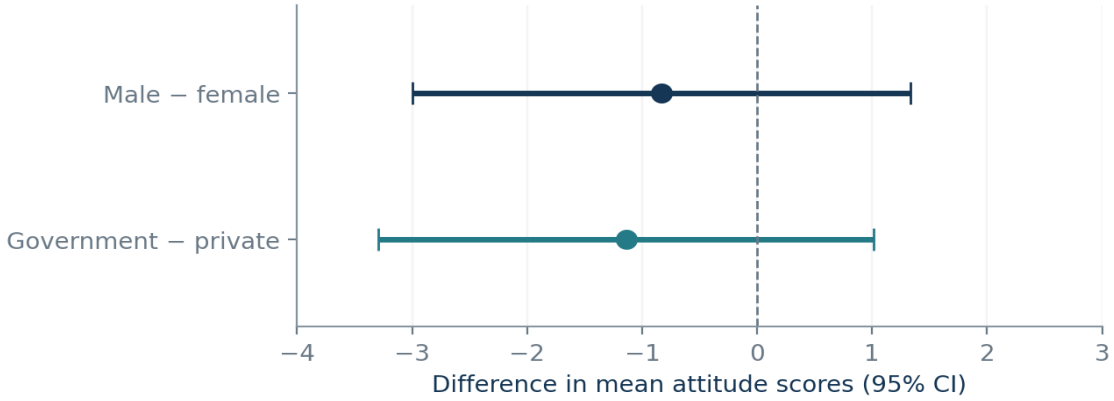


Figure 6. Mean-difference estimates and conventional 95% confidence intervals.

Figure 6 makes the decision logic transparent: each interval crosses the dashed zero-difference line. The intervals are conditional on standard independent-student assumptions and do not account for the eight-school cluster design.

Table 7. Research Hypotheses and Statistical Decisions

Hypothesis	Reported comparison	Decision at $\alpha = .05$
H01	Male vs. female attitudes	Fail to reject
H02	Government vs. private attitudes	Fail to reject

Note. Failure to reject is not proof of equal population means.

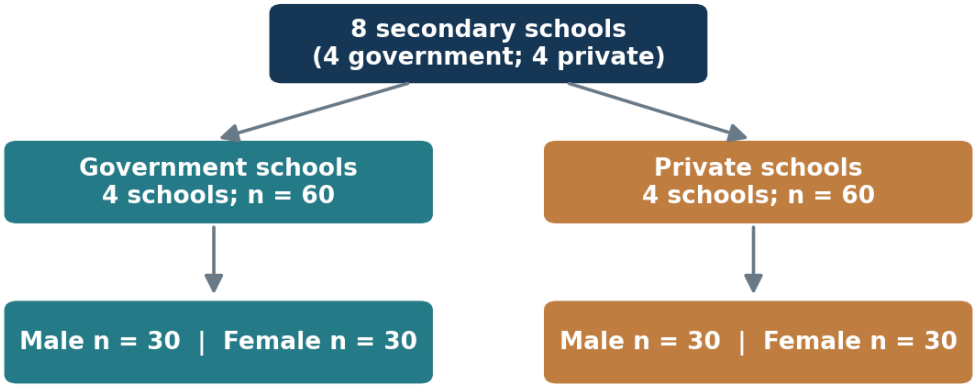


Figure 7. School and participant sampling structure reported in the dissertation.

Figure 7 summarizes the reported balanced design and emphasizes that 30 pupils were included in each gender-by-sector cell. It does not depict unverified details about how particular pupils were randomized.

5. Discussion

The predominant empirical result is a moderate central attitude score with two small, statistically non-significant group differences. From an educational standpoint, the students in the studied groups showed similar average scores. This is a description of the sample studied, not an assertion that gender or management could not affect the learning of science. A cross-sectional attitude score is context sensitive; to interpret, one must discern evidenced data from contextual arguments.

Small gender differences are in line with the general body of knowledge, which reflects a consistent lack of a stable gender pattern in all contexts. Iwuanyanwu (2022) found differences in school arrangements and other dimensions, while Kang (2023) describes unequal participation and experiences in inquiry based science. Chan (2022) relates STEM-related differences to cultural and gender norms. Rozgonjuk et al. (2024) add to the body of knowledge, inquiring science anxiety, to study gender differences in science. The current dataset contains no observed measures of participation in inquiry, anxiety or science-related gender stereotyping. As such, none can be assessed as the cause of the near zero gender differences in Longding.

The private school's mean score was higher than the government schools' mean scores, but the difference was not significant (re-test of the conventional test of significance) This means interpretation should not assume the two school sectors represent identical instructional conditions, or conversely, that the institutional labels determine the academic climate. For example, Rogers and Fraser (2023) noted associations with practical science experiences and attitudes, and Mackenzie et al. (2024) mentioned peer and teacher support as well as the utility of science and its importance. These would require further measurement in order to be considered explanations for the Longding results. Any proposal for change that focused solely on school type would outrun the available evidence.

The central score of 41.80 merits some attention. Because the scores ranged from 0 to 80, it is not necessarily the case that students rated themselves as being disengaged and disinterested. Rather this suggests a moderate rating as defined in this study's terms of reference. The school may have students who are interested in science, but feel anxious taking exams, prefer demonstrations to written work, and aspire to be a scientist despite being in a resource poor setting, where there are few, if any, opportunities to practice and/or develop scientific skills. To obtain a more informed account, researchers may wish to analyse attitude sub-scales and/or include student narratives. Manassero-Mas and Vázquez-Alonso (2025) examined the relationship between classroom perceptions and STEM vocation, while Pont-Niclòs et al. (2024) examined creativity and classroom engagement and attitudes.

An important contribution of the current reporting approach is the explicit presentation of confidence intervals and effect sizes. A p value greater than 0.5 rules out neither modest subgroup differences nor potential differences of practical concern. The evidence was not sufficient to reject the null at that threshold under the specified statistical model. The two tested outcomes do not demonstrate gender neutrality or institutional equivalence. Pre-specified equivalence analysis and better school level design are needed to make stronger claims.

Finally, the small number of schools is a significant issue. Students in the same school can share teachers, timetables, laboratories, and neighborhoods. Conventional Independent sample tests treat all 120 scores as unrelated, while clustered sampling decreases the effective information. Without the micro-data and ID's of the schools, intraclass correlation and school cluster-adjusted confidence intervals can not be computed. Thus, the outcomes can be considered as comprehensive descriptive evidence of the educational inequities in the district, rather than definitive evidence.

Lastly, the results suggest that academic improvement may come from utilizing strategies that promote engagement for all students. This can be as simple as using locally appropriate examples, or engaging students in group discussions or collaborative experiments or investigations. While inquiry based learning may make some concepts seem as if students are leaving to find answers, this should not be the case (Urdanivia Alarcon et al., 2023; Meulenbroeks et al., 2024).

Second, students' sense of perceived competence and personal relevance of science also represent workable targets for the assessment and review of teaching and learning in the classroom. For example, curriculum teams can investigate students' sense of perceived competence to explain the concepts; whether lesson provide opportunities for practical application; and students' ability to imagine possible futures related to science, etc. Mackenzie et al. (2024) and Valenzuela-Peñuñuri et al. (2024) support the importance of task values and self-efficacy for engagement; however, evidence from the piloted programs in the local context should inform the conclusions.

Third, school management and district authorities should rather look into opportunities than consider public/private labels as guarantees of quality. Relevant opportunities should include the actual use of experiment materials, teacher's choice and guidance, attendance, language, class size, participation of children of all ages, and opportunities to engage in other related science activities. The National Curriculum Framework (NCERT, 2023) supports learning through activity and integration; meanwhile, UNESCO (2023) encourages the context-sensitive, responsible use of ICT in education. Equity monitoring should include, but not be confined to, management type and gender.

Fourth, since confidence intervals for attitudes of both males and females overlapped, gender stereotyped interventions are not warranted. It is however, important to promote opportunities for girls and women to participate in demonstrations; lead student science clubs, and provide varied role models for girls. UNESCO (2024) supports these suggestions and also brings up the policy concerns of women and technology opportunities and stereotypes. These concerns however were not addressed by the Longding survey.

6. Limitations and Opportunities for Future Research

This article analyzes aggregated data only. Due to the lack of primary data, it was not possible to verify answers and conduct reverse-coding. Furthermore, it was not possible to determine how data was coded. It was not possible to determine if data was imputed, or if data was skewed, nor was it possible to assess how reliably items functioned or how school means differed. Author conclusions were generally consistent, however, some differences in printed means and test statistics required reconstruction from rounded values.

The original data was collected from only 120 students from 8 schools and 1 academic session. Caution should be taken when generalizing results from these studies. Future research should collect original data from schools and document the original consent process. A multilevel model should be able to differentiate differences within schools vs. between schools, as well as test a gender-by-sector interaction if a large enough sample size of schools is collected.

One way to address the unobserved mechanisms and attitudes might be to incorporate a qualitative research component as part of future studies. Following current trends in research, greater transparency in reporting future research might help encourage other researchers to help share data to facilitate secondary analysis.

7. Conclusion

According to the Longding Survey, there was a moderate average orientation toward learning science and small differences in the specified male-female and government-private groups. Reanalysis of the dissertation's aggregate statistics showed that the results for both tests of conventionality were non-significant (gender $p \approx .449$; management $p \approx .297$), and the effect sizes were small. Confidence intervals for both effect sizes spanned zero. Based on these findings, it is not justified to conclude that the groups are identical. There may be other variables that help explain the difference in the attitudes toward science. Considering the attitudes of district level policies on education and teaching practices (pedagogy) that are modifiable,

the findings suggest that involving students in research on science practices and activities be part of the focus for policy planning and educational improvement efforts. Although, future studies might include respondent and school level data to fully explore the educational opportunities offered within the district.

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