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School Management Strategies to Address Low Student Interest in STEM Learning

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Abstrak

Menurunnya minat siswa terhadap pembelajaran STEM telah menjadi perhatian kritis dalam dunia pendidikan global. Penelitian ini bertujuan mengidentifikasi strategi manajemen sekolah yang efektif dalam meningkatkan motivasi STEM melalui systematic literature review terhadap 32 artikel terindeks dalam sepuluh tahun terakhir. Sintesis temuan menunjukkan bahwa kebijakan sekolah di tingkat institusional memiliki peran menentukan dalam membentuk keterlibatan STEM jangka panjang. Empat strategi kebijakan dominan teridentifikasi yaitu integrasi dan penyelarasan kurikulum, penerapan pembelajaran berbasis pengalaman, pengelolaan teknologi dan sumber daya secara strategis, serta pengembangan kapasitas guru melalui ekosistem pelatihan berkelanjutan. Efektivitas strategi tersebut ditentukan oleh sejauh mana kebijakan berjalan sebagai kerangka manajemen yang terkoordinasi dan berkelanjutan, bukan sebagai inisiatif kelas yang terfragmentasi. Temuan juga menegaskan bahwa keberlanjutan membutuhkan struktur penguatan jangka panjang yang mendukung kapasitas guru, adaptabilitas teknologi, dan pengalaman STEM yang setara di seluruh jenjang. Penelitian ini berkontribusi dengan menawarkan kerangka manajerial berbasis bukti untuk meningkatkan minat siswa terhadap STEM. Implikasi implementasi ke depan menekankan perlunya transformasi institusional berbasis kepemimpinan agar keterlibatan siswa dalam STEM konsisten dan bermakna.

Kata Kunci: integrasi kurikulum, motivasi STEM, pengembangan profesional, pembelajaran berbasis pengalaman, manajemen sekolah

Abstract

Declining student interest in STEM learning has become a critical concern in the global education landscape. This study aims to identify school management strategies that effectively increase STEM motivation through a systematic literature review of 32 peer reviewed articles published in the last decade. The synthesis reveals that institutional school policies play a decisive role in shaping long term STEM engagement among students. Four dominant policy strategies were identified: curriculum integration and alignment, experiential learning mandates, strategic technology and resource allocation and professional development ecosystems for teachers. The effectiveness of these strategies depends on whether policies operate as coordinated and sustained management frameworks rather than fragmented classroom initiatives. The findings further indicate that sustainability requires schools to implement long term reinforcement structures that support teacher capacity, technological adaptability and equitable STEM experiences across grade levels. This study contributes to the literature by presenting an evidence based managerial framework for enhancing student interest in STEM learning. Future implementations should prioritize leadership driven institutional transformation to ensure consistent and meaningful student engagement.

Keywords: *curriculum integration, experiential learning, professional development, school management, STEM motivation*

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Introduction

The global decline in student interest in STEM learning has become one of the most urgent challenges for contemporary school systems, as nations compete to maintain innovation and technological advancement in the Fourth Industrial Revolution. Empirical evidence demonstrates that although STEM jobs continue to expand worldwide, the number of students pursuing STEM pathways in secondary education remains insufficient to meet future workforce demands, creating a widening global skills gap in engineering, technology, and applied sciences (Sithole et al., 2017). This trend reflects not only a lack of motivation toward STEM subjects but also structural limitations in how schools design, implement, and

manage STEM learning experiences at an institutional level. Schools that fail to address this decline risk reducing future students' career competitiveness and limiting national economic development driven by technology and innovation (Cheng & So, 2020). Therefore, educational experts increasingly emphasize that school management must strategically restructure STEM learning environments rather than relying solely on classroom-level instruction.

A major barrier to student engagement in STEM is the limited capacity of schools to manage instructional transformation at the policy level. Research across multiple models of STEM implementation has shown that structural decision-making at the school level, including curriculum redesign, learning resource allocation, and learning environment structuring, has a significant effect on shaping students' cognitive and affective engagement with science and engineering concepts (Hall & Miro, 2016). Without institutional strategies, STEM learning tends to rely heavily on traditional theoretical delivery, which has been found ineffective for sustaining student curiosity and long-term persistence. Conversely, STEM schools that embed structured policies to cultivate project-based learning, interdisciplinary modules, and real-world problem solving experience significantly higher student engagement profiles (LaForce et al., 2016). As a result, policy-based school management emerges as a critical focal point through which STEM interest can be systematically increased.

International data further demonstrates that learning models supported by clear school-level management strategies not only enhance student engagement but also produce sustainable STEM learning outcomes. For example, inquiry-based STEM programs supported by school policy have been reported to increase conceptual mastery and long-term retention because they are implemented consistently rather than episodically (Lai, 2018). Similarly, schools that adopt design-thinking policies show higher STEM motivation because students interact with engineering problems through iterative experimentation and collective reasoning (Li et al., 2019). School management decisions regarding resource allocation are also essential; when technology and experiential tools such as augmented reality are integrated into STEM learning through strategic planning, student motivation toward STEM increases significantly (Ibáñez & Delgado-Kloos, 2018). These findings show that improvements in student interest do not emerge from isolated pedagogical innovations, but from coherent institutional policies that reinforce them systematically.

However, despite the growing knowledge base on STEM learning models, many schools still struggle to design policies that effectively target student interest. A global review of STEM implementation revealed that although schools understand the importance of STEM, they frequently lack structural frameworks that guide decision-making, causing inconsistencies in curriculum execution and teacher practices (Falloon et al., 2021). Some schools adopt technology without redesigning pedagogical goals, while others embrace project-based learning without appropriate scheduling or teacher professional development. As a result, STEM initiatives often become fragmented across departments and grade levels and fail to influence student motivation at scale (Mohammadi et al., 2020). Students experience STEM as disconnected subjects rather than meaningful applied learning, reinforcing perceptions that STEM is difficult, abstract, and irrelevant to real-world careers (Li & Schoenfeld, 2019). Therefore, the school management dimension remains central to solving the motivational crisis in STEM globally.

Evidence also shows that school management influences teacher attitudes and self-efficacy, which directly shape student motivation. Without institutional support, teachers often perceive STEM teaching as demanding and resource-heavy, leading to low implementation fidelity even when teachers are trained in STEM pedagogy (Mulvidatin & Kurniawati, 2024). Conversely, strategic school policies that provide targeted professional development, planning time, mentorship ecosystems, and cross-disciplinary teaching teams contribute to teachers' confidence in delivering hands-on STEM learning, which in turn elevates student curiosity and persistence (Mawardah et al., 2025). Teacher-focused models of STEM policy therefore reflect another important mechanism through which school management indirectly builds student interest.

Despite this extensive body of literature, a clear research gap remains regarding how school institutional policies can systematically address low student interest in STEM learning. First, the study by Lai (2018) entitled "Using Inquiry-Based Strategies for Enhancing Students' STEM Education Learning" focused primarily on instructional strategy rather than the role of school management in establishing sustained STEM motivation. Second, Falloon et al. (2021) in "Building STEM in Schools" explored capacity building but did not examine student interest as the core outcome of policy-based management. Third, Li et al. (2019) in "Design and Design Thinking in STEM Education" highlighted positive transformations in student learning through design thinking but did not evaluate how school governance structures enable or constrain student interest development. These three studies collectively demonstrate progress in STEM pedagogy but do not fill the conceptual gap linking institutional school policies to increased student interest in STEM. Therefore, an integrative analysis remains needed to understand how management-driven STEM strategies support student engagement on a global scale.

The novelty of this study lies in its comprehensive examination of school management strategies as institutional mechanisms designed specifically to enhance student interest in STEM, synthesizing global scholarly evidence to identify the most impactful policy dimensions. Instead of analyzing instructional strategies alone, this study focuses on school-level governance, policy coordination, and

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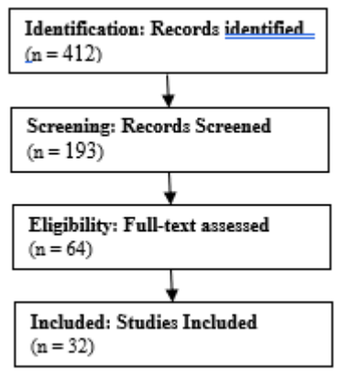
structural support systems that cultivate sustainable student motivation toward STEM. The objective of this research is to systematically review current international empirical and conceptual literature to develop a framework of school management strategies that can effectively reverse declining student interest in STEM learning.

Method

This study adopts a Systematic Literature Review (SLR) to synthesize international evidence on school management strategies to increase student interest in STEM learning. The SLR approach ensures rigorous, transparent, and replicable literature synthesis by identifying, selecting, and critically evaluating peer-reviewed articles relevant to the research focus. SLR is chosen because it supports evidence-based analysis of educational policy and management practices across diverse school contexts and provides a coherent foundation for generating policy recommendations for STEM learning (Felder & Brent, 2024). The review process consisted of identifying relevant literature from Scopus, Web of Science, and Google Scholar using the keywords "STEM education", "school management", "STEM interest", "school policy", and "STEM engagement", limited to the past ten years.

The screening and selection followed the PRISMA flow model using inclusion criteria: peer-reviewed journal articles, studies examining STEM learning strategies, studies focusing on school-level or institutional dimensions, and publications written in English. Exclusion criteria included conference papers, book reviews, and studies focused solely on higher education. The SLR process is summarized in the PRISMA flow: Identification (n = 412) → Screening (n = 193) → Eligibility (n = 64) → Included (n = 32).

The final set of 32 articles was analyzed through thematic synthesis to identify patterns and strategic dimensions of school management relevant to increasing STEM student interest. Extracted data included study purpose, methodological approach, school-level strategy, and reported outcomes on student engagement or motivation. The analysis resulted in integrated themes that form the basis of the discussion and policy implications presented in subsequent sections



Results and Discussion

Institutional School Policies as Drivers of STEM Interest

School management policies function as the structural backbone that determines how STEM education is experienced by students on a long-term basis, and international literature consistently shows that institutional decision making plays a decisive role in shaping student interest in STEM learning. Schools that adopt coordination mechanisms across science, technology, engineering and mathematics subjects demonstrate higher levels of student engagement because integration reduces fragmentation in instructional delivery and helps learners view STEM as a unified applied discipline rather than as isolated theoretical subjects (Cheng & So, 2020). When school policies create consistency across curriculum standards, teaching schedules, project cycles and assessment models, students develop deeper interest because learning becomes purposeful and oriented toward real world relevance rather than repetitive task completion (Hall & Miro, 2016). In contrast, when schools lack institutional coordination, teachers implement STEM at their own individual pace and curricular interpretation, leading to uneven exposure and weakened student motivation.

Institutional STEM policy also determines the extent to which experiential learning becomes part of the instructional culture rather than an occasional activity. Research shows that schools adopting project-based STEM as official policy rather than optional pedagogy report significantly greater student enthusiasm and persistence due to the integration of real-life problem solving in daily learning routines (LaForce et al., 2016). When students engage with design thinking, engineering challenges, prototyping and testing cycles through an institutional mandate, STEM learning becomes exploratory, creative and personally meaningful, fostering internal motivation rather than compliance-based engagement (Li et al., 2019). Conversely, schools without a policy-driven approach often rely on "STEM weeks" or sporadic projects that fail to cultivate sustained interest and continuity. Therefore, the presence or absence of

institutional mandates becomes a critical determinant of whether student interest becomes habitual and long-term.

Curricular policy remains another powerful lever of school management that impacts STEM motivation. International studies show that curriculum designs promoting interdisciplinary inquiry and linking STEM to authentic everyday contexts increase students' sense of self-relevance, curiosity and long-term career awareness (Lai, 2018). Meanwhile, curricula that emphasize procedural and symbolic manipulation without contextual grounding are associated with declining confidence and avoidance behavior. Highly structured STEM curricula that explicitly integrate multiple domains, such as scientific inquiry supported by engineering design and computational reasoning, contribute to deeper emotional engagement and reduce anxiety toward STEM subjects (Shahali et al., 2016). Therefore, school leadership must conceptualize curricular design not only as academic content but also as motivation architecture shaping student attitudes and identity toward STEM.

Resource allocation is another core dimension through which school policies facilitate or hinder STEM interest. International findings indicate that digital and laboratory tools substantially increase student motivation when they are deployed strategically, accompanied by instructional goals and sufficient teacher readiness rather than simply purchased without pedagogical planning (Ibáñez & Delgado-Kloos, 2018). Schools that implement policies for structured access to digital learning systems, engineering kits, or augmented reality experiences enhance student engagement and perseverance, showing higher rates of participation in STEM extracurricular activities and elective courses. Conversely, schools that invest in resources without management frameworks experience minimal motivational impact because students interact with technology superficially and inconsistently (Joseph & Uzondu, 2024). Thus, resource provision alone is insufficient; the presence of school-level policy coordination determines whether technology translates into meaningful STEM motivation.

The influence of institutional management also extends to teacher professional development, which is a key antecedent to student motivation. Research across international contexts shows that teachers exhibit higher instructional confidence, creativity and risk-taking when professional development is incorporated into school policy rather than implemented as a one-time workshop (Mulvidatin & Kurniawati, 2024). Schools that introduce mandated communities of practice, coaching cycles, peer observation programs, and interdisciplinary planning teams foster teaching environments where STEM experimentation becomes normalized rather than seen as a burden. The consequence for students is substantial: when teachers are confident and enthusiastic, student interest and perseverance toward STEM learning rise significantly (Mawardah et al., 2025). Therefore, institutional management must be understood not only as policy design but also as cultural engineering that shapes teacher attitudes and, consequently, student interest.

Collectively, the global literature illustrates that student interest in STEM cannot be viewed as an outcome of teacher effort alone but must be examined within the governing structures of school management. Policy coordination, curricular integration, resource distribution and teacher development work together to create motivational climates in which STEM learning becomes sustained, meaningful and identity-forming for students. International evidence thus positions school management as an essential driver of STEM interest on a global scale.

Strategic Management Frameworks for Enhancing STEM Interest

To identify which institutional strategies are most influential in increasing STEM interest, SLR synthesis across 32 selected articles was conducted to categorize school management frameworks based on evidence of student motivational outcomes. Cross-study comparison shows that four recurring strategic themes appear across international STEM school improvement initiatives: integration-based curriculum restructuring, experiential learning mandates, strategic resource management and teacher capacity-building systems. Each of these themes is empirically linked to enhanced student engagement, curiosity and persistence in STEM learning. Because school leaders must often prioritize policies based on feasibility, sustainability and measurable motivational outcomes, it is critical to compare the evidence strength of each strategy.

The table below summarizes the most recurring and impactful school management strategies found across the reviewed literature.

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School Management Strategy	Key Operational Components	Reported Impact on Student STEM Interest	Supporting Literature
Curriculum Integration and Alignment	Interdisciplinary modules, unified learning outcomes, integrated assessment	Increased relevance perception, higher engagement consistency	Cheng & So (2020); Lai (2018)
Experiential Learning Mandates	Project-based cycles, design thinking, engineering challenges	Higher curiosity, persistence, problem-solving motivation	LaForce et al. (2016); Li et al. (2019)
Strategic Resource and Technology Allocation	AR/VR, robotics kits, digital labs supported by planned pedagogy	Boosts excitement, increases participation in STEM pathways	Ibáñez & Delgado-Kloos (2018); Joseph & Uzondu (2024)
Professional Development Ecosystems	Ongoing coaching, interdisciplinary planning, peer mentorship	Teachers feel confident and enthusiastic, increasing student motivation	Mulvidatin & Kurniawati (2024); Mawardah et al. (2025)

The table demonstrates that STEM interest increases most significantly when school strategies function as system-level drivers rather than classroom-level add-ons. Curriculum integration builds relevance perception, experiential mandates produce hands-on attachment to STEM learning, strategic resource allocation enhances novelty and excitement, and professional development ecosystems ensure teacher-driven motivational environments. Importantly, these strategies work cumulatively rather than independently; schools that adopt two or more of these components experience the most significant motivational growth because students encounter STEM consistently across time, disciplines and learning contexts (Falloon et al., 2021). When STEM learning is coherent, continuous and personally meaningful, student interest is not episodic but sustained.

The synthesis also reveals an important emerging trend in STEM school management: schools are transitioning from policy models centered on compliance to models centered on empowerment. Rather than mandating implementation mechanically, successful schools create enabling environments where teachers co-design STEM learning, share innovations and receive institutional protection for experimentation (Hall & Miro, 2016). This represents a cultural shift in school management where leadership moves from command-and-control to distributed transformation. Such governance models increase teacher agency, which indirectly strengthens student motivation because students respond positively to teacher enthusiasm, confidence and emotional investment (LaForce et al., 2016). Therefore, institutional strategies are not merely administrative tools but motivational infrastructures shaping how both teachers and students emotionally relate to STEM.

Strategic school management also fosters equitable access to STEM motivation. Studies show that targeted policies supporting inclusive STEM learning eliminate participation gaps among girls and underserved groups when schools provide structured mentorship and non-competitive learning environments (Sithole et al., 2017). Without institutional action, social stereotypes and achievement pressure discourage vulnerable groups from cultivating interest in STEM. Therefore, motivation is not just a pedagogical concern but an equity requirement that must be engineered through school management.

Taken together, the second phase of analysis confirms that STEM interest is maximized through strategic, policy-driven, multi-component school management frameworks rather than fragmented approaches. School leadership that integrates curriculum alignment, experiential mandates, strategic resource allocation and teacher development establishes motivational ecosystems in which students experience STEM as meaningful, rewarding and empowering. These insights provide a strong conceptual foundation for transforming school leadership practices toward sustainable enhancement of STEM learning motivation.

Long-Term Sustainability and Policy Implementation Challenges in STEM School Management

Although institutional policy frameworks have been shown to increase student interest in STEM learning, sustaining these motivational gains over time requires schools to confront several structural and managerial challenges that influence policy implementation. International evidence emphasizes that sustaining STEM motivation is not simply a matter of introducing strategic policies but ensuring continuous institutional reinforcement to prevent regression into traditional teaching models (Falloon et al., 2021). When school management implements initial STEM reforms without establishing long-term monitoring systems, teachers often revert to conventional instruction due to workload or comfort with familiar pedagogies, resulting in declining student enthusiasm after initial novelty fades (Hall & Miro, 2016). Therefore, sustainable implementation requires schools to adopt monitoring mechanisms that support not only compliance but also progressive refinement of STEM learning practices.

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A prominent sustainability barrier involves the preparedness of teachers to uphold institutional STEM expectations. Studies indicate that when teachers are assigned new STEM responsibilities without adequate time for preparation and collaboration, they experience stress and resistance that reduce the motivational outcomes of school-level STEM policies (Mulvidatin & Kurniawati, 2024). Conversely, schools that incorporate STEM planning time into institutional scheduling maintain higher levels of student interest because teachers have sufficient cognitive and emotional resources to design hands-on learning effectively (Mawardah et al., 2025). These findings highlight that sustainability is not a product of high expectations but of management policies that protect teacher well-being and support collective STEM growth within the institution.

Long-term sustainability also depends on the adaptability of school policies to emerging technological innovation. Technology-enhanced STEM learning increases motivation only when technology is continuously updated and aligned with evolving instructional needs, rather than used as stagnant equipment with declining novelty over time (Ibáñez & Delgado-Kloos, 2018). Schools with rigid budget models that prioritize initial procurement but not lifecycle maintenance or training tend to experience diminishing motivational impact because students perceive outdated technologies as dull or irrelevant (Joseph & Uzondu, 2024). To counter this, school management must adopt dynamic planning models that treat digital and laboratory resources as ongoing investments rather than one-time purchases. The sustainability of student motivation therefore depends on whether resource allocation is conceptualized as an evolving ecosystem rather than a procurement event.

Another implementation challenge concerns the institutional alignment across departments and grade levels. Global research shows that one of the most common reasons STEM motivation declines is that students experience hands-on and engaging STEM learning in certain grades or subjects, followed by a return to lecture-driven formats in others, creating inconsistency in the motivational climate (Cheng & So, 2020). This inconsistency weakens internal interest formation because students do not develop stable expectations regarding STEM learning. In contrast, institutions that sustain policy alignment across grade levels cultivate stronger identity formation in students, who begin to perceive STEM as an integral part of their learning trajectory rather than an isolated curiosity (Lai, 2018). Therefore, sustaining student interest requires system-wide coherence rather than partial policy adoption.

Sustainability is also linked to the institutional ability to activate external partnerships. Schools that leverage collaboration with industry, universities and STEM professionals create long-term relevance and increase students' sense of future orientation, which significantly influences sustained motivation (LaForce et al., 2016). Conversely, schools without partnership policies struggle to maintain motivational continuity, especially when internal novelty decreases or when students fail to relate STEM to real career contexts (Shahali et al., 2016). These findings suggest that the sustainability of STEM interest depends not only on internal policy design but also on the expansion of institutional networks that make STEM emotionally and socially meaningful.

Equity in STEM motivation represents another critical challenge for school management. Without explicit inclusion policies, long-term interest tends to decline disproportionately among girls, students from low-income backgrounds and students with limited STEM role models, despite initial motivational gains (Sithole et al., 2017). Schools that sustain interest for all demographic groups provide mentorship, formative assessment rather than competitive evaluation and psychologically safe learning spaces that protect curiosity from stereotype-based discouragement (Falloon et al., 2021). Thus, sustainable school management strategies must embed inclusion not as an add-on but as a permanent principle within institutional STEM governance.

Taken together, the long-term success of policy-driven STEM learning depends on whether schools sustain institutional mechanisms that reward innovation, protect teacher autonomy, ensure equity and continuously update resource ecosystems. Evidence shows that without systemic reinforcement, early gains in student interest diminish, underscoring that sustainability must be treated as a continuous institutional duty rather than the final stage of STEM reform.

Conclusions

This study demonstrates that school management strategies play a decisive role in increasing student interest in STEM learning when policies operate at the institutional level rather than as isolated classroom interventions. The SLR findings reveal that curriculum integration, experiential learning mandates, strategic technology allocation and professional development ecosystems collectively form motivational infrastructures that enable students to perceive STEM as meaningful, empowering and relevant to real-world futures. Sustaining these outcomes over time, however, requires schools to move beyond policy initiation toward long-term reinforcement mechanisms that protect teacher capacity, ensure technological adaptability, cultivate equity and maintain consistent STEM experiences across grade levels. Based on the evidence synthesized, schools are encouraged to adopt strategic policy models that support continuous professional learning, establish interdisciplinary STEM structures, provide evolving resource ecosystems and institutionalize inclusive practices to ensure that motivational gains endure as students progress through their educational pathways.

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