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UNCOVERING KEY INSIGHTS: NAVIGATING SCIENCE EDUCATION IN OVERCROWDED CLASSROOMS

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Abstract
Overcrowded classrooms are a persistent challenge in developing countries like Pakistan, where increasing student enrollments exceed the capacity of educational institutions. This study explores the lived experiences of secondary science teachers in Lahore, focusing on how large class sizes affect teaching practices and student outcomes. Rooted in an interpretive paradigm, the study employed a qualitative research design with a phenomenological approach to investigate the experiences of secondary school science teachers. Using purposive sampling, In-depth interviews were conducted with six public school science teachers, and the data were thematically analyzed. Findings revealed that overcrowded classrooms hinder teaching effectiveness, classroom management, and student-teacher interactions. Moreover, disruptive behaviors, limited physical space, and the inability to provide individual attention affect student engagement and performance, with low-achieving students being more affected. Overcrowding also contributes to increased teacher stress, burnout, and limited academic progress for students. While coping strategies such as lesson simplification, prioritizing critical topics, group discussion, seating plan, and multimedia provide temporary relief, they fail to address systemic issues, such as overcrowded classrooms and often compromise their effectiveness. The study highlights the urgent need for systemic reforms, including policy changes and increased investment in educational infrastructure, to create a more effective and inclusive learning environment that better supports teachers and students in their academic journeys.

Keywords: Overcrowded Classrooms, Secondary Science Education, Classroom Management, Phenomenological Study, Low-Performing Students

Introduction
Science education helps students develop critical thinking, problem-solving abilities, and innovation skills essential for solving global problems and supporting economic growth. Globally, education system emphasizes STEM (Science, technology, Engineering, and Mathematics) to prepare students for careers in technology and innovation. At secondary level science is important for building interest in STEM fields and building thinking skills needed for higher education and future jobs (Kennedy & Odell, 2023).

Effective science education depends on interactive teaching strategies, practical experimentation, and individualized instruction, in order to foster a profound understanding of scientific concepts and promoting inquiry-based learning (Morris, 2025). However, these methods are difficult to implement in overcrowded classrooms, where inadequate resources and limited teachers' attention hinder their effectiveness (Vakili et al., 2024).

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In Pakistan, population growth and urban migration, along with inadequate infrastructure have contributed to an educational crisis characterized by overcrowded classrooms. This issue is particularly severe in urban areas like Lahore, where public schools frequently exceeds their capacity. Classrooms designed for 30-35 students now routinely accommodating 45-50 or more, severely impairing the quality of teaching and learning (Pakistan Bureau of Statistics, 2023). This problem is even more critical in science education, where practical experiments, collaborative learning, and interactive discussions are essential (Ahmad et al., 2018; Khalid, 2019). As a result, student engagement decrease and academic outcomes in science subjects suffer due to limited opportunities for active and experiential learning.

Teachers face numerous issues when dealing with these overcrowded classes. These challenges include increased stress levels, amplified responsibilities, and diminished job satisfaction, which impact their ability to manage classroom discipline, provide individualized instruction, or even apply creative strategies in teaching them. Overcrowding affects students, particularly by narrowing down accessible resources from the teachers, lack of active participation in class sessions, and, consequently, lowering their academic performance. Different research has proven that smaller class sizes are directly linked to enhanced educational results since they enable teachers to give one-on-one attention, promote cooperation, and employ flexible teaching methods to meet the diverse needs of students (Blatchford et al., 2018).

Pakistan is facing the issue of overcrowded classrooms due to rapid population growth and limited investment in educational infrastructure. The country's population increased from 207.68 million in 2017 to over 241 million by 2023, growing at an annual rate of 2.55% (Pakistan Bureau of Statistics, 2024). This growth added more than 26 million children out of school, marking 39% of school-age children around 5-16 years as unregistered in the education system (Shabbir, 2024). While some government initiatives have aimed to improve access through school construction and hiring new teachers, these efforts have not kept pace with the growing demand for education. Consequently, many urban public schools, especially in cities like Lahore, operate beyond their designed capacity, often accommodating 45–50 students in classrooms intended for 30–35, which undermines the quality of teaching and learning (Ali & Rehman, 2021; Graduate Institute of Development Studies, 2024). This overcrowding restricts students' opportunities to engage in hands-on experiments critical for understanding scientific concepts and creates significant challenges for teachers managing diverse groups of learners (Amjad, 2013).

Extensive global research, such as the Tennessee STAR (Student/Teacher Achievement Ratio) project, has examined the quantitative impact of class size on student achievement, most studies have focused on subjects like mathematics and reading (Opatrny et al., 2023; Shamsu, 2023). These studies highlight the benefits of smaller class sizes for academic performance. However, there is a noticeable gap in qualitative research exploring the lived experiences of teachers and students in overcrowded classrooms, particularly in science education within developing countries like Pakistan. Addressing this gap is critical for

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understanding how overcrowding affects teaching-learning and identifying strategies to improve educational outcomes in resource-constrained settings.

Objectives of the Study

1. To explore the challenges experienced by science teachers in managing overcrowded classrooms at the secondary level in Pakistan.
2. To investigate the teaching strategies implemented by secondary science teachers to manage overcrowded classrooms

Research Questions

1. What are the key challenges science teachers experience in managing overcrowded classrooms at the secondary level in Pakistan?
2. What teaching strategies do secondary science teachers implement to manage overcrowded classrooms effectively?

Methodology

This study used an interpretive paradigm. Based on this paradigm, qualitative research design was selected to gain deeper understanding of human experiences. Within qualitative design, a phenomenological approach was selected to explore the lived experiences of secondary teachers in overcrowded classrooms. The phenomenological approach was explicitly focused on a deeper understanding of participants' perceptions and uncovering the meanings they attribute to their experiences (Creswell, 2013; Cohen et al., 2011). This approach is relevant because it describes the consequences of overcrowded classes and the objectives of the study.

A purposive sampling strategy was used to choose six secondary science teachers from public schools in Lahore registered with the Board of Intermediate and Secondary Education. This technique was used to ensure that participants were directly affected by overcrowded classrooms, defined by a student-to-teacher ratio exceeding the ratio of 40:1.

This sampling ensured that participants had adequate experience managing an overcrowded classroom so they could meaningfully contribute to the study. Data was collected through semi-structured interviews that lasted for 60 to 90 minutes and were conducted in a comfortable school environment so that participants could speak freely. An open-ended interview guide made it possible to provide narrative details on what they encountered and how they coped with the challenges posed to them. Key themes and patterns in the data were identified using thematic analysis, which provided a deeper understanding of how overcrowding influences teaching effectiveness and professional well-being. In order to keep the details confidential, participants were given codes such as P1 for Teacher 1—this methodology aimed to capture the complexities of teaching in a resource-constrained environment and explain the educational dynamics.

Table 1

Challenges faced by teachers in Overcrowded Classroom

Theme	Central Idea
Maintenance of Effective Learning Environment	Teachers find it difficult to maintain discipline and concentrate in overcrowded science classes due to disruptive behaviour, which

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Theme	Central Idea
	forces them to make compromises that affect learning.
Reduces Students' Engagement	Due to increased disruptions, overcrowding lowers student involvement and interest in science-related activities.
Inconsistent Enforcement of Rules	In overcrowded classrooms, high student ratio make it difficult to apply consistent rules, weakening authority and creating a chaotic classroom climate.
Diverse Learning Needs	Overcrowding makes it hard to support diverse learners, stressing the need for smaller classes, more staff, and tailored resources.
Difficulty Establishing Authority	Limited personal interaction weakens teacher-student relationships, making managing behavior and maintaining safety harder.
Limited Individual Attention	Overcrowding in scientific classrooms blocks personalized instruction and feedback, which worsens learning gaps.
Limited Physical Space	Overcrowded science classrooms limit participation, mobility, and safety, particularly when hands-on activities are being conducted.
Lacks Inquiry-Based Learning	Teachers are forced to adopt lecture-based instruction due to a lack of time, space, and resources, which inhibits inquiry and curiosity.
Limits Hands-on Experience	Overcrowding restricts lab access, lowers safety, and makes it more challenging to study practical science.
Difficulty in Teaching Abstract Concepts	Having too many students and not enough resources makes it challenging to teach complex scientific subjects effectively.
Obstructed Student Visibility	Teachers struggle to monitor all students, leading to missed learning cues and poor behavior management.
Reduced Feedback Quality and Frequency	Teachers cannot give meaningful feedback due to time constraints, impacting student learning and growth.
Supervision and Safety Issues During Practical Work	Teachers cannot monitor all students during labs, increasing safety risks and lowering learning quality.
Professional Burnout	Overcrowded classrooms cause stress and exhaustion, leading to teacher burnout and reduced effectiveness.
Time Constraints on Assessment	Large class sizes force teachers to simplify assessments, reducing the depth and quality of evaluation.
Unequal Participation	Some students dominate class activities, while others disengage, especially in large, hard-to-manage classes.

Maintenance of Effective Learning Environment

In the overcrowded science classrooms, disruptive student behavior emerged as a key challenge that directly impacts the teacher's ability to maintain an effective learning environment. The participants reported that high student numbers make it difficult to monitor every individual, leading to frequent incidents of off-task behavior, noise, talking out of turn,

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and general inattentiveness. These behaviors become more pronounced in science classes, where practical activities require focus, discipline, and safety.

One of the participants shared that

> *"Maintaining a learning environment is not just about discipline—it is about engagement, and overcrowding ruins that." [P2]*

Another teacher expressed that

> *"Sometimes I just ignore minor disruptions to keep the lesson going. Otherwise, nothing gets done." [P3]*

As a result, disruptive behavior hinders effective teaching and learning, forcing teachers to compromise between maintaining order and delivering lessons, making classroom management a constant challenge.

Reduces Students' Engagement

Students' disruptive behavior, particularly in overcrowded classrooms, poses significant challenges for science teachers in maintaining student engagement. Science instruction often involves hands-on activities, experiments, and complex concepts that require students' full attention and active participation. However, when students disrupt these activities—whether by talking during lab sessions, interrupting explanations, or refusing to collaborate—it compromises safety and productivity and disengages other students.

One of the participants reported that

> *"Sometimes, when I'm trying to get the students to think critically about a topic like the environment, the disruptions from a few students make others stop engaging altogether. It's as if the negative energy spreads and no one wants to participate." [P2]*

Another participant shared that

> *"Some students need extra guidance to grasp scientific concepts, but I can't provide that help when I'm constantly managing disruptions." [P4]*

As a result, the teacher's ability to deliver content effectively is diminished, and students miss out on the opportunities for active learning and more profound understanding that science classes are designed to provide.

Inconsistent Enforcement of Rules

Science teachers struggle to enforce rules consistently in overcrowded classrooms due to time constraints, student volume, and the fast-paced nature of managing behavior while teaching. Participants reported that dealing with these inconsistencies dealt a blow to authority, promoted further disruption, and caused students to feel a sense of inequality. One of the participants stated that

> *"It is hard to keep track of everything and at the same time try to treat everyone fairly. Sometimes, before I can figure out who started it, everything has already escalated." [P4]*

Another participant shared

> *"Smaller classes tend to return better results with rules. Here, I feel like I am responding to behaviors more than actually teaching." [P6]*

In conclusion, lack of consistency in enforcing rules appears to be a systematic problem in overcrowded science classrooms. The educational environment shifts from instructional to

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reactive due to disparities in punishment, damaged classroom trust, and an increase in behavioral issues.

Diverse Learning Needs

It becomes challenging to manage diverse learning needs in overcrowded scientific classes. Students attending the classes have different academic ability levels, language skills, specific educational needs (SEN), and other behavioral difficulties. The participants indicated that they must provide differentiated teaching while ensuring safety in practical lessons and keeping control of the class simultaneously.

According to one participant,

> *"Some students need instructions repeated or explained in another way but I can't stop the whole class every time something needs to pause." [P3]*

Other participants mentioned that

> *"Having behavioral needs combined with learning needs and ones with language gaps makes classroom management much more difficult." [P4]*
>
> *"I need training and materials to enable me to help diverse learners—but more than anything, I need fewer learners in the room." [P5]*

In conclusion, the inability to adequately respond to all student's needs is not a lack of concern or effort but rather an inherent problem of trying to fit too many students in a classroom. The need for systemic support, which includes master scheduling, staff assignments, materials, and even targeted professional development, was highlighted.

Limited Individual Attention

One of the most prominent issues in overcrowded science classes is the absolute lack of individual attention provided. The educators in the study noted that they struggle with addressing and identifying the learning gaps, misconceptions, and intended milestones for every single student. This is especially problematic in science when students work with abstract concepts, and sophisticated explanations require guidance and oversight.

One of the participants expressed

> *"I use group work to help with time management, but they still fall behind when we get to the portion that requires direct teaching or one-on-one attention". [P4]*

Another participant noted

> *"Every student deserves to feel seen and supported. Overcrowding strips that from them." [P2]*

As a result, the absence of individual learning opportunities diminishes the level of instruction provided and intensifies the existing disparities in achievement.

Limited Physical Space

For many primary and secondary science educators who teach practical lessons, the physical confines and lack of space in students' desks pose a significant challenge. Practical science lessons require movement, use of the equipment, and active student engagement, but all of these are constraints in a simplified manner. Participants noted that keeping discipline, ensuring student safety, and creating dynamic learning experiences while operating within a limited space is difficult.

One of the participants shared:

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"We need space to demonstrate, to move, to group students strategically. But when you're boxed in, all those options disappear." [P5]

Another participant expressed that:

"Even if I want to separate students who are distracting others, there's just no space to move them. I end up having to tolerate more than I should." [P3]

As a result, the limited physical space restricts the mobility and safety of teachers and students and worsens disruptive behavior by increasing tension and reducing teacher control. This, in turn, increases the student's disruptive behavior and tension with reduced teacher control. Compromises in the teaching strategies, classroom arrangement, and overall pedagogical approach to science are inevitable, impacting the quality of instruction offered.

Lacks Inquiry-Based Learning

Effective science education incorporates inquiry-based learning that emphasizes the exploration of scientific phenomena through investigation, experimentation, and critical thinking. Excessive students relative to the available space and resources result in teachers reverting to lecture-based teaching, pre-planned narratives, or dull, highly regulated activities to minimize disorder from proactive, hands-on, and learner-driven engagements.

One of the participants shared:

"I want students to ask questions and investigate, but there is no time or structure for that in a class this large."[P2]

Others participants noticed

"Inquiry learning requires some flexibility, but congestion traps me in a set timetable. It's rigid, with no room to move." [P4]

"It's become much more about managing the class than inviting them to reason scientifically." [P6]

Overcrowding also constrains students' opportunities to pose questions, participate in meaningful dialogue, or collaborate effectively in groups. Instruction becomes more of a 'talk-and-test,' where exploring becomes impossible, inhibiting curiosity and critical thinking.

Limits Hands-on Experience

Students in overcrowded science classes face under-division of labor in class. Lack of space, too many students, and inadequate lab equipment severely limit advanced practical work. Participants said they face challenges in ensuring safety, controlling behavior, and providing sufficient attention to learners during commotion or other lab activities.

One of the participants shared

"It's almost impossible to allow everybody to engage in hands-on activities. Everything has to be rationed, including time." [P2]

Another participant expressed that

"Hands-on learning is important in science, but when students are crammed in one room, there are so many things that can go wrong and no assistance can be provided during the experiment. It becomes a safety issue." [P4]

As a result, learners tend to lose out on fundamental, exploratory learning opportunities vital for grasping scientific concepts and enhancing important analytical skills.

Difficulty in Teaching Abstract Concepts

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The most significant learning barrier is providing instruction on abstract notions and concepts because students do not possess adequate basic knowledge or context to appropriately frame the material in question and its use in real-life scenarios. From many students' perspectives, many abstract concepts, such as atomic structures, energy transfer, and theoretical models, highly depend on concrete examples and visuals. It is even more challenging for under-resourced or overcrowded classrooms that do not permit personalized teaching and hands-on activities.

One of the participants reported

> *"We can adapt to abstract topics, but it takes time and different techniques. In my batch, they need more than the time I have to give them the attention they require to grasp it properly." [P1]*

Other participants mentioned

> *"Some concepts are just too theoretical. I can explain them over and over, but if they don't possess the images to go along with what I'm saying, it won't be grasped." [P5]*
>
> *"It's easy to say, but hard to do. A great challenge is making the unseen visible. If I'm not given proper models or tools, all I can do is draw on the board and hope they catch it." [P6]*

As a result, students may struggle to understand key principles, leading to gaps in learning and decreased motivation.

Obstructed Student Visibility

Obstructed student visibility is a common challenge in overcrowded science classrooms, where high student numbers and cramped seating arrangements make it difficult for teachers to see all learners. This limits the teacher's ability to monitor engagement, identify off-task behavior, or assess student reactions and understanding in real-time. When students are seated behind others or in tight corners, they may become distracted without the teacher noticing.

The participants shared

> *"There are students I can't even see from where I stand. If they're off-task or confused, I might not notice until much later." [P1]*
>
> *"I often miss nonverbal cues—confusion, boredom, or disengagement because I simply cannot see everyone." [P3]*
>
> *"Visibility issues make me feel disconnected from parts of the class. It's like teaching to a partial audience." [P5]*

In conclusion, it hinders effective classroom management and instruction, ultimately impacting student engagement and learning outcomes.

Reduce Feedback Quality and Frequency

Feedback is essential for learning in science, especially when students are developing lab skills, constructing explanations, or working through scientific problems. However, due to their sheer workload, teachers often cannot provide timely, detailed, or formative feedback in overcrowded classrooms.

> *"I end up giving very general comments because I just don't have time to read through every student's work in depth. It's not ideal, but it's all I can manage." [P1]*

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"In a class with over 50 students, I simply cannot give personalized feedback to everyone. I try my best, but it often gets reduced to general comments due to time constraints. "[P2]

"The class is so big that I end up focusing on the most vocal students during feedback sessions. Those who need more guidance often don't get the attention they need."[P4]

In conclusion, teachers struggle to provide personalized, in-depth feedback in overcrowded classrooms due to large class sizes and time constraints. As a result, feedback is often reduced to general comments, limiting students' opportunities for meaningful guidance and hindering their learning progress.

Supervision and Safety Issues during Practical Work

Science involves lab work, experiments, and group activities. High student numbers make it difficult to supervise safely and ensure that all students follow procedures correctly. It can lead to accidents or missed learning opportunities during practical sessions.

"I cannot be everywhere at once. Labs are supposed to be hands-on, but with so many students, I spend most of the time just trying to ensure nothing goes wrong. [P1]

'During practical lessons, it becomes difficult to monitor all students. Some get distracted, and I worry about safety in the lab with so many students."[P2]

"With so many students, it's tough to keep track of everyone's progress during hands-on activities. Sometimes, students miss instructions, leading to mistakes."[P3]

In conclusion, insufficient supervision due to overcrowding leads to safety risks during practical activities, which can result in accidents and missed learning opportunities.

Professional Burnout

The pressure to meet curriculum goals, manage a large class, and still try to support individual learners can lead to stress and burnout. Teachers may feel guilty for not meeting every student's needs, which affects their morale and job satisfaction.

As participants stated that

"I feel like I'm constantly letting someone down—either the advanced students, the ones who need more help, or myself." [P1]

"The stress of managing overcrowded classrooms affects my motivation. I feel like I'm just going through the motions instead of actively engaging with the students."[P2]

"I am physically and mentally exhausted. The workload increases with large classes, and I often find myself late to finish grading and planning". [P3]

The overwhelming number of students in overcrowded classrooms leads to teacher burnout, as they cannot manage the workload and offer high-quality instruction.

Time Constraints on Assessment

Assessing many students requires significant time, especially with tasks like lab reports, written explanations, or project-based learning. In overcrowded classes, teachers may feel forced to rely on quicker, less personalized forms of assessment (like multiple-choice tests), which do not fully capture a student's understanding.

"There's just no way I can carefully read and grade 45 lab reports every week. I have to cut corners, even if I don't want to."[P2]

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"I am constantly racing against time to finish my lessons and assessments. There is little time left for detailed feedback or one-on-one assessments." [P3]

"Assessment becomes a rushed process in large classrooms. I cannot dedicate enough time to evaluate every student's work meaningfully." [P4]

To conclude, Time constraints due to overcrowding significantly hinder teachers from conducting thorough and meaningful assessments, affecting students' academic growth.

Unequal Participation

In large classes, ensuring that every student is engaged and contributing equally within their group is harder. Some students dominate while others become passive or disengaged, mainly if the teacher cannot circulate enough to support each group.

"Some students end up doing all the work while others just sit back. I want to hold them accountable, but I can't track everyone."[P1]

In large classes, only a few students dominate discussions. It is hard to encourage quieter students to participate or get their feedback."[P2]

Another participant stated that

"I try to call on everyone, but it is hard in a class of 50 students. The shy students rarely speak up, and I can't engage all of them equally."[P3]

In conclusion**,** overcrowded classrooms lead to unequal participation, where a few active students dominate while others, especially the shy ones, remain silent and disengaged.

Strategies

Table

Strategies used by Secondary Science Teachers in Overcrowded Classrooms

Theme	Central Idea
Use of Seating Plans	Strategic seating arrangements help minimize distractions and promote engagement in large classrooms.
Verbal and Non-Verbal Cues	Effective communication through tone, facial expressions, and gestures manages behavior and builds a supportive environment.
Early Rule-Setting & Student Involvement	Establishing clear rules at the beginning of the term sets expectations, creates structure, and fosters responsibility.
Consistent Enforcement	Consistent application of rules ensures fairness, promotes trust, and supports a predictable classroom environment.
Use of Praise and Rewards	Acknowledging students' efforts reinforces positive behavior, builds motivation, and supports a growth-oriented learning atmosphere.

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Theme	Central Idea
Recognition of Student Efforts	Recognizing students' hard work fosters confidence and encourages perseverance.
Think-Pair-Share	Encourages critical thinking and collaboration but may require monitoring in large classes.
Group Discussions	Promote peer learning and deeper understanding but need structured guidance to ensure equal participation.
Interactive Quizzes	Technology-based quizzes enhance engagement and provide instant feedback while mindful of student anxiety.
Use of Multimedia	Multimedia simplifies abstract concepts and creates a more dynamic classroom environment.
Rotating Group Roles	Assigning roles within groups fosters accountability and skill development, helping students stay active and responsible.
Participation Tracking	Monitoring student involvement encourages accountability and helps identify those needing support.
Peer Tutoring	Students teaching each other reinforces learning and promotes collaboration in the classroom.
Project-Based Assessment	Engaging students in real-world applications supports deeper learning and critical thinking.
Portfolio Evaluation	Assessing a collection of student work over time provides a holistic view of growth and learning progress.
Collaborative Problem Solving	Engaging students in real-life challenges promotes teamwork and critical thinking.
Use of Digital and Low-Cost Tools	Leveraging technology and affordable materials enhances learning and collaboration despite resource limits.

Use of Seating Plans

In overcrowded science classrooms, seating plans are crucial for maintaining discipline and promoting engagement. Students' organization is meant to reduce interruptions, aid learners with various learning styles, and improve overall behavior within the classroom. Most participants indicated that they attempt to take the students' personalities and learning preferences into account when developing these plans, often collaborating with students to promote ownership and comfort.

> *"I use seating plans to group students with similar learning needs or abilities, allowing me to target my instruction more effectively." [P1]*

> *"I regularly review and adjust seating plans to ensure they continue to meet the needs of all students." [P5]*

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The proper arrangement of seats can help teachers better control students while minimizing undue influence, offering a step that can be altered gradually to help with arising concerns from the students.

Verbal and Non-Verbal Cues

Science teachers in larger classrooms depend on verbal and non-verbal cues just like any other form of instruction that outlines expectations and discipline. Other aspects that define a cue may include voice pitch and access to facial features, which entails posture proxies that may performed with the limbs)

> *"I'm paying attention to my non-verbal cues, including body language and facial expressions, to ensure that I am supportive and inclusive." [P2]*
>
> *"I utilize verbal reminders and prompts to keep students on task and meeting expectations." [P3]*

The participants highlighted that the deliberate application of these cues significantly improves the communication between teachers and students and enhances the overall responsiveness of the classroom atmosphere.

Early Rule-Setting and Student Involvement

Having clear rules and expectations from day one is one of the foundational strategies for managing the often congested science classrooms. The teachers observed that students follow rules better when they are communicated early and consistently. Many involve students in setting these rules, cultivating a sense of ownership and respect.

> *"On the very first day of school, I set clear rules and expectations that are bound by mutual understanding and cooperation." [P1]*
>
> *"I use the provided feedback from students as well as colleagues to adjust rules and ensure that they remain relevant." [P5]*

Teachers help promote a productive learning environment by setting rigid, student-centered expectations that foster consistency and order.

Consistent Enforcement

In congested systems, where discipline is prone to be disorganized, a focus on consistency improves calmness in applying the rules.

According to self-reported surveys, using effective consequences both positively and negatively resulted in an acceptable learning atmosphere where students knew what to anticipate. A teacher reported that

> *"I uphold rules and consequences in my class so that students know what is expected of them and actually pay attention to those expectations." [P1]*

Another participant stated that

> *"Participants believe that in order for consistency within enforcement of rules to occur, reflection in action needs to happen to make the rule enforcement fair." [P5]*

Such uniformity aids in building the teacher's credibility, which will assist in fostering an environment of responsibility and trust.

Use of Praise and Rewards

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Praise and rewards are practical motivational tools used by science teachers to encourage good behavior and academic effort. Participants highlighted the importance of providing specific, meaningful praise and involving students in designing reward systems.

As participants stated

> *"I use specific, genuine praise to acknowledge students' efforts and achievements, helping to build their confidence and motivation." [P1]*
>
> *"I'm careful not to overuse praise and rewards, ensuring that students don't become too reliant on external motivators." [P4]*

These practices contribute to positive reinforcement and help students develop a sense of self-efficacy.

Recognition of Student Efforts

Acknowledging learners who make an effort rather than achieving a set goal is especially important in big classrooms, where learners may feel neglected. Methods shared included verbal praise, feedback comments, and parental involvement to celebrate student milestones. As stated by participants

> *"In my practice, I celebrate and recognize each milestone, no matter how small, to encourage confidence and motivation among learners." [P2]*
>
> *"I reflect on my practice to ensure I appreciate diverse efforts and achievements from every student." [P5]*

As a result, the student's motivation, especially in more difficult contexts, is sustained and helped to develop in a more positive light focused on growth.

Think-Pair-Share

Think-Pair-Share is an Inclusivity strategy to enhance active participation within dense classroom environments. This approach promotes communication and problem-solving skills, although some teachers find it challenging to manage.

One of the participant stated that

> *"I use Think-Pair-Share to ensure every student participates. I ask a question related to the topic we're studying, and the students first think about it individually, then pair up with someone nearby. After discussing their thoughts, I call on pairs to share with the entire class. It gives every student a chance to speak and prevents any single student from dominating the conversation." [P1]*

Another participant stated that

> *"Sometimes, it's hard to manage the time for pair discussions, so I try to be strategic about how long students have to talk. I also move around the classroom to listen in on their conversations. It helps me guide the discussion if needed and ensures that everyone is involved." [P4]*

Despite challenges, this strategy remains valuable for fostering active learning in science classrooms.

Group Discussions

Group discussions enable students to share ideas and learn from diverse perspectives. Teachers use this method to enhance teamwork, though they also noted challenges in ensuring equal participation.

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A participant stated the implementation of group discussion startegy as

> *"In group discussions, I often assign students roles, like a facilitator, note-taker, and speaker. This ensures that every student is engaged. When we discuss complex topics like cell division, each group member has a specific task, which makes the discussions more productive and ensures no one is left out." [P3]*

Another participant stated that

> *"I often use group discussions for topics that require exploration and different perspectives, like the impact of pollution on ecosystems. I break the class into smaller groups and encourage them to share their views. I make sure every student gets a chance to contribute by asking each group to appoint a speaker who will share the group's ideas with the class." [P4]*

Facilitating balanced discussions remains a key concern, but the benefits of peer learning are widely acknowledged.

Interactive Quizzes

Technology-enhanced tools like interactive quizzes engage learners and offer immediate feedback. Teachers find these tools particularly useful in managing large classrooms.

Participants stated that

> *"I find that interactive quizzes really help gauge how much students have understood. I usually incorporate them in the middle of the lesson to see if anyone is struggling. But I also make sure the quizzes are not too difficult to reduce any anxiety students might feel, as large classes can make them nervous." [P3]*

> *"While interactive quizzes make science fun, they can sometimes be stressful for students, particularly in large groups where everyone can see each other's scores. I try to make them lighthearted, with immediate feedback, so students can learn from their mistakes without feeling anxious.." [P4]*

Despite some drawbacks, interactive quizzes support self-assessment and active participation.

Use of Multimedia

Teachers incorporate multimedia tools—such as videos, animations, and images—to explain complex scientific concepts. These tools cater to different learning styles and enhance classroom engagement.

> *"I frequently use videos in science classes, especially for concepts like the water cycle or chemical reactions. These visuals help make the material more accessible and engage students who might struggle with just text or lectures" [P5]*

> *"Multimedia tools have made a huge difference in how I present lessons. I use diagrams, simulations, and even interactive websites to explain difficult topics. For instance, I might show a video on the human circulatory system to help students understand the flow of blood." (T2)*

Effective use of multimedia requires balance, but it remains a powerful tool for differentiated instruction.

Rotating Group Roles

Assigning rotating group roles—like team leader, recorder, or timekeeper—was recognized as a strategy to build leadership and ensure student shared responsibility.

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One participant remarked,

> *"In my classroom, I use rotating roles to keep students engaged. For every group task, each student is given a specific role. This approach helps ensure that everyone participates and learns leadership skills." [P1]*

However, in larger classrooms, some found it challenging to implement effectively.

> *"Rotating group roles can be challenging to manage, especially in larger classes." [P4]*

Still, this technique was appreciated for its potential to engage all learners.

> *"I assign different roles to students in group activities, especially during lab work. For example, one student might handle the materials while another keeps the group on task. Rotating these roles helps all students develop different skills, ensuring no one is left passive." [P3]*

To conclude, rotating roles offer a structured approach to cooperative learning but demand careful monitoring to ensure balance and fairness.

Participation Tracking

Tracking offers a detailed insight into a learner's participation and work towards all the activities. Tracking participation helps allocate extra assistance to students facing difficulties while ensuring they are held accountable for their academic self-regulation.

One teacher noted,

> *"Participation tracking helps me identify students who may need additional support or encouragement." [P1]*

However, concerns were raised about its subjectivity and emotional impact:

> *"Some students may feel anxious or stressed about being tracked, especially if they're shy or introverted. However, I'm careful to create an environment where students feel encouraged, not pressured." [P4]*

Still, many found it helpful:

> *"I maintain a weekly participation chart where I note each student's involvement in class discussions and experiments. This helps me identify quieter students and plan activities to bring them forward." [P3]*
>
> *"I keep track of student participation through regular quizzes and activities. I also ask follow-up questions to individual students to encourage them to engage more." [P2]*

In conclusion, participation tracking is a helpful tool for enhancing engagement but should be applied with care to support, rather than pressure, students.

Peer Tutoring

Peer tutoring involves students teaching and supporting each other to reinforce learning. In overcrowded science classrooms, this strategy indirectly helps teachers offer individualized attention while promoting collaboration.

One participant explained,

> *"Each group has a weekly 'student leader' who helps others with assignments and classwork. Next week, the leader changes, so everyone gets a chance to teach." [P1]*

Other participants stated that

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"When students tutor each other, they improve their communication. It is not just about the science content—they learn how to explain, listen, and work together." [P2]

"I pair strong students with weaker ones, especially during lab work or difficult topics. I tell the stronger ones to explain using simple words and examples." [P3]

In conclusion, peer tutoring is a practical method for managing large classes, though it demands careful planning to ensure effectiveness and inclusivity.

Project-Based Assessment

Through project-based assessment, students are motivated to apply scientific processes creatively and practically, departing from traditional testing paradigms that foster memorization.

Participants shared,

"Project-based assessment promotes application and deeper learning of concepts. I ask students to design simple models like water filtration systems or circuits. It helps them see how science applies to their daily lives." [P1]

"Projects are done in small groups. I instruct them to allocate tasks among themselves so that they can research and present their conclusions in class. It cultivates cooperation and enhances their cognitive skills." [P2]

Another participant noted that:

"Students need to be able to demonstrate their creativity and skills. With project-based assessment, it's not just the outcome that matters - I pay attention to the process too. I talk to the students while they work and, honestly, apply a rubric at the end." [P3]

Project-based assessments are an effective method for evaluating a student's scientific understanding, although they need to be structured properly with clear and uniform rubrics to maintain objectivity.

Collaborative Problem Solving

Engaging pupils in collaborative problem-solving activities is designed to promote critical thinking, creativity, and cooperation among learners. Collaborative problem-solving occurs when a group of students is given an authentic problem or case that they need to explore together and devise a solution collaboratively. The participants said that collaborative problem-solving has proven to be effective in their lessons.

Participants stated:

"I always give a problem to my students, such as creating a model of a renewable energy solution, and ask them to work on it as a group. The tasks supporting cooperation, critical thinking, and even creativity." [P2]

"I develop some of the problem solving that can be done through group work. For example, students are given the task of making a simple circuit. They must think together on how best to put it together." [P4]

"Collaborative problem solving has been effective in my classroom. For instance, during a particular chemistry class, I had my students collaborate in groups to design an experiment. They shared their ideas, tried to find solutions, and presented their findings to the rest of the class." [P5]

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In conclusion, collaborative problem-solving seems to be a means to improve the learning experience and social interaction among students."

Digital and Low-Cost Tools

"Over the past few years, the adoption of technology and other low-cost resources has been on the rise, particularly with large or overcrowded classrooms. These resources aid in teaching and learning, increase student participation and collaboration, and ensure equitable access to education."

Participating teachers commented

> *"Digital engagement tools are really helpful. I use Kahoot! and let my students participate in group quizzes. With such large classes, it's an easy way to engage students since everyone is into competition. It is instant evaluation and every student is able to see how well they did." [P2]*
>
> *"Teachers in my subject area prefer low-cost materials for use in overcrowded classrooms. In many cases, students are able to make a model out of a plastic bottle and paper. It's inexpensive but useful in getting them to work together." [P5]*

One other participant went on to say:

> *"Using WhatsApp groups is one of the easiest ways to set up group work. They can share information, ask questions, and work on the homework collaboratively. Even a large class size does not change the fact that this tool allows them to communicate and work together." [P6]*

As a result, the integration of low-cost resources and digital tools has shifted their teaching practices to be more engaging and interactive. The positive impacts of digital tools fostering students' participation in learning, others reminded them of the importance of low-cost materials and their role in hands-on learning, resourcefulness, creativity, and resourcefulness.

Conclusion

Overcrowded science classrooms present major challenges that hinders both teaching quality and student learning. The limited scope for practical activities reduces student involvement, while difficulties in explaining complex scientific ideas often result in learning gaps. A lack of individualized attention further weakens skill development, leaving students without key academic abilities. Limited physical space also limits teacher movement and monitoring, and frequent behavioral disruptions increase these difficulties, contributing to teacher stress and emotional exhaustion. The inability to provide differentiated instruction also affect diverse learners, diminishing their motivation and engagement.

Regardless of these challenges, certain teaching strategies show potential in managing large science classes. Strategic seating arrangements can help reduce distractions and maintain student focus, while using both verbal and non verbal cues improves communication and discipline. Seating and applying clear rules earlier with consistency encourage a sense of order and responsibility. Although group activities like think-pair-share promote peer interaction and ensure equal participation of students. Tools such as multimedia and interactive quizzes support engagement by addressing different learning preferences. Peer tutoring also allows students to reinforce each other's learning in overcrowded classroom. To

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improve student outcomes, educators must adopt effective classroom management strategies and embrace diverse teaching methods, fostering a supportive environment that nurtures every learner's potential. Addressing these challenges is essential for creating a more effective and inclusive learning environment supporting all students' academic journeys.

Discussion

Overcrowded science classrooms pose ongoing and complex issues that obstruct teaching quality and student learning effectiveness. A significant drawback is the diminished ability of educators to offer individualized attention—an important aspect of science education that frequently requires thorough explanations and practical examples (Ali & Rehman, 2021). Science instruction, especially laboratory instruction and experiential learning is much more difficult to administer in situations where there is no space for materials and active participation (Khan & Akhtar, 2022). The physical limitations of crowding also limit the application of student-centered teaching techniques. Because leading big groups during practical sessions might present safety challenges, teachers are frequently compelled to use lecture-based training rather than more interactive techniques like experiments or group projects (Zaman et al., 2023). These limitations reduce scientific education's overall efficacy and students' chances to hone their critical thinking and problem-solving abilities (Mahmood et al., 2022). Overcrowding in classrooms generates an equally significant set of problems regarding behavior. Reduced student involvement levels and more classroom disruptions are closely linked to high student-teacher ratios (Muthoni et al., 2021). These disruptions can significantly lower learning effectiveness in science classes, where focus is essential for comprehending intricate ideas and carrying out experiments. Disengaged students perform worse in science classes and are less likely to participate, which results in gaps in learning and accomplishment (Mwangi, 2021). To address these challenges, many educators implement collaborative teaching methods such as peer tutoring, group work, and think-pair-share activities to foster engagement (Agboola, 2023). These strategies have shown promise in promoting student interaction and deeper learning. However, the crowded setting, where group dynamics are challenging to manage, and classroom resources are overextended, frequently undermines their efficacy (Rahman, 2020). Furthermore, low mobility and loud noise make it even more challenging to carry out these tasks correctly (Iqbal & Bano, 2022). In addition to the limitations of the classroom, overcrowding is also a significant contributor to teacher stress and burnout. Due to the difficulty of upholding discipline and high-quality instruction without sufficient resources, such as assistance, teachers in these situations report feeling more emotionally exhausted (Zaman et al., 2023). Stress can cause teachers to lose their passion and become indifferent, which can hurt student performance and morale (Ahmed, 2023). Because these issues are structural, long-term reforms must be implemented to support short-term pedagogical strategies. These include providing ongoing professional development suited to the requirements of teaching science in high-enrollment schools, improving classroom infrastructure, and lowering student-teacher ratios (Ali & Rehman, 2021; Ahmed, 2023). Additionally, to empower teachers and raise the standard of scientific instruction in congested settings, institutional support—through improved administrative assistance and policy interventions—is required (Rahman, 2020).

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The research highlights how the growing class sizes in science education seriously undermine scientific learning and instruction. The limitations imposed by overcrowding can only be reduced by systemic solutions prioritizing equitable education policies, effective use of school infrastructure, and adequate provision of materials, even though teachers exhibit flexibility in employing various engagement strategies.

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