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INTENDED VERSUS ENACTED CURRICULUM AND PRACTICE IN SECONDARY SCHOOLS' SCIENCE CLASSROOMS: EVIDENCE FROM SELECTED DISTRICTS OF NEPAL

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ABSTRACT

Introduction: *Nepal's secondary science curriculum emphasises learner-centred, inquiry-oriented pedagogy, yet classroom practice is widely perceived as textbook-bound. This study examined the alignment between intended and enacted curricula and practice in secondary science classrooms.*

Methods: *We used a mixed-methods, descriptive–exploratory design. Disproportionate stratified random sampling and pragmatic snowballing identified secondary science teachers across selected localities in both districts. Data sources included a structured questionnaire, classroom and meeting observations, semi-structured interviews, focus group discussions (FGDs), key informant interviews (KIIs), and case studies; tools were pre-tested and refined before full administration. The final sample comprised 149 teachers.*

Results: *Classroom practice was predominantly transmission-oriented. Most teachers read from the textbook during instruction (77.18%; 115/149), indicating strong reliance on text over concept-driven teaching. Lesson planning was rarely child-centred: no teachers reported fully child-centred plans, and the modal category was "least child-centred" (39.59%). Lecture-dominated methodological choices (39.59%), whereas heuristic/inquiry approaches were uncommon (4.02%). Practical work was infrequent: over two-thirds reported never using a practical approach (71.14%). Science-popularising activities were scarce, with reports from only a small minority of schools. Training profiles diverged by sector: most government teachers reported formal training, while few private-school teachers did so; however, textbook-bound practice persisted across both sectors. Qualitative accounts suggested private-school classrooms were somewhat more student-centred under stronger administrative and parental accountability, whereas government schools were more conventional.*

Conclusions: *Findings reveal a pronounced intended–enacted curriculum gap in secondary science. Despite policy aspirations and substantial training (particularly in the government sector), classroom instruction remains dominated by textbook reading, lecture, and minimally*

child-centred planning, with limited practical work and few co-curricular science activities. Addressing this misalignment will require aligning assessment with inquiry; strengthening school-level accountability and instructional coaching; expanding low-cost practicals, mobile lab kits, and science-club programming; and embedding meaningful ICT use within teacher professional learning. These steps, implemented within the study area contexts, can make learner-centred, inquiry-oriented science both expectable and doable in everyday practice.
Keywords: *curriculum; practice; curriculum-practice gap; secondary schools; science education; textbook-bound teaching; learner-centred education; inquiry-based pedagogy; mixed-methods; Nepal*

INTRODUCTION

Nepal is currently undergoing significant social, political, economic, and cultural transformations (Gautam, 2022; Adhikari & Lawoti, 2024; Yadav, 2016). These continual developments require enhancements in instructional design and delivery methods. Advancements in technology have significantly transformed the process of learning and teaching, offering novel learning possibilities and access to educational resources that go beyond the conventional resources available in Nepal (Shirazi & Hajli, 2021). Without a comprehension of the intricate learning requirements of socio-culturally and linguistically varied learners in present-day Nepal, debates about the educational path society should take are unlikely to hold significance or be mutually understandable. Is the current educational system capable of effectively addressing the increasing requirements of pupils from varied socio-cultural and linguistic backgrounds? Due to the conventional instructor-centred approach, students may struggle to comprehend the intended message of the teacher. Educators can comprehend how information is seen and processed in diverse ways by identifying learners' learning styles (Chang, 2010). An essential factor in motivating learners to engage in the learning process is comprehending and utilising their learning style preferences, which can have a significant impact on a learner's performance, either favourably or adversely (Rad et al., 2024).

A notable increase in the use of instructional technology in schooling in recent years has been confirmed by Lee and Winzenried (2009). Computer technology provides a wide range of alternatives for teachers and students to improve the teaching and learning process by utilising a variety of functions, from basic to advanced. In order to implement educational changes, the Nepalese government is currently looking into the use of information and communication technology (ICT). As Hanna noted in 2003 (Hanna, 2003), this involves looking into the possibility of cooperation between the public, business, and donor sectors to efficiently apply and reap the rewards of ICT capabilities. These problems include the development and application of a particular technology or approach without theoretical underpinnings, learning packages made without a strong instructional design foundation, or both (Lee and Winzenried, 2009; Ross et al., 2010). Moreover, Stones warns that these resources will become antiquated and pointless if teachers are not properly taught in learning about and utilising modern technology. Nobody is confident enough or has the requisite experience to use them.

Just adding science content can present significant challenges for every student, possibly hindering their ability to understand the teacher's intended message. In an English-medium classroom, a language barrier could make it more difficult for the pupils to understand what the teacher is teaching (Thomas and Watters, 2015). It is feasible to use constructivist-oriented teaching strategies to help students understand science in the English language (Mohammed, 2023). Therefore, the purpose of this study was to investigate how constructivist instruction affects students' ability to understand scientific concepts in science classes taught in English. Using a constructivist teaching methodology could provide educators with the tools they need to help students understand science.

Because science education is strongly linked to achieving modern economic growth, advanced technology, and a contemporary political and social perspective (McDonald, 2016), emerging nations like Nepal have a tremendous difficulty in maintaining the social relevance of science education. Attaining these goals is currently hampered by the unfavourable economic conditions, the challenging educational goals, and the social and cultural aspects of education. There is a dearth of scientific educators with training in science education in Nepalese secondary schools. There is a disconnect between science education as it is theoretically taught and as it is actually taught, which frequently depends only on textbooks, due to a lack of pedagogical knowledge and skills. In the subject of science education, textbooks have primarily been used to teach science, which has caused a gap between the lives of teachers and pupils. This is partially because there aren't enough suitable facilities and laboratory supplies available. The purpose of the study is to look at the difficulties faced by Nepalese schools and how these difficulties are addressed when teaching science. We will also suggest ways to incorporate science instruction with the varied backgrounds of teachers and students in the classroom.

Science learning necessitates a balanced integration of cognitive, emotional, and psychomotor processes. Students' bodies, minds, and emotions are stimulated through these activities, which develop critical thinking abilities (Gardner, 2008). A teacher-centred approach falls short in promoting discussion, debate, and cognitive engagement in the classroom. In the classroom, students are arranged in neat, well-prepared rows. If science is taught using a dogmatic approach, students will become bored and will be forced to memorise methods.

In Nepal, theoretical concepts are emphasised primarily in science education. Real-world scenarios are rarely incorporated into the educational environment. Many science schools, according to Shrestha (2009), neglect to teach basic concepts and fail to relate them to real-world issues (Shrestha, 2011). Even though practical, hands-on exercises are the most efficient approach to properly grasp and assimilate scientific knowledge, classroom lectures typically do not cover the practical aspects of science. This indicates that a large number of Nepalese secondary educational institutions use the logical approach to scientific instruction.

Because science has the potential to be a technical topic and lead to careers in engineering and medicine, it is required as a mandatory subject in Nepal. Parents and students alike strongly support science. Informal observations indicate that most scientific professors use a theoretical approach while instructing students in science. As a result, students believe science to be a difficult subject that is out of reach for those from lower socioeconomic backgrounds, and they find it difficult to acquire the necessary degree of scientific knowledge and proficiency. Improving pupils' science performance was the main goal of the study. Understanding and analysing the differences between the theoretical framework and the way science is currently taught in schools is crucial. Furthermore, it's critical to create a comparison between the theoretical and practical techniques. When teaching students about science in the classroom, teachers face a number of difficulties. The purpose of this study is to compare how pedagogy is applied in science classrooms as it is envisioned by educational science pedagogy and in science teacher preparation.

Teachers in government schools are usually credentialed and licensed educators. This suggests that the educators have received specific training in teaching approaches or have gained knowledge of the theoretical underpinnings of scientific education. Moreover, the statistics have shown that those schools' scientific instruction has relied unduly on textbooks. Numerous problems can have come from the government, the teacher, the students, or the school. A thorough investigation aimed exclusively at revealing the actual status of science education in Nepal is necessary in order to look at these phenomena.

The purpose of this study is to examine the theoretical and practical approaches used in science instruction in Nepali secondary schools. The main aim of the study is to investigate the teaching techniques, practical approaches, and theory of science education in selected districts of Nepal. Specifically, the study sights: (1) to investigate science education practices in the area of investigation; (2) to analyze the application of theoretical and practical approaches to science education; (3) to investigate the disparity between science educations based on textbooks and the theory of science education; (4) to identify how educators feel about the implementation of a practical approach to scientific education; and (5) to explore the challenges to science education and strategies to improve scientific teaching. This study offers a contextualised account of curriculum intentions and textbook-bound practices, reviews and comments on policies and their efficacy, and makes recommendations for change that can inform teacher education, school leadership, and system actors.

METHODS

Research Design and Approach

This study adopted a descriptive–cum–exploratory research design to investigate the current state of science teaching in secondary schools and the situational issues science teachers encounter. The exploratory component was used to examine practices, theoretical frameworks, and policy directives; the descriptive component documented prevailing instructional strategies and classroom realities. Mixed methods were employed, integrating quantitative and qualitative approaches to provide a comprehensive understanding of curriculum-based versus textbook-bound teaching.

Philosophical stance (Ontology, Epistemology, Axiology)

The research proceeded from explicit ontological, epistemological, and axiological stances. Ontologically, the study acknowledged debates between scientific realism and constructivism and recognised their implications for whether schooling favours inquiry-driven curricula or textbook-centred practice. Epistemologically, the study contrasted constructivist views—learning as active knowledge construction through inquiry and application—with positivist views emphasising the accumulation of objective facts. Axiologically, the study foregrounded the values embedded in science education (e.g., curiosity, critical thinking, and ethical responsibility) and considered how these values shape curriculum choices, teaching methods, and assessment, especially within resource-constrained Nepali classrooms. These foundations guided instrument design, data collection, and interpretation.

Study Area and Population

The study was conducted in Kathmandu and Nuwakot districts. In Kathmandu, focal localities included Kalanki, Soalteemode, Bafal, Kalimati, and Kirtipur; in Nuwakot, Bidur Sub Metropolitan City, Deurali, and Khadga Bhanjyang were covered. The secondary-school study population comprised instructors, students, principals, and other relevant authorities. A total of 149 teachers (55 female and 114 male) employed in various institutions were engaged as key informants to document practices, challenges, and developments that science educators presently encounter.

Sampling Strategy

A disproportionate stratified random sampling (DSRS) design was used to ensure representation across key strata, with particular attention to gender representation, given the relatively smaller number of female instructors. DSRS was chosen to assign appropriate weight to strata where proportional allocation might otherwise underrepresent important groups. In addition, snowball sampling was used pragmatically to locate relevant respondents and facilitate data collection in schools where access and identification were challenging.

Data Sources

Primary data were collected through face-to-face interviews, focus group discussions (FGDs), classroom and meeting observations, key informant interviews (KIIs), and case studies. Secondary data were gathered from published books, journals, articles, reports, unpublished theses, newspapers, and other documentary sources to contextualise and triangulate primary findings.

Data Collection Instruments and Procedures

A structured questionnaire (48 sections) captured quantitative data on individual characteristics and classroom practices. Semi-structured and open-ended interview guides supported in-depth interviews, KIIs with science teachers, principals, and school officials, and FGDs organised into three relatively homogeneous groups. Direct observation was undertaken in multiple classrooms and teachers' meetings to document enacted practices. Case studies were compiled to portray real-life experiences and constraints faced by teachers. Fieldwork included recruiting and training field assistants, compiling name/address lists of selected respondents, managing logistics, coordinating with relevant offices for permissions, and attending to ethical protocols of confidentiality and privacy.

Pre-test and Instrument Validation

The tools were pre-tested with eight respondents from varied categories. Revisions were made before final administration to enhance clarity and alignment with research objectives. Validity (the extent to which tools measure what they intend to measure) and reliability (precision/consistency of measurement) were addressed through design rigour, rapport-building to elicit authentic responses, and iterative refinement.

Data Processing and Management

Data management bridged collection and analysis through editing, classification, coding, and tabulation. Quantitative responses were coded and entered for tabulation; qualitative materials (field notes and audio-recorded interviews) were transcribed and expanded into detailed textual records. Qualitative data were then sorted, thematised, graphed (as needed), and organised using codes and sub-codes.

Data Analysis

Quantitative analysis used frequency distributions, simple tabulation, cross-tabulation, and visual displays (graphs and pie charts) as appropriate. Qualitative analysis followed analytic induction and a thematic approach, using the semi-structured and open-ended materials to derive categories linked to curriculum intentions and enacted practices. Mock tables were prepared in the interim to aid verification and clarification before the final presentation.

Rigour and Trustworthiness

To uphold rigour, the study addressed issues of representation, legitimisation, and practice. Multiple techniques and layered presentation were used to incorporate diverse perspectives; interpretations preserved contextual authenticity and textual faithfulness; and theoretical procedures were applied to assure accuracy and consistency. Follow-up interviews with informants (on five distinct occasions) and re-transcription further strengthened confirmability.

Ethical Considerations

Ethical protocols adhered to principles of respect, confidentiality, and informed consent. The researcher built rapport, explained study objectives, and proceeded after obtaining verbal consent. In line with ethical theory, the study observed non-maleficence, beneficence, self-determination/autonomy, and equity, ensuring participants were treated fairly and not harmed, and that the research produced discernible benefits.

RESULTS

This section presents the socio-demographic characteristics of the respondents. It also analyses the teacher's role in the classroom, the importance of the teacher's education, theories of learning science and many more. It also attempts to analyse and explain exemplary practices of teaching science. This chapter also links with science education and society, with a rigorous study of the relationship between various aspects that affect teaching science.

Socio-Demographic Information about the Respondents

Socio-demographic information provides a broad understanding of the age, sex, gender, and other characteristics of the respondents. To gain a comprehensive understanding of the population's features, this discussion will focus on some socio-demographic factors. The features include age, qualifications, the type of schools where they teach, training, and other relevant factors. The respondents are a subset of individuals selected from the larger population. The samples were picked from the entire population of teachers who teach in government and institutional schools in the study area. This sample reflects half of the total number of instructors, which is 149. It consists of 114 male teachers and 55 female teachers. These samples aid in determining the distinctive features of a representative group. The data is displayed in the form of diverse tables and charts.

Age and Gender of the Respondents

Age is a crucial determinant that affects the overall perception among parents and students. There is informal hearsay that students tend to prefer mature teachers. Some schools have implemented a minimum age requirement for teacher vacancies. The table provides information regarding the age and gender of the respondents. We have surveyed 149 instructors who specialise in teaching science in both public and private schools located in the study area.

Table no. 1: Distribution of age and gender of the respondents

SN	Age Class	Female	Male	Total
1	18–25	3 (9.67%)	5 (4.23%)	8 (5.36%)
2	25–33	7 (22.58%)	51 (43.22%)	58 (38.92%)
3	33–41	8 (25.80%)	39 (33.05%)	47 (31.54%)
4	41–49	8 (25.80%)	14 (11.86%)	22 (14.76%)
5	49–59	5 (16.15%)	9 (7.62%)	14 (9.39%)
Total		**31 (100%)**	**118 (100%)**	**149 (100%)**

The sample consisted of a total of 149 respondents. Within the study population, the age group of 25-33 had the largest number of responders, with 58 individuals, accounting for 38.92% of the total. The data indicates that the age group with the highest representation is between 25 and 33 years old, with a greater number of male participants than female participants. The data indicate that the majority of respondents were in the age range of 25-33, with a higher proportion of males engaged in teaching occupations. This indicates a prevailing trend where a greater number of males across all age groups are engaged in the field of science education.

Demonstrating content knowledge in teaching science

Content knowledge is seen as a crucial attribute in all forms of teaching, including science teaching. Research has shown that teachers with a strong grasp of the subject matter are perceived as skilled educators, and their pupils find their classes enjoyable. It has been noted that teachers with a strong understanding of scientific topics can teach in the classroom without relying on the textbook. The provided table displays data regarding teachers' behaviour during teaching, namely, whether they read from a book in front of the pupils or teach fluently without referring to the book.

Table no. 2: Use of books during teaching in class

SN	Respondents	Yes	No	Total
1	All the age groups	115	34	149
Total		**115 (77.18%)**	**34 (22.81%)**	**149 (100%)**

Table 2 indicates that a majority of the scientific teachers who participated in science teaching were observed to be reading from a book while teaching in the classroom. Out of a total of 149 teachers, 115 of them, or 77.18%, use books during their teaching sessions. The remaining 34 teachers do not use books during their scientific classes. It is imperative to enhance the competency level of teachers.

Use of a child-centred lesson plan

This indicates that science education in Nepalese schools mostly focuses on imparting information. The table below presents an analysis of whether the teacher's lesson plan functions as a facilitator or not.

Table no. 3: Use of child-centred lesson plan

SN	Type of lesson plans	The total number of teachers using the specific lesson plan
1	Not child-centred	33
2	Least child-centred	59 (39.59%)
3	Moderately child-centred	56
4	Highly child-centred	0
5	Fully child-centred	0 (0%)
Total		**149 (100%)**

The data in Table 3 indicates that the number of teachers who utilise the least child-centred lesson plan is the largest, with a total of 56, representing 39.59% of the total. There are no teachers who employ a fully child-centred lesson plan, making the number of such teachers the lowest possible value. This indicates that the utilisation of child-centred lesson plans is highly inadequate. It is necessary to alter the current condition.

Use of different teaching techniques

Here is the table which shows the use of different methods of teaching science.

Table no. 4: Use of different teaching techniques

SN	Teaching methods	Number of teachers using a specific method
1	Lecture method	59 (39.59%)
2	Discussion method	55
3	Role-play methods	21
4	Demonstration method	8
5	Heuristic approach	6 (4.02%)
Total		**149 (100%)**

Table 4 shows that 59 (39.59%) respondents chose the lecture technique as their primary teaching approach. Of the total respondents, 55 use the conversation approach. Twenty-one of them employed the role-playing method, while eight used the demonstration method. The least value of data in Table 5 is 6, indicating that teachers are utilising the heuristic method.

Practices of teaching science in different schools

During the observation, it was discovered that scientific instruction at private schools is somewhat student-centred. These schools have been connected to larger training facilities and educational institutions in Kathmandu. However, the teaching methodology at government schools is more conventional. One of the instructors at a private school in the Nuwakot district stated, "We receive less training than teachers at government schools and even fewer resources, but we are working to make our classes more student-centred because, should we fail to meet the needs of our students, they will complain to the administration and parents, potentially costing us our jobs." Conversely, a government school teacher retorted, saying, "We have sufficient training and a degree in education… However, the outcomes are subpar." Based on the aforementioned claims, it may be said that although private school instructors receive lower compensation and less training, they nevertheless produce better work… Thus, it can be concluded that private and public schools in Nepal employ different teaching methodologies.

Use of a practical teaching approach in science class

Science education involves more than just imparting knowledge from teachers to students. It is important to provide pupils with an understanding of scientific phenomena and to instil in them a scientific mindset. Information about teaching science using a practical approach is provided in the table below.

Table no. 5: Use of a practical approach in science class

SN	The frequency of using practical teaching	Government school	Private school	Total
1	Never	86	20	106 (71.14%)
2	Seldom	9	6	15
3	Frequent	18	10	28
Total		**113**	**36**	**149 (100%)**

Table No. 5 above demonstrates that just 28 respondents use the practical teaching technique with students frequently, while the largest percentage of respondents, 106 (71.14%), don't use it in the classroom. From the standpoint of public and private educational institutions, the majority of government school teachers do not employ a practical teaching methodology. As a result, the preceding chart demonstrates that most responders who frequently employ a practical approach also attend government schools. This is a result of the lack of laboratories in many private institutions for hands-on learning. The entire table demonstrates the need to educate educators on the practical nature of science education.

Analysis of the availability of trained teachers

One of the most important requirements for every career is training. Skilled educators are regarded as excellent educators and exhibit high levels of professionalism. The government of Nepal gives government instructors a lot of training. Teachers employed in the private sector receive less training from commercial organisations. NCED offers government school teachers in Nepal training.

Table no. 6: Teacher training status in the study area

SN	Respondents	Yes	No	Total
1	Government school teachers	96	0	96 (64.42%)
2	Private school teachers	4 (2.68%)	49 (32.88%)	53 (35.57%)
Total		**149**	**0**	**149 (100%)**

Table 6 indicates that there are a total of 96 trained teachers in government schools, which accounts for 64.42% of the total. Only four out of all the remaining instructors in private schools, which account for 2.68%, have received training. The remaining 49, which accounts for 35.57% of the total, have not received training. This demonstrates that teachers employed by the government undergo extensive training and possess a higher level of competence. However, it is still necessary for teachers in private schools to receive training.

Science popularising activities in schools

Science clubs harness the energies of students and effectively employ their abilities and talents, so fulfilling their intrinsic goals and contributing to the holistic development of their personality… The Science Club facilitates the development of skills such as experimentation, critical thinking, and problem solving by bridging the divide between in-class and out-of-school learning.

Table no. 7: Status of science popularising activities in the school

SN	Respondents	Yes	No	Total
1	Government school teachers	2	94	96 (64.42%)
2	Private school teachers	10	43	53 (35.57%)
Total		**12**	**137**	**149 (100%)**

The data from Table 7 indicates a scarcity of science popularisation initiatives in both government and private institutions. Only two respondents who teach in public schools reported engaging in scientific popularisation initiatives at their school… In summary, it is necessary to carry out science popularisation initiatives in schools.

Students' assessment and results

Evaluating students is a critical aspect of the teaching process. Through observation, it has been determined that all teachers utilise both formative and summative evaluation methods as part of their regular teaching practices. Private schools administer formative tests more frequently than government institutions. The following are several sorts of assessments employed in scientific education.

Formative evaluation

Formative evaluation is used to monitor the educational progress of pupils during the teaching period. The main objective is to provide continuous feedback to both the teacher and student regarding their learning progress and areas for growth during the instructional process. Offering feedback to students helps to strengthen effective learning and identify specific learning deficiencies that need to be addressed. Offering feedback to a teacher provides essential information that may be utilised to modify classes and assess the necessity for both group and individual remedial work. Formative evaluation allows a teacher to consistently evaluate the advancement of students… The core principle of formative evaluation centres on the production of knowledge that can be used to modify or improve educational approaches.

Synthesis with respect to intended vs. enacted curriculum

During the investigation, the researcher found that the scientific teachers were providing instruction instead of enabling science lessons… Evidence indicates that science education in Nepalese schools mostly focuses on imparting information.

The above quantitative and qualitative findings across Kathmandu and Nuwakot show dominant textbook use during teaching, low utilisation of fully child-centred lesson plans, reliance on lecture and discussion over practical and heuristic approaches, infrequent practical work, uneven teacher training between government and private schools, and scarce science-popularising activities in both sectors. (Details summarised directly from Tables 2–8 and accompanying field narratives.)

DISCUSSION

The enacted classroom practices in secondary science remain predominantly textbook-bound and teacher-centred, diverging from curriculum intentions that emphasise facilitation and activity-based learning. Quantitatively, most teachers read from the textbook during instruction (115 of 149; 77.18%), underscoring a performative reliance on text rather than fluent, concept-driven teaching. Lesson planning was seldom child-centred: none of the teachers reported using fully child-centred plans, and the modal category was "least child-centred" (39.59%). Methodologically, lecture dominated (39.59%), whereas inquiry-oriented "heuristic" teaching was rare (4.02%), signalling limited uptake of constructivist pedagogies in day-to-day practice. Practical work was infrequent: over seven in ten teachers reported they never used a practical approach (71.14%), with government schools especially unlikely to do so. Beyond the classroom, science-popularising activities were scarce; only 12 of 149 respondents reported any such initiatives in their schools.

Qualitative accounts revealed a consistent pattern: private-school classrooms were described as "somewhat student-centred" under stronger administrative oversight and parental accountability, whereas government-school classrooms were more conventional, with weak monitoring and few consequences for poor outcomes. Together, the findings substantiate a marked intended–enacted curriculum gap in secondary science.

Comparison with prior literature

These results mirror the portrait in the literature of Nepal's "silent classroom" norms and teacher authority that constrains dialogue and critique (Thapaliya, 2022). Prior work documents expectations that students passively absorb content while teachers demonstrate solutions on the board—conditions antithetical to inquiry and debate (Shrestha, 2011). The present evidence of pervasive lecture, minimal child-centred planning, and rare practical work is therefore consistent with longstanding critiques of dogmatic, textbook-driven pedagogies in Nepal that foster rote learning rather than conceptual understanding. At the same time, the curriculum's constructivist orientation positions the teacher as a facilitator who scaffolds collaborative, contextualised problem-solving (Ozkan, 2022; Shrestha, 2011). The low adoption of heuristic and practical approaches observed here sits in tension with these theoretical commitments, reinforcing the gap between policy prescriptions and classroom realities (Cuban, 1984; Khanal, 2018; O'Toole Jr, 2004; Shah, 2021; Spillane et al., 2002). Moreover, earlier accounts attribute textbook dependency partly to resource constraints (Joshi & Dangal, 2020; Singh, 2024)—insufficient laboratories and facilities—again resonating with the limited practical work and thin ecosystem of science-popularising activities we documented.

Determinants and system-level interpretation

Two sets of determinants emerge. First, accountability and monitoring: private schools appear to enforce closer supervision and face immediate parental feedback, which teachers describe as pushing them toward more student-centred practice despite fewer formal trainings. Government schools report extensive training opportunities but minimal accountability and weaker oversight—conditions that teachers themselves connect to "subpar outcomes." Second, resources and enabling conditions: the scarcity of laboratories and peripheral supports (science clubs, exhibitions, Olympiads) likely depresses hands-on activity and inquiry practices, especially in government schools.

Against a constructivist policy backdrop, the system signals mixed incentives: curricular rhetoric promotes facilitation and practical work, yet institutional arrangements (assessment regimes, supervision, workloads) and school-level resource profiles nudge teachers back to coverage-driven lecturing and textbook reading.

Implications

For curriculum and assessment: Bridging the intended–enacted gap will require aligning assessment with inquiry and application, reducing incentives for coverage-only lectures and verbatim note-taking. The curriculum's social-constructivist aims should be operationalised through tasks that require investigation, collaboration, and contextualised problem-solving (Kivunja, 2014).

For teacher development: In-service support should pivot from generic "training received" to coaching on planning and facilitating child-centred lessons, with observation–feedback cycles tied to concrete artefacts (lesson plans, lab tasks, portfolios). The private-school pattern suggests that coaching, supervision and classroom-embedded accountability, not just workshop dosage, shape practice (Houston, 2015).

For school resourcing and the learning ecosystem: Expanding low-cost practical, mobile lab kits, and a structured programme of science-popularising activities (clubs, exhibitions, Olympiads) can scaffold inquiry when full laboratories are not immediately feasible. The literature details how such activities cultivate experimentation, critical thinking, and problem-solving and complement classroom learning (Hebebci & Usta, 2022; Tan et al, 2023).

For technology and supports: ICT integration, alongside teacher preparation to use it meaningfully, can diversify modalities and lower the activation energy for demonstrations and simulations in constrained settings—provided professional learning addresses design and pedagogy, not just hardware (Jung, 2005; Jimoyiannis, 2010; Lewis et al., Bell et al., 2013; 2014; Mpuangnan, 2024).

Strengths and limitations

A key strength is the mixed-methods, multi-site design across two districts, which triangulated survey evidence with qualitative accounts of classroom realities and school-level incentives, thereby deepening interpretation of the curriculum–practice divide. The study's limitations—documentation and access challenges, administrative bottlenecks, COVID-19 disruptions, and time constraints—may have constrained observation opportunities and the breadth of participating schools, potentially biasing estimates of practical work and extracurricular provision downward or upward, depending on which schools remained accessible.

Future research directions

Future work should (i) experimentally test packages that combine accountability (e.g., instructional coaching and observation rubrics) with enabling resources (mobile labs, micro-practical) to estimate causal impacts on enacted pedagogy and learning; (ii) trace within-teacher change over time as assessment tasks are redesigned to reward inquiry; (iii) study cost-effective models for science clubs and exhibitions that can be sustained in rural and low-resource schools; and (iv) compare how private and government schools respond to identical facilitation-focused PD when external monitoring is held constant, to isolate the role of incentives versus capacity.

CONCLUSION

This study examined the comparative status of curriculum-based and textbook-bound science teaching in secondary schools across the study area, documenting practices, constraints, and school-level differences to assess how far the intended curriculum is enacted in classrooms. Across sites, the enacted pedagogy was largely transmission-oriented. Teachers commonly read from the textbook during instruction, and classroom observations indicated that many were only converting textbook knowledge for the pupils, whereas practical classroom activities are crucial for developing cognitive capabilities through psychomotor engagement. Consistent with this, there were no fully child-centred lesson plans reported, and the prevailing tendency was toward the least child-centred approach.

Differences by school type were evident. Private schools were described as predominantly student-centred, linked to closer connections with training centres and stronger accountability, even when teachers received less training and lower compensation; government schools tended to be more conventional. Private-school teachers, concerned about job insecurity, reported employing child-centred learning approaches to the best of their knowledge, whereas in public schools, students' socio-economic origins, weak oversight, and a sense of job permanence impeded outcomes, together indicating a disparity in teaching methods between sectors. Training profiles reflected systemic asymmetries. The classroom in both sectors remained textbook-driven, while government-employed teachers reported extensive training, and only a few private-school teachers were trained. These patterns emphasise that teachers in private schools still require training and, more broadly, that instructors need to be made aware that the curriculum, not the textbook, should be used when teaching. Both curriculum and textbooks are crucial to science instruction: the curriculum is an all-encompassing educational method or plan, while the textbook is a resource created to support its goals; yet the study revealed universal textbook use, with limited teachers demonstrating familiarity with the curriculum.

The wider learning ecosystem for inquiry was thin. Schools seldom hosted science-popularising activities such as clubs, exhibitions, and Olympiads, indicating that conducting science-popularising activities in schools is necessary; assessment practices combined formative and summative approaches, with private schools more frequently administering formative tests. Taken together, the findings confirm a pronounced misalignment between curriculum intentions and enacted classroom practice. Over the past decades, there has been a significant impetus to improve attainment through reforms in curricula, instruction, and teacher preparation; this requires a shift in teachers' roles, from traditional knowledge transformers to facilitators, planners, mentors, and collaborative professionals, supported by enabling conditions of work and resources. Enhancing professionalism and aligning stakeholder expectations across public and private schools remains central to translating the curriculum into learner-centred, inquiry-oriented practice.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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