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Research Article

An Observational Study of Teaching Methods in Secondary School Science Classrooms

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Abstract
Science education plays a critical role in developing learners' problem-solving, inquiry, and critical thinking skills. However, despite calls for student-centered and technology-enhanced methods, teacher-centered methods, particularly lecture-based instruction, still dominate the science classroom. While such methods ensure curriculum coverage, they often limit opportunities for active engagement, collaboration, and deeper conceptual understanding. This study, therefore, investigates the teaching methods most commonly used in secondary school science classrooms, examining the prevalence of teacher-centered, student-centered, and technology-enhanced instructional strategies. The instrument used was the Science Classroom Instruction Observation Sheet (SCIOS). Data were collected from 80 observed lessons in public and private schools. The findings revealed that lecture-based instruction dominates science classrooms, while student-centered methods such as small-group discussions, desk work, and student presentations remain infrequent, rarely exceeding five observations per interval. Additionally, technology-enhanced strategies, including multimedia and digital simulations, were among the least observed, appearing in fewer than three intervals on average. The heavy reliance on teacher-centered instruction, while effective for content delivery, raises concerns about its impact on student engagement and inquiry-based learning. These findings emphasize the need for a more balanced instructional approach that integrates interactive, student-driven strategies to enhance science education.

Keywords: Science Instruction, Teaching Method, Teacher-Centred Learning, Student-Centred Learning, Science Classrooms

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1. INTRODUCTION

Science education plays a fundamental role in equipping learners with critical thinking skills, problem-solving abilities, and the right understanding of the natural world. As an inquiry-driven discipline, science emphasizes exploration, experimentation, and reasoning rather than rote memorization, which we can find in science classrooms today. Effective science teaching should therefore not only transmit knowledge but also cultivate in the learners higher-order thinking skills that prepare them for scientific inquiry and real-world problem-solving. Despite widespread advocacy for student-centered and constructivist approaches, many science classrooms continue to rely heavily on teacher-centered strategies, particularly lecture-based instruction (Hora, 2015; Kranzfelder et al., 2019). This persistent use of teacher-centred methods raises concerns about whether current instructional practices foster deeper understanding and meaningful engagement among the learners.

Studies show that teachers often favor the lecture method, which is an example of a teacher-centred method because it allows efficient coverage of extensive curricula within limited instructional time (Hora, 2015; Schermer & Fosker, 2020). Observational research further indicates that lectures dominate classroom time, accounting for as much as 65% of 2-minute instructional intervals (Hora, 2015). Although variations such as the use of visuals, demonstrations, or whole-class explanations are employed, these approaches still reinforce the teacher's role as the primary source of knowledge, often leaving students in passive roles

(Kranzfelder et al., 2019). In contrast, student-centered instructional methods, such as inquiry-based learning, group work, peer discussion, and problem-solving activities, have been shown to enhance engagement, conceptual change, and critical thinking skills (Wu & Huang, 2007). This method aligns with constructivist perspectives, emphasizing that students actively construct meaning through interaction and participation (Agwu & Nmadu, 2023; Shaby et al, 2024; Vygotsky, 1978). However, their use remains limited in practice. This can be attributed to factors such as curriculum demands, pressure to prepare students for high-stakes examinations, large class sizes, and teachers' limited training in alternative pedagogies (Chang & Tsai, 2005).

Parallel to debates on teacher versus student-centered instruction, researchers have also explored the role of technology in enhancing science learning (Wang & Yang, 2016; Yılmaz, 2023). Multimedia-based instruction, simulations, and interactive digital platforms have been found to improve students' grasp of abstract and complex concepts by providing visual and interactive representations (Chang, 2003; Wu & Huang, 2007). Technology-enhanced instruction is also associated with increased student motivation and engagement (Duterte, 2024), aligning with the broader push toward active learning and 21st-century skills. However, despite its promise, studies reveal that technology integration in science classrooms is uneven and often underutilized (Francom, 2020; Demirbilek, 2024). Barriers such as inadequate access to digital resources, insufficient infrastructure, and limited teacher preparedness constrain effective implementation (Lowther et al., 2006; Woodrow et al., 2000). Consequently, while research has established the benefits of technology-supported approaches (Duterte, 2024; Wang & Yang, 2016; Yılmaz, 2023), they rarely displace traditional methods and are often used only as supplementary tools rather than as integral components of instruction.

Despite the valuable insights into the prevalence of lecture-based instruction, the benefits of student-centered methods, and the emerging role of technology in science classrooms. However, much of this research relies on teacher self-reports, surveys, or broad lesson-level observations (Hora, 2015; Minner et al., 2010; Schermer & Fosker, 2020). Such methods, while informative, may lack the crucial thing needed to capture how teaching practices unfold during lessons. Specifically, there is limited empirical evidence on the moment-to-moment patterns and transitions in instructional methods within a single lesson, for instance, when and how teachers shift from lecturing to demonstrations, student discussions, or technology use. As a result, we know relatively little about the dynamic interplay of instructional strategies in real classroom contexts, despite the recognized importance of understanding how different approaches are balanced in practice. This study, therefore, seeks to address this by using a systematic observation method to document instructional practices in secondary school science classrooms. Unlike previous research that often captures teaching practices in broad strokes, self-reported data, and surveys, this paper will provide a detailed description of the instructional strategies employed, their frequency, and the transitions between them.

1.1. Research Objectives

1. To identify the teaching method that dominates science teachers' classrooms in secondary schools.
2. To compare the prevalence of teacher-centered and student-centered instructional methods in secondary school science classrooms.
3. To examine the extent to which science teachers integrate technology-enhanced instructional strategies alongside traditional methods.

1.2. Research Question

1. What is the teaching method that dominates science teachers' classrooms in secondary schools?
2. How do teacher-centered and student-centered teaching methods compare in terms of prevalence in secondary school science classrooms?
3. To what extent do science teachers integrate technology-enhanced instructional strategies alongside traditional methods?

2. METHODOLOGY

2.1. Research Design

This study employed a systematic observational research design, utilizing a time-sampling protocol. Specifically, the Science Classroom Instruction Observation Sheet (SCIOS) was used to record teaching methods at fixed 2-minute intervals during 40-minute lessons. This structured time-sampling approach ensured that teaching strategies (e.g., lecture-based, interactive, and student-centered methods) were consistently captured across the observation period, thereby enhancing reliability and reproducibility (Hora, 2015; Kranzfelder et al., 2019).

2.2. Sample and Sampling Techniques

A total of 80 master's students who specialized in Science Education were engaged as observers. They were purposively selected due to their academic background and familiarity with science pedagogy, making them suitable for systematically recording teaching methods. Their role was solely observational, not participatory. The participants of the study were science teachers across selected secondary schools. Schools were chosen through stratified random sampling to ensure representation across local government areas (LGAs) and school types (public and private). Within each school, observations were conducted in Physics, Chemistry, Biology, and Basic Science classrooms at both junior and senior secondary school levels.

2.3. Research Instrument

The instrument was divided into two sections. Section A captured teachers' demographic characteristics such as gender, teaching experience, and class level taught, as these contextual variables were expected to influence instructional methods. Section B consisted of the Science Classroom Instruction Observation Sheet (SCIOS), a structured observational tool designed to systematically capture instructional behaviours in science classrooms. The instrument contained 11 items grouped into one main domain. The domain, Teaching Methods (Items 1–11), covered instructional strategies such as lecture, lecture with visual aids (pre-made or handwritten), demonstration of phenomena, interactive lecture, small group work or discussion, deskwork, whole-class discussion, multimedia use, problem-solving, and student presentations. For the administration of the instrument, the observer was instructed to tick the appropriate behaviours observed in each 2-minute interval across a 40-minute lesson. Multiple behaviours could be recorded within the same interval if they occurred simultaneously.

2.4. Validity and Reliability of the Research Instrument

To ensure validity, the SCIOS was reviewed by specialists in science education for clarity and comprehensiveness, resulting in refinements. Reliability was confirmed through a pilot study, with inter-rater agreement measured using Cohen's Kappa statistic ($\varkappa$ = 0.75), which yielded a high level of consistency, confirming replicability (Schermer & Fosker, 2020).

2.5. Method of Data Analysis

Data were analysed using descriptive statistics, frequency counts, and bar charts.

3. FINDINGS

Research Question 1: What is the teaching method that dominates science teachers' classrooms in secondary schools?

The most frequently observed teaching method in secondary school science classrooms is the lecture method, which consistently appeared at all recorded time intervals. The frequency of lecture-based instruction starts high (37 observations at the 2-minute mark) and remains the dominant approach throughout the lesson, though it gradually decreases in the later stages.

Table 1. Teaching Method Frequency Over Time

S/N	Teaching Method	2 Minutes Time Interval																			
		2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**
1	L	37	28	18	15	15	18	15	14	9	12	8	10	6	7	6	5	3	3	5	5
2	LPMV	9	5	6	5	5	4	7	4	6	3	2	4	2	3	-	1	2	-	1	-
3	LHWV	4	9	7	7	7	3	6	5	5	5	11	7	3	3	2	3	1	2	1	1
4	LDT	13	17	9	5	6	8	7	4	9	5	4	5	5	5	6	2	2	1	2	-
5	IT	8	12	18	22	15	9	12	11	11	10	10	10	8	7	10	6	5	5	6	6
6	SGD	2	4	5	5	3	3	1	4	4	3	1	1	4	4	2	3	2	1	1	-
7	D	2	1	4	1	2	3	3	1	-	4	2	2	-	1	2	2	3	4	1	1
8	WCD	4	4	6	-	3	2	3	6	4	6	8	6	7	5	4	6	1	2	3	-
9	M	1	1	1	2	1	1	2	1	-	-	-	-	1	2	-	3	1	2	3	-
10	WP	3	5	4	7	5	3	4	3	2	2	1	3	1	2	4	2	1	1	-	-
11	SP	1	3	1	2	2	2	2	3	1	1	3	3	1	-	-	2	-	1	1	1

Key: L-Lecture, LPMV-Lecture with pre-made visual, LHWV-Lecture with handwritten visual, LDT-Lecture with demonstration of the topic, IT-Interactive lecture, SGD-Small group discussion, D-Deskwork, WCD-Whole class discussion, M-Multimedia, WP-Working out problems, SP-Students' presentation

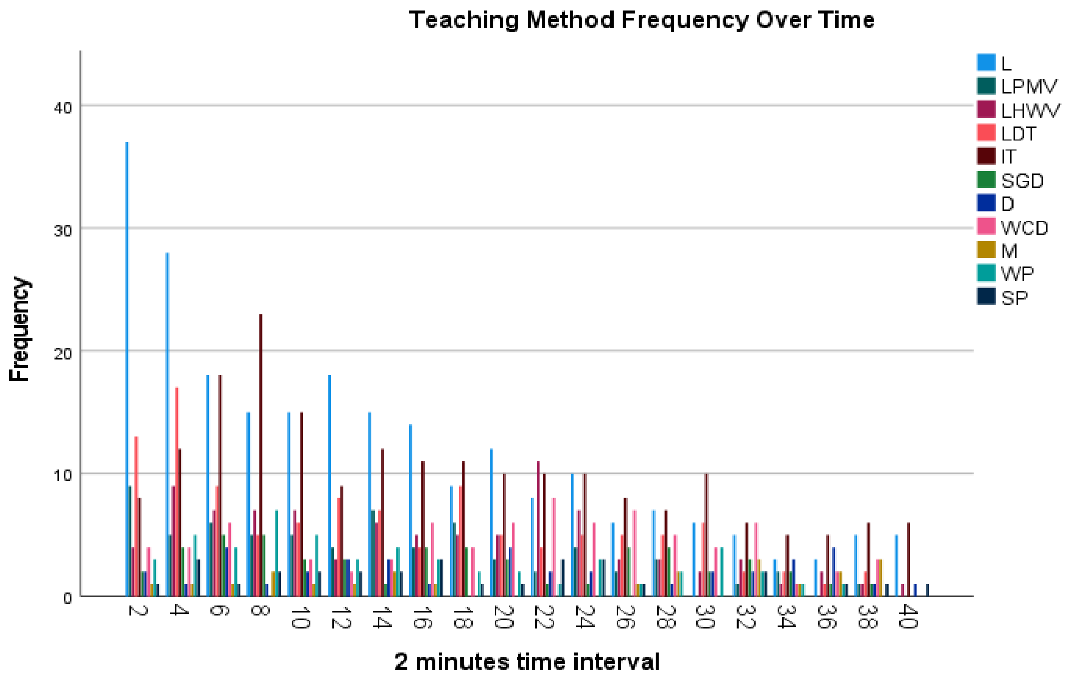

Figure 1. Visualization of Teaching Method Frequency Over Time

Key: L-Lecture, LPMV-Lecture with pre-made visual, LHWV-Lecture with handwritten visual, LDT-Lecture with demonstration of the topic, IT-Interactive lecture, SGD-Small group discussion, D-Deskwork, WCD-Whole class discussion, M-Multimedia, WP-Working out problems, SP-Students' presentation

Research Question 2: How do teacher-centered and student-centered teaching methods compare in terms of prevalence in secondary school science classrooms?

The results from Table 1 show that teacher-centered teaching methods were more prevalent than student-centered methods in secondary school science classrooms. Among the teacher-centered approaches, Lecture (L) recorded the highest frequencies across all observation intervals, with values ranging from 37 at the initial interval to 5 at later intervals, indicating consistent occurrence throughout the observed lessons. Other teacher-centered methods, including Lecture with Demonstration (LDT), Lecture with Handwritten Visuals (LHWV), and Lecture with Pre-made Visuals (LPMV), were also frequently observed across multiple intervals, although at lower frequencies than the traditional lecture method. In contrast, student-centered teaching methods were observed less frequently. Interactive Lecture (IT) was the most prevalent student-centered method, recording moderate frequencies across the intervals. However, other student-centered strategies, such as Small Group Discussion (SGD), Deskwork (D), Whole Class Discussion (WCD), Working out Problems (WP), and Students' Presentation (SP), recorded generally low frequencies, often not exceeding five observations per interval. Multimedia (M) was the least frequently observed student-centered method, with several intervals recording no occurrence.

Research Question 3: To what extent do science teachers integrate technology-enhanced instructional strategies alongside traditional methods?

The results from the findings revealed that technology-enhanced instructional strategies are minimally integrated alongside traditional methods in secondary school science classrooms. Multimedia use, a key indicator of technology-enhanced instruction, is among the least observed methods, with several intervals recording zero occurrences. When present, its frequency does not exceed three observations in any interval, indicating that digital tools and multimedia resources are rarely incorporated into lessons. Similarly, lectures with pre-made visuals (which may include digital presentations) are observed inconsistently, appearing at single-digit frequencies per interval, with some intervals recording no usage. In contrast, traditional lecture-based methods, including those without technological enhancements, appear consistently across all intervals, with significantly higher frequencies. The low occurrence of multimedia use and technology-integrated visuals, compared to the dominance of lecture-based instruction, suggests that science teachers make limited use of technology-enhanced instructional strategies alongside traditional methods in classroom teaching.

4. DISCUSSION

The findings from this study revealed that lecture-based instruction remains the dominant teaching method in secondary school science classrooms, confirming earlier reports of the persistence of teacher-centered practices (Hora, 2015; Kranzfelder et al., 2019). More recent evidence similarly shows that teacher-led approaches continue to dominate in many contexts despite the global call for active learning (Byusa et al., 2020; Ndihokubwayo et al., 2022; Uziak et al., 2021). While interactive lectures and demonstrations occasionally supplemented traditional lectures, student-centered approaches, such as small-group discussions, peer collaboration, and problem-solving exercises, were significantly underutilized. This underrepresentation aligns with research showing that inquiry-based strategies, though effective in enhancing students' engagement and conceptual change, remain marginal in practice (Agwu & Nmadu, 2023; Shaby et al., 2024).

The persistence of teacher-centered methods may be explained by contextual and structural constraints. Teachers often face pressure to cover extensive curricula within limited timeframes, prioritize examination preparation, or manage large class sizes (Chang & Tsai, 2005; Schermer & Fosker, 2020). From a theoretical standpoint, this reflects a misalignment between constructivist views of learning, which emphasize active meaning-making (Vygotsky, 1978), and the realities of classroom practice. When students are relegated to passive roles, opportunities for cognitive conflict, peer negotiation, and deeper conceptual restructuring are diminished, limiting the development of higher-order reasoning skills (Agwu & Nmadu, 2023; Ndihokubwayo et al., 2022).

Another critical finding is the minimal integration of technology-enhanced strategies. The use of digital simulations, multimedia platforms, and interactive tools was among the least observed instructional practices. This mirrors recent reports that, while technology has the potential to transform science education, its adoption remains inconsistent due to infrastructural limitations, inadequate teacher training, and misalignment with curriculum priorities (Demirbilek, 2024; Francom, 2020; Ntawiha et al., 2023). Studies show that technology integration can increase engagement, foster visualization of abstract concepts, and improve long-term retention (Chasokela & Hlongwane, 2025; Wang & Yang, 2016; Yılmaz, 2023), yet without proper institutional support, its role in classrooms remains supplementary rather than transformative.

The combined reliance on teacher-centered instruction and the limited adoption of student-centered and technology-supported methods suggests that many students are not experiencing the kind of inquiry-driven, participatory learning environments necessary for developing 21st-century scientific competencies. Contemporary research stresses that such competencies, problem-solving, collaboration, and digital literacy are best nurtured through blended instructional approaches that integrate direct instruction with active and technology-mediated learning (Burchard et al., 2025; Shaby et al., 2024; Uziak et al., 2021). Therefore, the observed instructional patterns highlight the urgent need for a pedagogical shift that balances efficiency with engagement.

The findings further underscore a critical gap between policy-level advocacy for active learning and classroom realities. If this gap persists, students may continue to struggle with conceptual understanding and the transfer of scientific knowledge to real-world contexts. Addressing these challenges requires systemic interventions: targeted teacher professional development, curriculum restructuring that prioritizes depth over coverage, and investment in digital resources. By situating these results within broader research, this study reinforces the call for more balanced and innovative teaching practices that foster inquiry, engagement, and meaningful learning in science classrooms.

5. CONCLUSION

The findings of this study revealed that teacher-centered instructional methods, particularly lecture-based instruction, dominate secondary school science classrooms, with minimal integration of student-centered and technology-enhanced approaches. While interactive lectures and demonstrations are sometimes incorporated, student-driven strategies such as small-group discussions, problem-solving exercises, and student presentations remain infrequent. This pattern aligns with previous research indicating that science instruction continues to rely heavily on traditional content delivery methods, often at the expense of active student engagement and inquiry-based learning.

Furthermore, the limited use of technology-enhanced instructional strategies highlights a gap in the integration of modern digital learning tools in science classrooms. Multimedia-based instruction, which has been shown to improve conceptual understanding and engagement, was one of the least observed methods, reflecting broader challenges such as infrastructure limitations, inadequate teacher training, and curriculum constraints. These findings suggest that the prevailing instructional practices may not fully support the development of critical thinking, problem-solving, and scientific reasoning skills—key competencies required for deeper engagement with science concepts.

Overall, the study underscores the need for a more balanced instructional approach that integrates teacher-centered efficiency with student-centered engagement and technology-supported learning. While lecture-based instruction provides a structured means of content delivery, the inclusion of interactive discussions, collaborative learning, and digital tools could enhance students' ability to construct knowledge, apply scientific principles, and develop inquiry skills. Understanding the patterns and effectiveness of instructional methods in science classrooms remains essential for shaping pedagogical improvements that foster meaningful learning experiences and long-term interest in science education.

6. LIMITATIONS AND FUTURE DIRECTIONS

6.1. Limitations of the Study

This study offers insights into teaching methods in secondary school science classrooms; however, it has notable limitations. It focuses on the frequency of instructional methods rather than their effectiveness, making it hard to gauge their impact on student learning outcomes. The findings are specific to a particular educational context, potentially limiting their applicability elsewhere. Additionally, the presence of observers may have caused teachers to adjust their behaviors, affecting data accuracy. The absence of student feedback or performance data limits the analysis of how teaching methods influence engagement and achievement. Lastly, factors like school infrastructure, class size, and institutional policies were not thoroughly examined, though they could affect instructional choices and the implementation of student-centered strategies.

6.2. Future Directions

Future research should use a mixed-methods approach, combining quantitative data with qualitative methods like interviews and surveys, to better understand instructional effectiveness. Longitudinal studies can track changes in teaching practices over time, especially in response to student-centered learning interventions. It's essential to identify barriers teachers face in implementing inquiry-based strategies, particularly in resource-limited settings. Additionally, the role of digital learning tools, such as multimedia and AI-driven platforms, should be explored to enhance science instruction. Comparative studies across different regions could shed light on effective practices and inform targeted improvements in science education.

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Research Ethics. Ethical approval for this study was obtained from the appropriate school authorities, who granted permission for the research to be conducted within their institutions. Prior to data collection, the purpose of the study was clearly explained to the participating students. Their voluntary participation was emphasized, and informed consent was obtained. To ensure confidentiality, all personal identifiers were removed, and participants' responses were treated with strict anonymity. The data collected were used solely for academic purposes and handled in accordance with ethical research standards.

Data Availability Statement. The only data available for this study are those presented within the article. No additional data are available.

Conflicts of Interest. The Authors declare no conflict of interest.

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