Challenges of Secondary School Science Teachers: A Pragmatic Perspective

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Abstract

This study explored the challenges faced by secondary school science teachers in Lahore regarding instructional methodologies, qualification relevance, use of equipment, and professional development. Employing a mixed-method approach within the pragmatic paradigm, data were collected from 200 science teachers through a structured questionnaire and from 12 participants through semi-structured interviews. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were thematically analyzed. Results revealed that most teachers possessed relevant qualifications and confidence in teaching science; however, they encountered significant obstacles related to limited laboratory resources, inadequate professional development, and administrative constraints. The lack of practical training, large class sizes, and insufficient access to modern teaching aids further restricted the implementation of inquiry-based learning. Qualitative findings confirmed that institutional support, resource provision, and sustained professional development are essential for improving instructional quality. The study concludes that the challenges faced by science teachers are largely organizational rather than individual and recommends ongoing, context-based professional development and better resource allocation. Addressing these issues will enhance science teaching effectiveness and foster scientific literacy among students at the secondary level.

Keywords: *Science Education, Secondary teachers, Instructional challenges, Professional development, Pakistan*

Introduction

Science education is the foundation for understanding the natural world, promoting innovation, and addressing the challenges of modern society. It develops knowledge, skills, and attitudes that enable individuals to comprehend natural phenomena and the influence of human activity on the environment. At the secondary level, science teachers play a critical role in shaping students' understanding and curiosity toward scientific inquiry. However, they face numerous pedagogical, institutional, and societal challenges that affect the effectiveness of science instruction and the achievement of learning outcomes (National Science Board, 2020).

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The present study was undertaken to explore the challenges faced by secondary school science teachers. Teachers often encounter constraints related to instructional methodologies, qualification relevance, professional development, and limited access to equipment and resources. These challenges hinder their ability to effectively engage students in science learning and create inquiry-based or project-based learning environments (National Science Board, 2020). Science teachers must also integrate technology, address scientific misconceptions, and maintain laboratory safety, all while ensuring that assessments accurately reflect student understanding.

Administrative and policy-related barriers further compound these difficulties. Teachers are required to cope with frequent curriculum revisions, standardized testing pressures, and institutional budget limitations, all of which restrict flexibility and creativity in classroom practice. At the same time, teachers must balance their workload while keeping abreast of educational research and subject-specific advancements (National Science Board, 2020). Insufficient access to quality textbooks, laboratory materials, and updated facilities, particularly in public-sector schools, exacerbates the resource gap and limits hands-on learning opportunities.

In addition, societal and cultural factors—including low science literacy, limited parental support, and misconceptions about science as a "difficult" subject—further hinder students' engagement and interest (National Science Board, 2020). Despite these constraints, the importance of science education remains undeniable. It is essential not only for individuals' intellectual growth but also for the progress and sustainability of societies at large (Brodowicz, 2024).

Science education equips learners with critical thinking, analytical, and problem-solving skills, empowering them to make informed decisions and engage meaningfully in civic and global issues. It enhances curiosity, creativity, and evidence-based reasoning, competencies indispensable for thriving in an increasingly technological world (Rauf et al., 2021). On a societal scale, science education drives economic development, innovation, and environmental sustainability, while preparing students for STEM-related careers and interdisciplinary problem-solving. Globally, it supports international collaboration and addresses pressing issues such as climate change, pandemics, and resource management (Rauf et al., 2021).

A growing international consensus highlights the relevance of science education for employability and competitiveness. A 2018 study reported that 79% of U.S. workers viewed a strong background in science, technology, engineering, and mathematics (STEM) as crucial for career success. Similarly, the Association for Science Education emphasizes that high-quality science education cultivates critical thinking and problem-solving skills applicable across fields. The OECD (2020) found that 93% of employers consider science education essential for preparing young people to compete in the global job market (Sims et. al., 2024).

Thus, understanding and addressing the multifaceted challenges faced by secondary school science teachers is vital for improving instructional quality and fostering scientific literacy among students.

Objectives of the Study

The study aimed to achieve the following objectives:

1. To find out the relevance of the qualification of science teachers at the secondary level.
2. To investigate the challenges faced by secondary school science teachers in using instructional methodologies for teaching science subjects.
3. To identify the challenges faced by secondary school science teachers in the use of equipment.
4. To explore the challenges of secondary school science teachers regarding their professional development.

Research Questions

The study was guided by the following research questions:

1. What is the relevance of the qualification of science teachers at the secondary level?
2. What challenges do secondary school science teachers face in using instructional methodologies for teaching science subjects?
3. What challenges do secondary school science teachers face in using equipment for teaching science?
4. What challenges do secondary school science teachers face regarding their professional development?

Review of Literature

Science education is defined as "the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence" (Science Council, 2022). It involves teaching and learning science to students of all ages, encompassing areas such as scientific content, process skills, and pedagogical approaches (MacDonald, 2025). Science education has transformed human life and contributed to modern comfort, communication, and efficiency through technological advancements (Wajid et al., 2025). The integration of information technology and communication systems—such as computers, mobile phones, and the internet—has revolutionized education and social interaction (Ejaz et al., 2025).

Research in Pakistan and elsewhere shows that secondary-level science teachers face persistent challenges that affect teaching quality. Lack of laboratory facilities, insufficient teaching materials, and outdated curricula are among the most cited barriers (Ahmad et al., 2021; Baber et al., 2023). Many teachers report difficulty integrating technology into lessons due to unreliable internet, poor infrastructure, and inadequate training (Gul et al., 2023). Professional development remains inconsistent and often disconnected from teachers' real needs, limiting its practical impact (Demir

& Qureshi, 2019). These deficiencies contribute to low confidence in teaching complex scientific concepts and reliance on lecture-based instruction.

The curriculum itself is often overloaded and overly theoretical, discouraging inquiry-based learning (Baber, 2022). Administrative workload, under-resourced schools, and societal expectations further burden teachers, resulting in stress and diminished motivation (Shahzad et al., 2024). Gender-specific constraints, especially for female teachers in remote areas, exacerbate these difficulties (Mehmood et al., 2024). Policy reforms such as the Single National Curriculum have been implemented with minimal teacher input, widening the gap between classroom realities and national objectives (Gul et al., 2023).

International standards such as the National Science Education Standards (NSES) emphasize inquiry, scientific literacy, and equitable access to science learning (Feldman et al., 2025; Lyle et al., 2023). These standards advocate for active learning environments, teacher empowerment, and system-wide support for science education (Hou et al., 2025). However, despite such frameworks, teachers worldwide continue to face challenges related to resources, curriculum relevance, and training (Calo & De Vera, 2025).

A recurring theme in the literature is the importance of laboratory work and hands-on learning for developing scientific reasoning and creativity. Yet, inadequate facilities, lack of expertise, and insufficient materials hinder effective laboratory instruction (Villaver et al., 2023). Research underscores that modern science education must prioritize inquiry-based and project-based learning, supported by adequate funding and teacher training (Hu & Bi, 2025; Mangarin et al., 2024; School Drillers, 2023).

Teachers often struggle with interdisciplinary approaches in STEM due to limited specialization beyond their primary subject area (Mangarin et al., 2024). The ever-changing nature of science curricula also poses adaptation difficulties, particularly when teachers receive little guidance or resources to implement reforms (Fazio et al., 2025; Villaver et al., 2023). Outdated curricula that neglect emerging fields such as artificial intelligence and biotechnology further disconnect classroom teaching from real-world applications (Jones et al., 2025).

Student engagement is another major concern. Traditional lecture-based teaching often fails to stimulate curiosity or sustain interest, while interactive and inquiry-based methods have shown greater effectiveness (Surya, 2024; Villaver et al., 2023). Similarly, the dominance of standardized testing pressures teachers to emphasize rote learning rather than critical thinking and experimentation (Resnick, 2023).

Technological challenges, such as poor connectivity, limited digital literacy, and inadequate access to devices, are common in developing countries and rural schools (Al Thani & Al Shafi, 2023; Aragba, 2023; ; Good Things Foundation, 2024; Yadav & Bhardwaj, 2022). Teachers' limited confidence in using digital tools for instruction remains a key barrier (Ali & Jamil, 2023; Maboya & Tiba, 2024). Effective

technology integration requires both infrastructure and sustained teacher training (Gull et al., 2023; Abbas et al., 2025).

Professional development (PD) is a recurring focus across studies. Research shows that short-term workshops are insufficient to produce lasting pedagogical change (Couture et al., 2024; Zhou et al., 2023). Long-term, reflective, and collaborative PD models, such as mentoring and lesson study, have been more successful globally (Kaur et al., 2024; Mavhunga, 2020). Countries like Estonia, China, and Ireland have institutionalized digital and AI-supported PD programs for teachers (Dellagnelo, 2023; Toome, 2023).

In Pakistan, however, PD remains fragmented and uneven. Teachers report that most programs are short, lecture-based, and disconnected from classroom realities (Bano & Mehdi, 2024). Recent initiatives such as the Holistic Science Teaching Fellowship and online professional learning platforms show promise but remain limited in scale and accessibility (Pakistan Innovation Foundation, 2025; Nawab & Quraishi, 2024). The literature consistently concludes that sustained, needs-based, and context-sensitive professional development supported by institutional leadership is crucial to improving science teaching quality (Nazir et al., 2025; Qaisara & Haider, 2024).

Methodology

This study adopted a mixed-method research approach within the pragmatic paradigm. The pragmatic paradigm emphasizes the use of both quantitative and qualitative data to gain a comprehensive understanding of educational problems. In the context of this research, it allowed the investigator to explore the challenges faced by secondary school science teachers through statistical trends and personal opinions, thereby combining the objectivity of quantitative measures with the depth of qualitative inquiry.

Research Design

A descriptive survey design was used to identify and analyze the challenges that secondary school science teachers encounter in their professional practice. This design was suitable because it enabled the researcher to collect information from a relatively large number of participants and to describe their experiences, perceptions, and opinions as they existed in natural educational settings.

Population and Sampling Procedure

The target population of the study consisted of all science teachers working in government secondary schools in Lahore. From this population, a sample of two hundred (200) science teachers was selected through convenience sampling, ensuring representation across subject specializations: physics, chemistry, and biology, and including both male and female teachers.

The purposive selection of 12 secondary school male and female science teachers for interview allowed the researcher to focus on teachers directly involved in teaching

science subjects at the secondary level, who were most likely to experience the identified challenges.

Research Instruments

Two main tools were used for data collection:

1. **A structured questionnaire**, developed by the researcher, served as the quantitative instrument. It consisted of closed-ended items rated on a Likert scale designed to measure teachers' perceptions of challenges related to qualifications, instructional methodologies, use of equipment, and professional development.
2. **A semi-structured interview guide**, used for qualitative data collection, provided open-ended questions that encouraged participants to elaborate on their experiences and suggest possible solutions.

Validity and reliability of the instruments

Both instruments were developed by the researcher after an extensive review of the literature and were validated by experts in science education and educational research. The pilot testing conducted on 20 (10%) of the sample ensured clarity of items and internal consistency of the questionnaire. The Cronbach Alpha value for the 5-point Likert Scale was .79, determining its reliability. The interview schedule was flexible and exploratory, allowing follow-up questions based on the respondents' initial answers. Together, these instruments provided complementary data for triangulation. It was validated by 5 experts in education and Senior Science teachers.

Data Collection Procedure

Data were collected personally by the researcher after obtaining formal permission from the relevant educational authorities. The questionnaires were distributed and collected from participants in person, ensuring a high response rate. Interviews were conducted face-to-face with selected teachers to gain deeper information. Ethical considerations such as informed consent, confidentiality, and voluntary participation were strictly maintained throughout the process.

Results

Quantitative Data Analysis

Table 1.

Teachers' Qualifications and Certification Relevance (N = 200)

Statement	M	SD	%
I hold a specialized degree in the science subject I teach.	1.54	0.81	91%
My teaching certification is relevant to the science subject I teach.	1.49	0.69	90%
My teaching experience is sufficient to teach science effectively.	1.49	0.71	96.5%
I feel confident in my ability to teach science.	1.34	0.61	93%

Note. Scale range: 1 = Strongly Agree to 5 = Strongly Disagree.

The results revealed that the majority (91%) of secondary school science teachers were academically qualified in their respective subjects, and 90% of the teachers held appropriate teaching certifications relevant to their science subjects, reflecting compliance with professional standards. Furthermore, 96.5% of the teachers expressed a high level of self-efficacy in teaching science. However, 93% of the teachers were confident in teaching science subjects.

Table 2.

Use of Instructional Strategies (N = 200)

Statement	M	SD	%
I am up to date with the latest developments in my science subject area.	1.71	0.80	85%
I use project-based learning effectively in my science class.	1.87	0.98	82%
Inquiry-based learning is challenging to implement in my class.	2.73	1.26	66%

Note. Scale range: 1 = Strongly Agree to 5 = Strongly Disagree.

As shown in Table 2, teachers are aware of innovative instructional methods such as project-based and inquiry-based learning; 85% and 82%, respectively; however, implementation remains challenging. Although most teachers value active learning, resource limitations, large class sizes, and time constraints hinder effective execution. These findings align with prior research (Resnick, 2023; Surya, 2024), suggesting systemic barriers to pedagogical innovation in science classrooms.

Table 3.

Availability and Use of Resources (N = 200)

Statement	M	SD	%
I have access to the necessary equipment for teaching science.	2.30	1.18	67%
I struggle to find alternative equipment for teaching science.	2.23	1.22	69%
Equipment calibration is a challenge.	2.38	1.20	65%
I receive adequate training for science equipment usage.	2.52	1.47	62%

Note. Scale range: 1 = Strongly Agree to 5 = Strongly Disagree.

The results in the table indicate that science teachers face many challenges related to instructional resources and equipment. About 67% of teachers reported having access to necessary equipment, yet this access remains inconsistent across schools. A slightly higher 69% of respondents stated they struggle to find alternative equipment when standard tools are unavailable, highlighting a lack of resource flexibility. Moreover, 65% of teachers identified equipment calibration as a persistent challenge. Only 62% agreed that they receive adequate training in using science equipment, indicating that professional preparation for laboratory work is limited.

Table 4.

Professional Development Opportunities (N = 200)

Statement	M	SD	%
Professional development aligns with my teaching needs.	2.10	1.14	72%
PD addresses emerging trends in science education.	1.94	1.11	75%
PD supports technology integration in science learning.	1.95	1.02	74%

The findings indicate that a majority of teachers recognize the value and relevance of professional development (PD) programs to their instructional needs. Approximately 72% of teachers agreed that PD activities align with their teaching requirements, while 75% acknowledged that such programs address emerging trends in science education. Similarly, about 74% confirmed that PD supports the integration of technology in science classrooms. However, the slightly higher mean scores suggest that the availability and consistency of these opportunities remain uneven across schools.

Table 5.

Independent Samples t-test: Comparison of Public and Private Schools

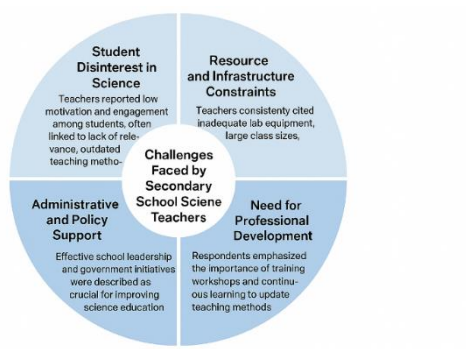
Institute Type	N	Mean	SD	df	t	Sig.
Public	90	64.04	13.212	177	-2.235	0.027
Private	110	68.59	13.975			

An independent samples t-test was conducted to determine whether there is a statistically significant difference in the level of instructional challenges faced by science teachers based on the type of educational institute (public vs. private). The *t-value* is -2.235 with 177 degrees of freedom, and the significance level (p-value) is 0.027. Teachers in private schools (M = 68.59, SD = 13.98) reported significantly higher levels of instructional challenges compared to those in public schools (M = 64.04, SD = 13.21).

Qualitative Data Analysis

Thematic analysis of 12 interviews revealed four main themes:

Figure 1: *Major Challenges faced by Secondary School Science Teachers*



1. **Student Disinterest in Science:** Teachers reported low motivation and engagement among students, often linked to a lack of relevance, outdated teaching methods, and limited exposure to practical learning. *"Since many students show little interest in science, I often have to revisit basic concepts before introducing new ones."P4*
2. **Resource and Infrastructure Constraints:** Teachers consistently cited inadequate lab equipment, large class sizes, and insufficient materials as barriers to effective instruction. *"Without proper lab tools, it becomes impossible to demonstrate real experiments—students end up memorizing instead of understanding."P2*
3. **Need for Professional Development:** Respondents emphasized the importance of training workshops and continuous learning to update teaching methods. *"Professional development gave me the tools and motivation to improve my teaching and support my students better."P8*
4. **Administrative and Policy Support:** Effective school leadership and government initiatives were described as crucial for improving science education. *"When the leadership understands our needs—like timely access to lab equipment and proper scheduling—it makes a huge difference."P7*

The quantitative and qualitative findings together suggest that while most secondary school science teachers in Lahore are qualified, confident, and motivated, they face persistent challenges related to inadequate resources, limited laboratory access, lack of consistent professional development, and insufficient administrative support. The convergence of both data strands highlights the systemic nature of these barriers, identifying the need for policy-level interventions and sustained capacity-building initiatives.

Discussion

The findings of this study align with previous literature indicating that systemic and infrastructural barriers hinder effective science teaching in developing contexts (Ahmad et al., 2021; Baber et al., 2023; Gul et al., 2023). Although teachers possess adequate qualifications, their instructional potential is limited by insufficient resources and institutional support. The difficulty in implementing inquiry-based and project-based methods reflects what Resnick (2023) and Surya (2024) observed globally, that standardized testing and rigid curricula constrain pedagogical innovation. Similarly, the lack of laboratory resources resonates with Villaver et al. (2023), who found that inadequate facilities reduce opportunities for practical science learning. Professional development was a recurring concern. Teachers' feedback confirmed that short-term workshops fail to produce meaningful changes in teaching practice, supporting the claims of Zhou et al. (2023) and Couture et al. (2024). The study also reinforced the argument by Nazir et al. (2025) that ongoing, reflective, and context-sensitive professional development is key to enhancing science education quality. The study's qualitative data added depth to these conclusions, showing how stress, administrative burdens, and poor infrastructure lead to teacher burnout.

Teachers called for more participatory and localized training models, echoing Nawab and Quraishi (2024) and Bano & Mehdi (2024).

Conclusion

The study concludes that the challenges faced by secondary school science teachers in Pakistan are multifaceted and interconnected. While most teachers are well-qualified and motivated, their effectiveness is constrained by systemic issues such as poor infrastructure, limited laboratory resources, inadequate professional support, and administrative overload. The research highlights that improving science education requires more than teacher qualification; it demands systemic reforms that address school resources, curriculum relevance, and ongoing professional development. Enhancing teacher morale, providing equitable access to resources, and reducing administrative burdens can significantly improve the quality of science teaching and learning outcomes.

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