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Exploring Divergent Science Teaching Practices: Private versus Public Secondary Schools in Urban Areas of Rawalpindi, Pakistan

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Abstract

Science education is of great importance to national development; at the secondary level it lays the groundwork for future scientific research and technological progress. The standard of science education depends on the rigor of the curriculum and on the availability of instructional resources. The present study looked at the facilities available for science teaching in both public and private schools. Its main aim was to compare the quality of science education in these two sectors. The study included 80 participants (N = 80), consisting of students, teachers, and school administrators from public and private schools in urban areas of Rawalpindi, Pakistan. Data were collected through questionnaires and analyzed using frequencies, percentages, and the Chi-square (χ^2) test. The conclusions reached from the results showed that students in private schools were satisfied with their science experience, while those in public schools were not. On the basis of the findings, a number of recommendations were made to improve science teaching at the secondary level. These recommendations were to provide essential resources such as effective teaching methods, to promote inquiry-based learning, to incorporate hands-on experiments, to link science with real-life situations, to ensure access to technological resources (such as audiovisual aids), to set up well-equipped science laboratories and to have the necessary equipment, to carry out continuous professional training programmes for science teachers, and to revise and strengthen the curriculum so as to meet the challenges and demands of modern society.

Keywords: Science Education, Secondary Education, Private Schools, Public Schools, Urban Areas, Teaching Practices

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INTRODUCTION

STEM education in Pakistan is obviously not adequate, and in many instances, it is so poor that it causes students to give up on both government and private schools (Rehman et al., 2025). Hali et al. (2021) explain that Several problems still have a negative effect on the quality of science teaching and learning in Pakistan. The textbooks prepared for the educational boards of all the provinces are boring and uninteresting, frequently flooding students with an excessive amount of factual information. Because they are poorly printed and offer only limited explanations, they give very little attention to visual material. The teachers are either unqualified or have not received proper training, and as a result they are not inspiring. Many of them do not have enough knowledge of the subjects they are teaching, which in turn discourages students from asking questions and stifles their curiosity (Hali et al., 2021). The exams place a strong emphasis on memorization, so students have little motivation to understand or really grasp scientific concepts. Laboratory facilities are available only in elite private schools or in a small number of well-maintained public schools. In most public schools where laboratory equipment is present, students are not permitted to use it because of the fear of damaging it, and the equipment is used solely for teacher demonstrations and not for hands-on experiments (Batool et al., 2020; Farooq et al., 2017).

STEM education in Pakistan is still largely unsuccessful, and as a result many students come to fear studying science at both the secondary and college levels (Naviwala, 2016; Sain, 2023). A large number of students in the higher grades opt for subjects in the arts and commerce, mainly because of the way in which science is taught. The National Academies of Sciences (2017) stress that instruction in science demands a high degree of concentration and special pedagogical training to develop intellectual abilities and increase curiosity. For science education to be effective, it is necessary to have laboratory facilities which enable learners to investigate and verify scientific phenomena and to take part in inquiry-based learning in both public and private schools. Science textbooks should set out the concepts in a manner that encourages systematic exploration. The exercises at the end of each chapter should go beyond questions that only require recall and instead

include those that call for thinking, reasoning, and analysis – an approach which should also be applied in the examinations. Unfortunately, however, such practices are mostly missing in most schools in Pakistan, whether they are government-run or independent, except in a small number of expensive elite institutions. Consequently, only a small number of students actually learn science well, while the rest continue to have difficulties (Siddiqui & Gorard, 2017).

Teaching science is an art and skill that teachers learn, practice and share through their interactions with students in the classroom. Science is significant in public and private schools as it offers students general education which helps them to understand and appreciate scientific discoveries, inventions and social progress. In primary education, the stated aim is "to cultivate in children the spirit of inquiry and independent thought, the ability to apply knowledge to real-life situations, and to provide facilities for technical and scientific education as preparation for further professional education and careers" (Mansoor & Din, 2023).

Many factors affect the level of achievement in science among the students of public and private schools, but the research evidence supports the common sense belief that the personal attributes, knowledge, skills and competencies of science teachers; their educational qualifications; the teaching methodologies used; the availability of technological resources (audiovisual aids); the access to science laboratories and equipment; the provision of science teacher training programs; and revision and improvement of curriculum are critically important for effective science teaching in both sections (Mandokhail et al., 2025).

OBJECTIVES

The main objectives of this study are:

1. To compare the quality of science education in government and independent secondary academic institutions.
2. To evaluate the performance of government and independent secondary academic institutions in key areas affecting science education, including teacher qualifications, teaching methods, instructional resources, laboratory facilities, teacher training programs, and curriculum quality.

3. To identify the factors contributing to differences in learners' academic performance in science between government and independent secondary academic institutions.
4. To present a comprehensive set of recommendations for improving the teaching of science at the secondary level.

LITERATURE REVIEW

Educational Qualification of Science Teachers: Research indicates that science teachers in public schools are often not highly qualified in their subject areas. Because they are not selected on merit, many lack depth of subject knowledge needed to develop science-related pedagogical skills and competencies. These skills are essential to communicate scientific concepts in ways that are understandable and interesting, using appropriate analogies, examples, illustrations, explanations and demonstrations based on each pupil's current level of knowledge (Lemos & Fernandes, 2023). Public science teachers frequently struggle to set clear and explicit learning objectives, which further limit effective instruction. On the other hand, science teachers and head teachers in private schools are academically and professionally qualified, have good command over science teaching methodologies and are usually selected on the basis of relevant teaching experience (Lemos & Fernandes, 2023).

Science Teaching Methodologies: Bibi and Aftab (2021) reported that mostly scope of science teachers in public schools is limited to writing notes or reading from the textbook directly. The science classes are conducted without any lesson planning and are based on rote learning, where students are required to repeat without understanding underlying concepts. In contrast, science teachers in private schools show more motivating and engaging teaching behavior. They also take students on educational and field trips that enhance science learning, prepare technology-based lesson plans before instruction and assign concept-based homework that develops students' creative and critical thinking skills.

Technological Resources: A research study by Ibáñez, Portillo, Cabada, and Barrón (2020) found that science teachers in public schools rarely use audio-visual aids beyond basic tools like

blackboards, chalk, markers, and dusters. They struggle to use English as language of instruction in science classes. As a result, students often do not attend science lessons regularly. Additionally, teachers frequently arrive late and leave class early, which disrupts learning. In contrast, science teachers in private schools use wide range of audio-visual aids. These include computers, PowerPoint slides, videos, internet resources, pictures, voice recorders, tape recorders, documentaries, blackboards, whiteboards, chalk, markers, and dusters. Students actively engage in class activities, teachers complete science syllabus on time, and learners cooperate and respond well to teachers' questions during science lessons (Ibáñez et al., 2020).

Laboratories with Equipment: Studies show that science teachers in public schools rarely use computers or science labs for hands-on work. Many public schools do not have labs, and when they do, there often is not enough equipment. Public schools also tend to lack working libraries, and even when library is available, students usually cannot use it (Ameen & Ibrahim, 2022). On the other hand, science teachers and students in private schools often use computers and labs for practical lessons, and equipment is provided. Private schools also have libraries, and both teachers and students are allowed to use them (Ameen & Ibrahim, 2022).

Science Teacher Training Programs: Hali et al. (2020) report that public schools are generally unable to provide teachers and head teachers with opportunities for science-teaching training aimed at improving instructional skills. Even when such opportunities are available, most teachers do not participate in training sessions. Additionally, public school teachers are often unable to implement measures that could enhance academic standards of their science departments. In contrast, science departments in private schools facilitate teacher and head teacher training by collaborating with non-governmental organizations, resulting in higher participation rates. Science teachers in private schools also demonstrate proactive approach to improving their teaching methodologies, techniques, skills, and instructional styles.

Science Curriculum: The researcher notes that public schools are unable to change or improve their science curriculum. The science

curriculum in these schools is not very broad, and many students have negative opinions about its value. Public schools use Punjab textbooks for science, but content is about ten years old and only cover changes each year. Curricula should be updated regularly to include new knowledge, emerging fields, and advances in technology. There is also a need for more trained professionals in modern science and technology. On the other hand, private schools update their science curriculum every year and use Oxford textbooks to teach students (Telu, 2016).

RESEARCH GAP

Previous studies have discussed different areas of science education, but few have compared the quality of science education in government and private schools in urban areas of Rawalpindi. This study fills this gap by comparing both sectors through the views of students, teachers, and school administrators.

METHODOLOGY

Research Design

Creswell and Creswell (2017) highlighted that survey research is one of the most widely used approaches in education. It is used to measure attitudes, opinions, or achievements across different variables in natural settings. Survey research designs are generally classified into two types: longitudinal and cross-sectional, both of which are commonly applied to sample populations. In the present study, a cross-sectional survey design was adopted. This approach involves collecting data at a single point in time from a random sample representing same population at that moment (Cohen, Manion, & Morrison, 2018).

Population

Population of this study consisted of teachers, head teachers, and students at secondary level in urban areas of Rawalpindi, Pakistan. A total of ten schools were selected, including five from government sector and five from private sector.

Sampling

According to Best and Kahn (2016), an ideal sample is sufficiently large to represent population researcher intends to generalize too, yet small enough to be selected economically in terms of subject availability, time and financial costs, and deal with complexity of data analysis.

Sudman (1976) states that population was large and heterogeneous. Consequently, in this study, a stratified random sampling design was adopted. Therefore, total of ten schools was selected, five from public sector and five from private sector. Of these ten schools total sample consisted of 20 teachers, with 10 from government sector and 10 from private sector. Moreover, 10 head teachers, 5 from public sector and 5 from private sector; and 50 students, with 25 from government sector and 25 from private sector. The distribution of the sample by school sector is presented in Table 1.

Table 1

Distribution of Sample by School Sector

Sample Category	Public/Government Sector	Private Sector	Total
Schools	5 (50%)	5 (50%)	10 (100%)
Teachers	10 (50%)	10 (50%)	20 (100%)
Head Teachers	5 (50%)	5 (50%)	10 (100%)
Students	25 (50%)	25 (50%)	50 (100%)

Research Instrument

After specifying population and selecting sample, next step was to collect data relevant to the problem under investigation. Three separate questionnaires were used for this purpose, as presented in Tables 3, 4, and 5. A tailor-made instrument comprising 13 items in each questionnaire was developed for three participant groups (teachers, students, and head teachers). The items were derived from relevant content areas through consultation with a jury consisting of two experts in education and one expert in English language to evaluate content grammatical structure. Additionally, a review of the literature, and the investigator's professional judgment also play

key role in validating content of questionnaires. The researcher acted on experts' advice and made corrections to each questionnaire to improve its validity in terms of both content and language clarity. This process ensured the content validity of the questionnaire. Table 2 below presents Cronbach's alpha of all three study questionnaires.

Table 2

Cronbach's Alpha Reliability Coefficients of three study questionnaires

Variable	Number of Items	Cronbach's Alpha (α)	Interpretation
Head Teachers Questionnaire	13	0.72	Acceptable
Teachers' Questionnaire	13	0.77	Acceptable
Students' Questionnaire	13	0.71	Acceptable

Table 2 presents the reliability analysis of all three study questionnaires. Each questionnaire demonstrated acceptable internal consistency. Cronbach's alpha coefficients were 0.72 for head teachers' questionnaire scale and 0.77 for teachers' questionnaire scale, and lastly 0.71 for students' questionnaire scale. All values indicate satisfactory internal consistency and suggest that three questionnaires were reliable for evaluating and comparing the quality of science instructions in both government and independent schools.

Procedure

Researcher personally administered questionnaires to respondents. According to Best, a questionnaire administered personally has several advantages. Researcher had opportunity to establish rapport, clarify unclear questionnaire items, and take advantage of having multiple respondents in one place, thereby saving time and expenses.

Data Analysis

Data was analyzed using both descriptive and inferential statistical procedures. Frequencies and percentages were used for

item-wise descriptive analysis, while Chi-square (χ^2) test was used to compare responses of head teachers, teachers and students from public and private schools.

Limitations of Methodology

The study had a small sample of 10 schools and 80 participants, which may limit how widely the findings can be applied. Stratified random sampling was used to include both public and private schools, but only five schools from each sector were selected. For data analysis, Chi-square (χ^2) test was used as the only inferential test. Therefore, study mainly focused on comparing selected variables between private and government schools regarding the quality of science education.

Ethical Consideration Statement

This study received ethical approval from Ethical Review Committee of National University of Modern Languages (NUML), Islamabad, Pakistan. All research procedures were conducted in accordance with ethical guidelines of committee, principles outlined in 1964 Declaration of Helsinki and its subsequent amendments, and other relevant ethical standards for research involving human participants.

DATA ANALYSIS & INTERPRETATION

Data analysis was performed using SPSS. Results were presented in detail in report table 3, 4 and 5 given below to ensure transparency and facilitate interpretation and replication of analysis.

Table 3

Result Of Questionnaire for Head Teachers

Statements	**Private School Percentage (Frequency)**		**Public School Percentage (Frequency)**		**Chi-square (χ^2)**
Total Number of Head Teachers (10)	**(5)**		**(5)**		
Head Teachers	**Agreed**	**Disagreed**	**Agreed**	**Disagreed**	**χ^2**

All basic facilities are provided in science departments.	80% (4)	20% (1)	20% (1)	80% (4)	3.60
Laboratories with sufficient equipment are available.	80% (4)	20% (1)	20% (1)	80% (4)	3.60
All necessary A.V. aids are available in science classrooms, which teachers use for effective teaching.	80% (4)	20% (1)	20% (1)	80% (4)	3.60
Teachers assign concept-based homework related to real-life situations.	80% (4)	20% (1)	40% (2)	60% (3)	1.67
Education in schools focuses on learning by doing rather than rote memorization.	80% (4)	20% (1)	40% (2)	60% (3)	1.67
Educational trips, science exhibitions, and co-curricular activities are organized in schools.	100% (5)	0% (0)	20% (1)	80% (4)	6.67
Parent-teacher meetings are regularly held.	100% (5)	0% (0)	60% (3)	40% (2)	2.50
Science teachers are academically qualified, and skilled in effective teaching methodologies.	80% (4)	20% (1)	80% (4)	20% (1)	0.00
Science curriculum in school is up-to-date and revised periodically.	80% (4)	20% (1)	40% (2)	60% (3)	1.67
Science teachers design modern	80% (4)	20% (1)	20% (1)	80% (4)	3.60

lesson plans that motivate students.					
You are working to raise academic standards while organizing teacher training to enhance science teachers' skills.	80% (4)	20% (1)	60% (3)	40% (2)	0.48
Student-teacher ratio is higher in your science departments.	60% (3)	40% (2)	80% (4)	20% (1)	0.48
Library is available in your school, and students and teachers are encouraged to make use of it.	80% (4)	20% (1)	20% (1)	80% (4)	3.60

The following findings are designed from analysis of questionnaires

1. In public schools, 20% of head teachers agreed that all basic facilities are available in their schools, including science departments, while in private schools, 80% of head teachers agreed. Despite this difference, Chi-square value ($\chi^2 = 3.60$) indicates that responses of head teachers from both two school types are similar.
2. In public schools, 20% of head teachers agreed that labs with sufficient instruments are available, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 3.60$) indicates little difference between responses of head teachers from public and private schools.
3. In public schools, 20% of head teachers agreed that all necessary A.V. aids are available in science classrooms and that teachers make use of them for effective teaching, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 3.60$) suggests that responses of public and private school head teachers are broadly similar.
4. In public schools, 40% of head teachers agreed that teachers assign concept-based homework and relate it to daily life, while 80% of private school head teachers agreed. Chi-square

value ($\chi^2 = 1.67$) suggests that responses of public and private school head teachers are broadly similar.

5. In public schools, 40% of head teachers agreed that education in their schools occurs through learning by doing instead of rote memorization, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 1.67$) suggests that responses of public and private school head teachers are broadly similar.
6. In public schools, 20% of head teachers agreed that educational trips, science exhibitions, and co-curricular activities are organized in their schools, while 100% of private school head teachers agreed. Chi-square value ($\chi^2 = 6.67$) indicates noticeable difference in responses of public and private school head teachers.
7. In public schools, 60% of head teachers agreed that they arrange parent-teacher meetings, while 100% of private school head teachers agreed. Chi-square value ($\chi^2 = 2.50$) suggests that responses of public and private school head teachers are generally similar.
8. In public schools, 80% of head teachers agreed that their science teachers are academically qualified, and have command over their teaching methodology, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 0.00$) indicates that responses of public and private school head teachers are identical.
9. In public schools, 40% of head teachers agreed that the science curriculum in their schools is up-to-date and revised from time to time, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 1.67$) suggests that responses of public and private school head teachers are broadly similar.
10. In public schools, 20% of head teachers agreed that their teachers are designing modern, up-to-date lesson plans and that their behavior towards students is motivating, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 3.60$) shows that there is no meaningful variation in responses between two groups.
11. In public schools, 60% of head teachers agreed that they take necessary actions to raise the academic standard of their schools and arrange teacher training programs for science

teachers to improve their teaching skills, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 0.48$) indicates very little difference between responses of public and private school head teachers.

12. In public schools, 80% of head teachers agreed that the student-teacher ratio is higher in their science departments, while 60% of private school head teachers agreed. Chi-square value ($\chi^2 = 0.48$) indicates very little difference between responses of public and private school head teachers.
13. In public schools, 20% of head teachers agreed that a library is available in their schools and that students/teachers are allowed to benefit from it, while 80% of private school head teachers agreed. Chi-square value ($\chi^2 = 3.60$) indicates little difference between responses of head teachers from public and private schools.

Table 4

Result Of Questionnaire for Teachers

Statements	**Private School Percentage (Frequency)**		**Public School Percentage (Frequency)**		**Chi-square (χ^2)**
Total Number of Teachers (20)	**(10)**		**(10)**		
Teachers	**Agreed**	**Disagreed**	**Agreed**	**Disagreed**	**χ^2 value**
Teachers design technology-based lesson plans before teaching science classes.	70% (7)	30% (3)	10% (1)	90% (9)	7.50
All necessary A.V. aids are available in science classrooms	80% (8)	20% (2)	20% (2)	80% (8)	7.20

that teachers use to actively engage students.					
You assign conceptual homework to students according to schedule.	70% (7)	30% (3)	30% (3)	70% (7)	3.20
You complete course on time, also organize parent-teacher meetings.	70% (7)	30% (3)	40% (4)	60% (6)	1.82
Your teaching primarily involves dictating notes and having students memorize science lessons.	50% (5)	50% (5)	70% (7)	30% (3)	0.83
Students attend science classes regularly also respond to your questions during lessons.	80% (8)	20% (2)	40% (4)	60% (6)	3.33

Laboratories with sufficient instruments are available, and you use them effectively for science teaching.	80% (8)	20% (2)	20% (2)	80% (8)	7.20
School library is available, and you are encouraged to make use of it.	70% (7)	30% (3)	20% (2)	80% (8)	5.05
Schools provide professional development opportunities to help teachers improve teaching methods and instructional practices.	80% (8)	20% (2)	60% (6)	40% (4)	0.95
You are taking necessary actions to raise academic standards of school.	80% (8)	20% (2)	20% (2)	80% (8)	7.20
To foster motivated behavior	70% (7)	30% (3)	40% (4)	60% (6)	1.82

toward science teaching, you organize field trips for students.					
You are academically and professionally qualified, with strong command of teaching techniques.	90% (9)	10% (1)	70% (7)	30% (3)	1.25
The favorable student-to-teacher ratio contributes to a high pass percentage.	90% (9)	10% (1)	30% (3)	70% (7)	7.50

The following findings are designed from analysis of questionnaires

1. In public schools, 10% of teachers agreed that they design technology-based lesson plans before teaching/taking science classes, while in private schools, 70% of teachers agreed. Higher chi-square value ($\chi^2 = 7.50$) means bigger difference between private and public-school teachers.
2. In public schools, 20% of teachers agreed that all necessary audio-visual aids are available in their science classes, and they use them to teach, with students taking an active part in class. However, in private schools, 80% of teachers agreed. High chi-square value ($\chi^2 = 7.20$) shows clear difference between two groups.
3. In public schools, 30% of teachers agreed that they assign science students conceptual-based homework according to the schedule, which develops/improves creative/critical thinking in them. In private schools, 70% of teachers agreed. Chi-square

value ($\chi^2 = 3.20$) is lower means moderate difference between public and private schools' teachers.

4. In public schools, 40% of teachers agreed that they complete science courses on time, also arrange parent-teacher meetings, whereas in private schools, 70% of teachers agreed. Chi-square value of 1.82 means there is small difference between private and public-schoolteachers for that statement.
5. In public schools, 70% of teachers agreed that their teaching is limited to dictating notes. They ask students to rote-memorize science lessons. However, in private schools, 50% of teachers agreed. Chi-square value of 0.83 means minor difference in teaching style between private and public schools.
6. In public schools, 40% of teachers agreed that their students attend science classes regularly and also show cooperation/response to their questions when learning science. Whereas, in private schools 80% of teachers agreed. Chi-square value of 3.33 means moderate difference, with private school students showing better participation.
7. In public schools, 20% of teachers agreed that all necessary lab equipment is available in their science department, and they use labs (both computers and science) for experimental/practical work in teaching science subjects. In private schools, 80% of teachers agreed. High chi square value ($\chi^2 = 7.20$) shows clear difference between two groups.
8. In public schools, 20% of teachers agreed that library is available in science department, and they are allowed to benefit from it, while in private schools, 70% of teachers agreed. Chi-square value of 5.05 means strong difference between private and public-schoolteachers.
9. In public schools, 60% of teachers agreed that they improve their teaching methodologies on their own and that science department gives them opportunities for training in order to improve their teaching skills. Whereas, in private schools 80% of teachers agreed. Chi-square value of 0.95 means very small difference between private and public-schoolteachers.
10. In public schools, 20% of teachers agreed that they are taking necessary actions that may help raise academic standard of their science department. However, in private schools, 80% of

teachers agreed. High chi-square value ($\chi^2 = 7.20$) shows clear difference between two groups.

11. In public schools, 40% of teachers agreed that their behavior when taking science classes is motivating and they arrange educational/field trips for science students. However, in private schools, 70% of teachers agreed. Chi-square value of 1.82 means small difference between private and public-schoolteachers.
12. In public schools, 70% of teachers agreed that they are qualified academically as well as professionally, with command over their teaching methodology for science, while in private schools, 90% of teachers agreed. Chi-square value of 1.25 means small difference between private and public-schoolteachers.
13. In public schools, 30% of teachers agreed that in their schools, ratio of science teachers to students is higher, and there are higher pass percentage of students in their science subjects. In private schools, 90% of teachers agreed. Chi-square value of 7.50 means strong difference between private and public-schoolteachers.

Table 5

Result Of Questionnaire for Students

Statements	**Private School Percentage (Frequency)**		**Public School Percentage (Frequency)**		**Chi-square (χ^2)**
Total Number of Students (50)	**(25)**		**(25)**		
Students	**Agreed**	**Disagreed**	**Agreed**	**Disagreed**	**χ^2 value**
Your teachers have a strong command of their subjects, making	92% (23)	8% (2)	40% (10)	60% (15)	15.15

lectures clear and easy to understand.					
You are satisfied with science facilities available in your school, including labs, instruments, library, etc.	96% (24)	4% (1)	20% (5)	80% (20)	29.17
You enjoy science and wish to continue studying at same school due to passion for subject.	80% (20)	20% (5)	40% (10)	60% (15)	8.33
Science-related exhibitions, competitions, and study tours are organized at your school.	96% (24)	4% (1)	20% (5)	80% (20)	29.17
To motivate and encourage students, teachers use audiovisual aids.	92% (23)	8% (2)	20% (5)	80% (20)	26.04
Your academically	88% (22)	12% (3)	40% (10)	60% (15)	12.50

qualified science teachers follow a modern, up-to-date curriculum.					
Education at your school emphasizes learning by doing, rather than rote memorization.	96% (24)	4% (1)	40% (10)	60% (15)	17.58
Your teachers assign concept-based homework relevant to daily life.	92% (23)	8% (2)	48% (12)	52% (13)	11.41
Student-teacher ratio is favorable at your school.	40% (10)	60% (15)	40% (10)	60% (15)	0.00
Monthly and weekly tests are conducted at your school.	96% (24)	4% (1)	40% (10)	60% (15)	17.58
Discipline is maintained in your science classrooms.	96% (24)	4% (1)	60% (15)	40% (10)	9.42
Oral assessments are	80% (20)	20% (5)	40% (10)	60% (15)	8.33

conducted in your science classrooms.					
Teachers arrive on time and leave class on time.	92% (23)	8% (2)	60% (15)	40% (10)	7.02

The following findings are designed from analysis of questionnaires

1. In public schools, 40% of students agreed that their science teachers have a strong command of subjects, deliver lectures that are easy to understand, and students are satisfied with teaching methods, while 92% of private school students agreed. Chi-square value $\chi^2 = 15.15$ shows very large difference between private and public-school students answers.
2. In public schools, 20% of students agreed that they are satisfied with science facilities available in their schools, such as labs, instruments, and library, etc., while 96% of private school students agreed. This $\chi^2 = 29.17$ value shows extremely large difference between private and public-school students' responses.
3. In public schools, 40% of students agreed that they like science and want to study in same school, while 80% of private school students agreed. Chi-square value of 8.33 shows large difference between private and public-school students' responses.
4. In public schools, 20% of students agreed that science-related competitions, exhibitions, and study tours are organized in their schools, while 96% of private school students agreed. This $\chi^2 = 29.17$ value shows extremely large difference between private and public-school students answers.
5. In public schools, 20% of students agreed that their teachers use A.V. aids for teaching, and that their teachers' behavior is motivating, this encourages students. However, 92% of private school students agreed. Chi-square value of $\chi^2 = 26.04$ shows very large difference between private and public-school students' responses.
6. In public schools, 40% of students agreed that their science teachers are academically qualified and that their curriculum is

up to date, while 88% of private school students agreed. This value of $\chi^2 = 12.50$ shows very large difference between private and public-school students answers.

7. In public schools, 40% of students agreed that learning in their science class occurs through "learning by doing" instead of rote memorization, while 96% of private school students agreed. Chi-square value of $\chi^2 = 17.58$ shows very large difference between private and public-school students' responses.
8. In public schools, 48% of students agreed that their teachers assign concept-based homework and relate it to daily life. However, 92% of private school students agreed. This value of $\chi^2 = 11.41$ shows large difference between private and public-school students answers.
9. In public schools, 40% of students agreed that student-teacher ratio is higher in their school, while 40% of private school students agreed. This value of $\chi^2 = 0.00$ shows no difference at all between private and public-school students' responses.
10. In public schools, 40% of students agreed that monthly/weekly tests are arranged in their schools, while 96% of private school students agreed. Chi-square value of $\chi^2 = 17.58$ shows very large difference between private and public-school students answers.
11. In public schools, 60% of students agreed that discipline is maintained in their science classrooms, while 96% of private school students agreed. This value of $\chi^2 = 9.42$ shows large difference between private and public-school students' responses.
12. In public schools, 40% of students agreed that oral assessments are conducted by teachers in their science classrooms, while 80% of private school students agreed. Chi-square value of shows $\chi^2 = 8.33$ large difference between private and public-school students answers.
13. In public schools, 60% of students agreed that their teachers come in and leave class on time, while 92% of private school students agreed. This value of $\chi^2 = 7.02$ shows large difference between private and public-school students' responses.

DISCUSSION

Overall, results from all three of the study participants, head teachers, teachers, and students, revealed that the quality of science education in private schools is better than what is the case in public secondary schools. The results were more prominent based on the responses from the student survey questionnaire. To add credibility to the results obtained, another study conducted by Nadeem, Qamar, and Aziz (2025) was reviewed. Their work was carried out in Pakistan to determine the level of science teachers' overall professionalism, as well as teaching quality, in both public and private institutions. The results were based on data collected from a larger audience of students and teachers compared to the sample size used in this study. The findings revealed that science teachers in private schools are more professional in terms of such indicators as teaching quality and use of resources than their colleagues in public institutions.

Based on the questionnaire results, the science education in private institutions was considered more effective in comparison with the public ones in terms of qualification of teachers, methods of teaching, equipment, laboratory practice, teacher training programs, and quality of curriculum. Similar findings reported by Shahzadi, Ali, and Mahmood (2022) conducted a study among eighty public and private school teachers in Punjab, Pakistan. The participants completed questionnaires and interviews. In general, both male and female teachers reported that the process of science teaching was more effective in private institutions compared to public ones due to appropriate methods and strategies.

To begin with, the overall results of the questionnaires showed that students' performance in the science sector was comparatively better in the private sector. The main reason to consider this information is a study conducted in Pakistan, where scientists analyzed the examination results of more than 15,000 students who studied in more than 150 public and private schools. These students were tested in science and math, and the results showed that those who studied in private educational institutions had comparatively better results and understanding of these subjects (Bhutta, Ahmad, & Ansari, 2024).

CONCLUSION

The results of this study demonstrated that students studying in private educational institutions were generally more satisfied with various aspects of science instruction such as collaborative work of teachers, methods of instruction, available teaching resources and equipment, laboratory opportunities, and scope for engaging in academic activities than their counterparts in public schools. In addition, achievement levels of private school students in science subjects were also found to be comparatively higher. Nevertheless, quality of science education provided in public schools can be further improved considering multiple factors affecting instruction, including availability of professional teachers, effective teaching methods, access to relevant resources, and implementation of appropriate curricula. In the local context, greater attention should also be given to strengthening science facilities and practical learning opportunities in public schools, particularly in disadvantaged and underserved communities, so that students have more equitable access to quality science education. Accordingly, a number of recommendations were made in order to ensure improvement of science education in public schools and bridge existing gap between public and private education.

RECOMMENDATIONS

In light of above data analysis and conclusion, researcher makes the following recommendations:

- Government oversight mechanisms should be strengthened to ensure proper check-and-balance systems aimed at improving quality and performance of public schools. Monitoring of private schools should also be enhanced, with government formulating clear rules and regulations to promote harmony in curriculum and science faculty standards.
- Science fairs, science exhibitions, study tours, and other competitions related to promotion of science in private and government schools should be encouraged and sponsored.
- Science curriculum should be revised, with more interesting topics included in books. Design of science subject books, illustrations, and experimental pictures should be made attractive for students in both public and private schools.

- At secondary level, it is important that teachers, especially science teachers, be appointed based on merit and relevant qualifications in both public and private schools.
- Heads of public schools should organize seminars, conferences, workshops, and symposia from time to time with help of private sector institutions.
- Separate administrators with backgrounds in science should be appointed in both public and private schools.
- Public and private schools must significantly enhance their capacity to manage and support professional development of science teaching staff, especially at leadership, academic, management, and coordination levels. We should encourage science teachers to adopt new teaching strategies and enhance professional practice of science teaching in both public and private schools.
- Government should provide necessary facilities in secondary schools and offer special allowances and incentives to science teachers to enhance teaching effectiveness.
- Teacher training institutions should revise curricula to focus on modern science teaching methodologies and provide proper in-service training for science teachers in both public and private secondary schools.

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