

Lesson Structure Shapes Engagement, Critical Inquiry, and Creative Thinking in Science Class

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Abstract. Science learning in junior high schools necessitates active participation, strong scientific attitudes, and creative thinking, aligning with contemporary educational paradigms to equip students for real-world challenges. Using qualitative methods, this study investigated instructional practices at an international-curriculum junior high school in Surakarta, focusing on student engagement through observations and interviews with 33 students and one teacher. Results revealed significant student passivity, notably passive listening (39.68%) and inactivity (27.78%), with teachers primarily employing traditional management and basic explanatory methods (each 32.65%). Students preferred visual and contextual media, significantly boosting their motivation and engagement. However, the prevalent question-and-answer method lacked sufficiently stimulating questioning techniques for fostering deep critical thinking. The findings highlight the need for innovative, visually-enriched instructional strategies to effectively enhance students' scientific attitudes and creative thinking, meeting the evolving demands of modern educational contexts.

Keywords: science learning, creative thinking, teaching methods, classroom interaction, active learning.

1 Introduction

The educational paradigms of the 21st century demand a fundamental shift in science pedagogy, moving away from traditional models centered on rote memorization toward approaches that cultivate robust critical thinking and creative problem solving skills. Navigating the era's complex global challenges requires a generation of learners equipped with a suite of 21st century skills that connect classroom learning to real world applications [1, 2]. Traditional instruction is increasingly insufficient, making it imperative to adopt student centered strategies that foster active inquiry and deeper growth [3, 4]. Consequently, modern science education faces a crucial mandate to evolve, prioritizing the development of higher

order thinking skills (HOTS) and creativity to ensure students can effectively solve the multifaceted problems of the contemporary world [5-7].

Central to this educational evolution is the cultivation of active student engagement, a multidimensional construct encompassing behavioral, emotional, and cognitive involvement [8]. Fostering this engagement is the fundamental driver for developing a genuine scientific attitude and creative thinking. When students participate behaviorally through student centered strategies, they move beyond passive reception to become active agents in their own learning and personal growth [3, 9]. This active participation nurtures a corresponding emotional engagement, where scientific interest and a positive attitude towards science can flourish [10, 11]. It is this holistic engagement that builds a robust scientific attitude, transforming classrooms into environments where curiosity and active learning thrive [12].

Despite the widespread acceptance of advanced educational theories, a significant problem arises from the persistent conflict between these modern principles and the reality of traditional, teacher led classroom practices. The core of this issue lies in the dominance of a transmissive teaching model, where knowledge is passively received from the teacher, which stands in direct opposition to constructivist approaches that champion active student participation [13]. This enduring gap between theory and practice often results in student passivity, as traditional pedagogical methods can limit opportunities for equitable, student centered learning [14]. Addressing this disconnect remains a key challenge in strengthening the quality of teaching and initial teacher education, highlighting the need to better align classroom practices with contemporary educational goals [15, 16].

To ground this inquiry in a specific educational environment, this study investigates the instructional dynamics within an international junior high school in Surakarta, Indonesia. Research from this region indicates that student centered methods, such as problem based learning, can be effective in improving student learning activities and outcomes [17]. Therefore, the primary objective of this case study is to diagnose the prevailing teaching methods and analyze their influence on student participation, a key factor in enhancing learning outcomes [18]. By examining the key factors that shape student involvement, from curriculum design to classroom interactions [19], this investigation seeks to understand how pedagogical theories are applied and experienced within this specific context [20, 21].

To address the documented gap between pedagogical theory and classroom reality, the present study asks a central question: How do specific instructional practices in this international junior high school truly impact student engagement? Through qualitative classroom observation and interviews, this investigation diagnoses the dominant teaching methods, the resulting levels of student passivity, and the effectiveness of questioning techniques for fostering critical thinking. By exploring student preferences for visual and contextual media, this study aims to provide actionable recommendations. Its significance lies in highlighting the critical need for innovative, visually enriched strategies to effectively enhance the scientific attitudes and creative thinking required by contemporary educational paradigms.

2 Method

This study employed a qualitative case study design, an approach chosen for its strength in providing an in depth and holistic understanding of a complex phenomenon, such as instructional dynamics and student engagement, within its specific real world context [22, 23].

2.1 Participants and Setting

The research took place in the 2023–2024 school year at an international-curriculum junior-high school in Surakarta, Indonesia. Participants were selected through purposive sampling to ensure rich, relevant information: one experienced science teacher and 33 Grade VII students from a single class (VII A), enabling a focused exploration of shared classroom experiences.

The investigation unfolded across two iterative data-collection cycles. Cycle 1 (28 October 2023) comprised non-participant observation of a double-period science lesson; teacher and student behaviours were captured in analytic memos and on video for later coding. Cycle 2 (16 November 2023) employed semi-structured interviews with the same teacher and two student focus groups to clarify and extend themes that emerged from Cycle 1.

2.2 Data Collection

The principal data-gathering methods were non-participant classroom observations combined with semi-structured interviews. This strategy allows for the triangulation of findings by comparing what participants do with what they say. Table 1 provides a summary of these techniques.

Table 1. Techniques for Gathering Qualitative Data.

Method employed	Data type	Definition of data types	Data obtained
Classroom observation	Observation notes and videos	Unstructured data obtained during observations and video recordings during lesson observations	Record collection through direct observation in the classroom and assisted by video recording of the learning atmosphere in the classroom for more accurate data.
Interview	Open-ended question interview script	Data in the form of unstructured text obtained from recorded interviews	Conducting open-ended interviews and recording the interview process

A series of science lessons were observed from beginning to end. The observer documented detailed field notes, or "analytic memos" [24], focusing on teacher activities, student behaviors, and the nature of classroom interactions. To ensure comprehensive and accurate data capture, lessons were also video-recorded with participants' consent, allowing for repeated review of nuanced events.

Researchers carried out semi-structured, open-ended interviews with the science instructor and several student focus groups. The interviews were designed to explore participants' perceptions of the teaching methods, their personal learning preferences, and their experiences

with engagement and motivation in the science classroom. All conversations were recorded, transcribed, and then systematically examined.

2.3 Data Analysis

We employed a reflexive approach to thematic analysis to generate nuanced, in-depth interpretations of the data [25]. This process was iterative and informed by the principles of constructivist grounded theory, moving from concrete descriptions to abstract themes [26]. The analysis began with data familiarization, which involved transcribing interviews and repeatedly reviewing all notes and recordings. Following this, a detailed initial coding of the entire dataset was performed to assign descriptive labels to discrete actions and statements, a foundational step for organizing the data [27]. These initial codes were then systematically reviewed, compared, and organized into broader, more conceptual categories. In the final stage, these categories were integrated and synthesized through theoretical coding to develop the overarching themes that form the basis of this paper's findings. To ensure the trustworthiness of the analysis, findings from observations and interviews were constantly triangulated, strengthening the validity and credibility of the conclusions drawn [28].

3 Results and Discussion

3.1 The Engagement Gap from Teacher Centered Practices

As presented in Table 2, classroom observations indicated a significant emphasis on teacher-centered instructional methods, particularly evident through high percentages of time dedicated to explaining the material (32.65%) and classroom management activities (32.65%). These methods positioned teachers as primary conveyors of knowledge, with minimal room for students to actively participate or engage deeply with lesson content. Consequently, this instructional approach restricted student activities predominantly to passive listening (39.68%) and extensive periods of inactivity (27.78%). Passive listening, while beneficial for specific types of information transmission, can significantly limit opportunities for students to develop higher-order thinking and interactive skills. Furthermore, prolonged inactivity periods suggest missed opportunities for stimulating student curiosity, collaborative problem-solving, and critical reflection. Such instructional dynamics not only limit immediate classroom engagement but may also hinder the development of crucial academic skills and attitudes necessary for students to navigate and effectively respond to real-world challenges.

The observed teacher-centered instructional dynamic aligns closely with findings from educational research. Tomljenović and Vorkapić [13] identified similar challenges, observing that excessive reliance on teacher-driven methods often diminishes student motivation and reduces their active participation. Additionally, Cochran-Smith, et al [29] found that traditional teacher-led pedagogies frequently result in superficial engagement, restricting students largely to rote memorisation and leaving scant scope for deeper questioning or inventive problem solving. This alignment emphasizes that prolonged use of traditional instructional models may significantly limit the depth and quality of students' cognitive and emotional engagement, thereby constraining their overall academic development and readiness for complex, real-world tasks. Therefore, transitioning toward more student-centered

instructional practices is essential for fostering deeper learning and developing critical thinking capabilities in students.

Table 2. Frequency of Coded Behaviors from Classroom Observations.

Aspects	Encode Observation Results	Percentage (%)
Students	Understand the previous concept	1.58
	Science experience	0.79
	Ability to read and understand concepts	3.17
	Communication skills	4.76
	Active in answering (oral activities)	8.73
	visual activities	8.73
	Listening activities	39.68
	Inactive	27.78
	Opening skills	4.08
	Teacher	Basic questioning skills
Advanced questioning skills		6.12
classroom management skills		32.65
reinforcement skills		4.08
skill in explaining the material		32.65

To effectively address this "engagement gap," it is essential to implement instructional practices aligned with constructivist pedagogical principles, which emphasize active student participation, collaborative learning, and inquiry-based instruction. Griffin [30] underscores the importance of shifting toward student-centered approaches, advocating for instructional methods that enable learners to actively construct knowledge and meaning through interaction and exploration. Similarly, earlier study have shown that inquiry-based, learner-centred strategies enhance students' intrinsic motivation, engagement, and academic success [9]. Empirical studies indicate that classrooms using these strategies show not only higher levels of engagement and stronger academic performance but also foster deeper conceptual grasp and sharper capacities for analytical reasoning and effective problem resolution. By embracing such pedagogical shifts, educators can effectively bridge the engagement gap, fostering learning environments conducive to the holistic development of students' academic and social-emotional competencies.

3.2 Barriers to Interaction and Critical Thinking

As presented in Table 3, subcategories and categories were derived from interview coding conducted after the second cycle. For students, three major categories were identified: engaging important science-related issues in everyday life (Science Concepts); the process of translating explanations that generate curiosity and critical thinking (Scientific Attitudes); and students' attitudes in developing knowledge (Scientific Attitudes). Teachers were categorized by classroom management, teaching methods, and curriculum, with prominent subcategories including classroom management skills (44.44%), assessment skills (26.67%), and the use of learning media (6.67%). The data suggest a dual pattern: while students show potential for engagement and critical inquiry, they often remain passive due to instructional strategies dominated by question-and-answer formats and conceptual textbook-based presentations.

Table 3. Thematic Categories and Subcategories from Teacher and Student Interviews.

Aspects	Category	Subcategory	Encode Interview Results	Percentage (%)
Students	Engaging important science-related issues in everyday life (Science Concepts)	Understand the concept by providing important events in daily life	Concept understanding	10.00
			Sensitive to the environment	10.00
	The process of translating explanations that generate curiosity and critical thinking (scientific attitude)	Identify the question given by the teacher	Communication skills	10.00
			Curiosity	20.00
	Student attitude in developing knowledge (Scientific Attitude)	Student learning activity is high	Learning activities	40.00
Learning motivation			10.00	
Teacher	Class management	Classroom management skills	Advanced questioning skills	8.89
			Classroom management skills	44.44
	Teaching method	Skills in using learning media	Skills in using learning media/resources	6.67
			Skill in explaining the material	6.67
			Assessment skills	26.67
	Curriculum	School curriculum	Cambridge Curriculum	8.89

Despite the perceived value of the question-and-answer method in science classrooms for promoting interaction, its implementation in this context appeared insufficient to foster meaningful student participation. When employed effectively, questioning techniques can support classroom dialogue and deepen student understanding [31]. However, the dominance of low-level questioning observed here limited opportunities for students to engage in higher-order thinking. The cognitive quality of a question determines the quality of students' responses [32], and teachers who lack skills in advanced questioning may inadvertently promote surface-level recall rather than analytical thinking. Effective questions serve as cognitive prompts, encouraging students to connect ideas, justify claims, and explore alternatives [33]. In this study, the limited use of advanced questioning hindered the development of students' scientific attitudes and critical inquiry skills.

Overall, the pattern shows a mismatch between constructivist intentions and teacher-led routines that suppress the behavioural, emotional, and cognitive facets of engagement needed for inquiry [8, 13]. Shifting toward student-centred, inquiry-oriented designs has been shown to re-activate participation and deepen learning processes [9]. In contexts comparable to this case, problem-based approaches supported by visual and contextual media have increased

activity and learning outcomes, aligning with students' stated preferences in this study. These adjustments, coupled with more purposeful questioning, offer a direct route to closing the interaction gap observed here.

3.3 Creative-thinking implications

The teacher-centred talk pattern documented in Table 2, not only constrained critical inquiry but also reduced chances for students to practise the divergent and evaluative moves that define creative thinking in science. When classroom discourse is limited to recall questions, learners have little incentive to propose alternative explanations, connect remote ideas, or elaborate on tentative thoughts. This finding echoes research showing that transmissive routines narrow the cognitive space required for flexible and original reasoning [5].

Interview evidence suggests a clear remedy. Students described higher curiosity and a readiness to ask what-if questions whenever lessons opened with visual or locally relevant contexts, an effect supported by studies in which multimedia prompts and authentic phenomena triggered idea generation and conceptual flexibility [18]. In particular, the use of augmented-reality visuals in junior-high science has been shown to raise fluency, flexibility, and originality scores on creative-thinking tests, indicating that sensory-rich anchors can serve as powerful gateways to divergent thought [34].

To turn this potential into routine practice, visual or contextual hooks should be embedded inside inquiry cycles that culminate in explanation-seeking dialogue and justification-focused questioning. Problem based learning sequences that incorporate creative-pedagogy principles have already produced significant gains in higher-order thinking in comparable science settings [35]. Coupled with systematic professional development in open questioning and media-rich lesson design, such sequences offer a concrete path for transforming passive reception into the creative exploration required by twenty-first-century science education [5, 18, 35].

4 Conclusions

This qualitative case study used two iterative cycles of observation and interview to examine how instructional practices in an international curriculum junior high science class influence engagement, creativity, and scientific attitude. Classroom observation showed that teacher centered talk, namely explanation and management, filled almost two thirds of the lesson, leaving students mainly listening passively (39.68 percent) or completely inactive (27.78 percent). Interviews confirmed that learners view such transmissive routines as disengaging and prefer lessons that begin with visual or locally contextualised phenomena, which spark curiosity and make later discussion more meaningful. The data also indicated that the teacher's frequent questions rarely moved beyond simple factual recall, limiting any explanation seeking dialogue and critical thinking.

To close this engagement gap, science instruction should begin with media rich, context laden prompts tied to real world problems, structure activities around inquiry cycles that require students to generate and test explanations, and expand teachers' repertoires of open justification focused questions. Professional development in questioning strategies and visual contextual lesson design is recommended. Although the findings come from a single class,

they underscore the need for replication across grades and subjects and for longitudinal research on how sustained creative-pedagogy practices affect engagement, scientific attitude, and the growth of students' creative-thinking skills in Indonesian junior-high classrooms and comparable contexts elsewhere.

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