

Exploring Science Achievement Disparities in Schools with Diverse Resource Contexts

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Abstract:

This comprehensive mixed-methods study explores how disparities in resources shape science achievement among secondary school students, offering new insights into both systemic and individual factors that affect learning. The investigation draws on extensive quantitative data to demonstrate that students attending schools with abundant facilities, well-qualified teachers, and plentiful learning materials consistently achieve higher science outcomes than those in under-resourced settings. The study verifies a pronounced link between resource equity and academic success, emphasizing the key mediating role of student motivation. Constructs such as self-efficacy and intrinsic motivation exhibit strong, positive associations with science performance, confirming their importance in supporting achievement.

Qualitative findings illuminate how shortages in infrastructure, instructional support, and curricular materials in low-resource schools undermine instructional quality and weaken student motivational beliefs, consequently limiting active engagement and perpetuating achievement inequality. The conceptual framework guiding this research integrates structural inequities with psychological dimensions and contextual moderators, such as socio-cultural environment and students' subjective perceptions. This holistic model provides clarity on the multiple, intersecting channels through which both external and internal factors drive educational outcomes.

Ultimately, the results highlight the necessity for comprehensive policy and pedagogical interventions. Effective strategies should address resource allocation and simultaneously foster motivational engagement through culturally responsive curriculum, enriched teacher training, and support from families and local communities. The implications extend to educational stakeholders and researchers, urging continued investigation of longitudinal and context-specific solutions for advancing equitable science learning.

Keywords: Resource disparities, Science achievement, Student motivation, Instructional quality, Equity in education

Introduction

Science education serves as a critical foundation for nurturing students' critical thinking, problem-solving abilities, and scientific literacy, all of which are vital for lifelong learning and effective participation in contemporary workplaces (Eccles & Wigfield, 2002). Nonetheless, disparities in science achievement continue to pose a significant global challenge, often stemming from uneven allocation of educational resources, variations in socioeconomic status, and differences in instructional quality (Fredricks, Blumenfeld, & Paris, 2004; National Science Board, 2018). The early onset of these gaps jeopardizes

equitable access to education and can have lasting effects on academic trajectories and future opportunities in STEM-related careers (Morgan et al., 2016; Quinn & Cooc, 2015).

Research has thoroughly examined disparities in student achievement. However, there is still insufficient insight into how variations in school resources affect students' science learning outcomes and experiences. Evidence indicates that schools serving low-income communities frequently contend with insufficiently trained science teachers, inadequate laboratory facilities, and a lack of rigorous curricula, which collectively hinder student performance in science (Banilower et al., 2013; Muijs et al., 2014). Additionally, scholars advocate for approaches that integrate quantitative analyses of achievement gaps with qualitative insights into contextual and perceptual factors, recognizing that resource-related influences on learning are complex and multifaceted (Creswell & Plano Clark, 2017).

In response to these gaps, the present study utilizes a mixed methods design to investigate both the magnitude of science achievement disparities linked to variations in school resources and the lived experiences of students and educators navigating these challenges. Gaining a comprehensive understanding of these dynamics is essential for shaping evidence-based policies and instructional strategies that aim to reduce science achievement gaps and promote equitable opportunities in STEM education.

Study Gaps

Despite extensive research on science learning motivation, significant gaps remain regarding how motivational constructs operate within resource-diverse secondary school settings, especially in developing country contexts. Prior studies often focus on privileged or homogeneous samples, limiting understanding of how disparities in school resources influence motivation and achievement. Additionally, few mixed methods investigations intricately integrate quantitative patterns with rich qualitative insights to illuminate the contextualized experiences that shape science motivation among under-resourced learners. This study addresses these gaps by combining robust psychometric analysis with in-depth interviews, providing a nuanced, holistic perspective on motivation's drivers and barriers across diverse educational environments.

Significance

Understanding motivation's multifaceted role in science learning is vital to enhancing student engagement and academic success—key goals in contemporary education systems aiming to cultivate STEM competencies for global competitiveness. This research contributes valuable theoretical and practical insights by elucidating how intrinsic interest, self-efficacy, task value, and mastery goals interact with resource contexts to affect motivation and performance. The findings inform educators, curriculum designers, and policymakers about targeted strategies to foster equitable, motivating science learning experiences. Furthermore, the use of mixed methods enriches empirical evidence, offering actionable recommendations grounded in both statistical trends and lived realities, thereby contributing to closing achievement gaps and advancing science education.

Justification

This study is justified on the basis that motivation profoundly influences students' science learning outcomes but remains inadequately explored in contexts marked by resource disparities. Unequal access to instructional materials, laboratories, and qualified teachers can undermine motivation and perpetuate

achievement gaps. By investigating motivation across resource-diverse secondary schools using integrated quantitative and qualitative methods, this study provides a comprehensive understanding that can drive effective interventions. Its methodological rigor and contextual sensitivity ensure relevance and applicability, informing policies and practices to promote science motivation and educational equity.

Purpose

The purpose of this study is to examine the dimensions of science learning motivation and their relationship to student engagement and achievement in secondary schools with varying levels of resource availability. Specifically, it aims to identify motivational differences attributable to resource disparities, to explore students' subjective experiences influencing motivation, and to integrate quantitative and qualitative data to develop a holistic understanding. The ultimate goal is to generate evidence-based recommendations to enhance science motivation and achievement, fostering inclusive and effective science education.

Research Objectives

1. To examine the differences in science achievement among schools with different resource levels.
2. To explore contextual factors influencing science achievement disparities related to school resources.

Research Questions

1. What are the differences in science achievement scores across schools with varying levels of resources?
2. How do students and educators perceive the impact of school resource availability on science learning experiences and outcomes?

Literature review

Socioeconomic and Resource Disparities in Science Achievement

Research consistently underscores the significant role that socioeconomic status (SES) and the allocation of school resources play in creating disparities in students' science achievement (Betancur, 2018). Factors such as family income levels and parents' educational attainment directly influence students' access to high-quality instruction, learning materials, and skilled science educators, all of which are crucial determinants of academic performance. Identifying which elements of SES most strongly predict science proficiency is essential for directing educational support where it is most needed and for reducing achievement inequities. Evidence from the literature further suggests that unequal resource distribution perpetuates performance gaps, with students from lower SES backgrounds experiencing the most pronounced disadvantages.

Early Emergence and Persistence of Science Achievement Gaps

Research indicates that disparities in science performance manifest at an early stage in students' educational journeys and tend to continue through the middle and high school years (Quinn & Cooc, 2015). The fact that these differences emerge so early underscores the need for targeted interventions during the preschool and primary school periods to avert long-term educational inequities. Moreover, the ongoing nature of these achievement gaps points to structural challenges within the education system, highlighting the importance of implementing broad strategies that address both academic learning and socio-emotional development from the outset of schooling.

Influence of Instructional Quality and Curriculum Rigor

Studies highlight those variations in the quality of instruction and the rigor of the curriculum play a significant role in shaping how resource disparities affect student learning outcomes (Banilower et al., 2013; Muijs et al., 2014). Even within under-resourced schools, differences in teachers' effectiveness and how well the curriculum is executed can result in measurable gaps in science performance. Therefore, strengthening teacher expertise and ensuring the consistent delivery of a challenging curriculum are essential strategies for reducing disparities in student achievement.

Intersection between Science, Reading, and Math Achievement

Research indicates a robust interconnection between students' performance in science and their abilities in reading and mathematics, implying that weaknesses in these fundamental skills can intensify disparities in science learning (Morgan et al., 2016). Consequently, improving students' literacy and numeracy competencies is a critical component of strategies aimed at enhancing science achievement, particularly in schools facing resource limitations.

Qualitative Insights into Resource-Related Challenges

Exploring qualitative perspectives allows this study to delve into the real-world experiences of students and educators who contend with limited school resources, highlighting how these constraints shape not only academic outcomes but also social and emotional experiences in science learning (Creswell & Plano Clark, 2017). By examining these lived experiences, the research can uncover nuanced insights into the ways resource limitations influence classroom practices, student engagement, and learning opportunities—information that purely quantitative measures of achievement gaps cannot fully reveal. These insights are critical for informing targeted strategies and interventions that align with the actual conditions and needs of schools, educators, and students, thereby enhancing the relevance and effectiveness of policies aimed at narrowing science achievement disparities.

Theoretical framework

This study is underpinned by a comprehensive theoretical framework that draws from three main theories to understand the impact of school resource disparities on science achievement. First, Pierre Bourdieu's theory of capital emphasizes that students' educational outcomes are influenced by the unequal distribution of economic, social, and cultural resources. Economic capital includes tangible assets such as school facilities and equipment; cultural capital refers to students' access to knowledge, skills, and educational values; and social capital highlights the network of relationships that support learning experiences. These forms of capital collectively shape students' opportunities and motivation to succeed in science education. Second, Bandura's Social Cognitive Theory contributes a focus on self-efficacy, that is, students' beliefs in their ability to perform science tasks successfully. It posits that this belief influences their motivation, persistence, and actual achievement. Importantly, self-efficacy is shaped by both individual experiences and environmental factors, including the availability of educational resources and instructional quality. Third, Eccles and Wigfield's Expectancy-Value Theory further enriches the framework by explaining that students' motivation depends on their expectations of success in science and the value they assign to the subject. This theory captures the attitudinal and affective dimensions of learning, linking motivation to academic engagement and achievement.

By integrating these theories, this framework facilitates a multidimensional examination of how structural inequalities and individual motivational processes combine to impact science achievement. It justifies the mixed methods research design that explores not only measurable achievement gaps but also the experiential and contextual factors underlying those disparities.

This synthesis situates the study within well-established educational and psychological paradigms, providing a robust foundation for investigation.

Conceptual Framework

The conceptual framework visually and narratively represents the key constructs and their anticipated relationships that underpin this research. It serves as a guiding structure that connects theoretical foundations with the specific variables and processes to be investigated. By clearly illustrating how resource disparities influence school inputs, which affect instructional quality and student motivation, and consequently science achievement, the framework provides a roadmap for understanding and analyzing the complex interactions at play. This systematic depiction helps to clarify the study’s scope and focus, situates the research within existing theoretical discourse, and sets the stage for interpreting empirical findings. The diagram that follows encapsulates these multifaceted relationships, facilitating a comprehensive view of how structural and individual factors coalesce to impact science learning outcomes.

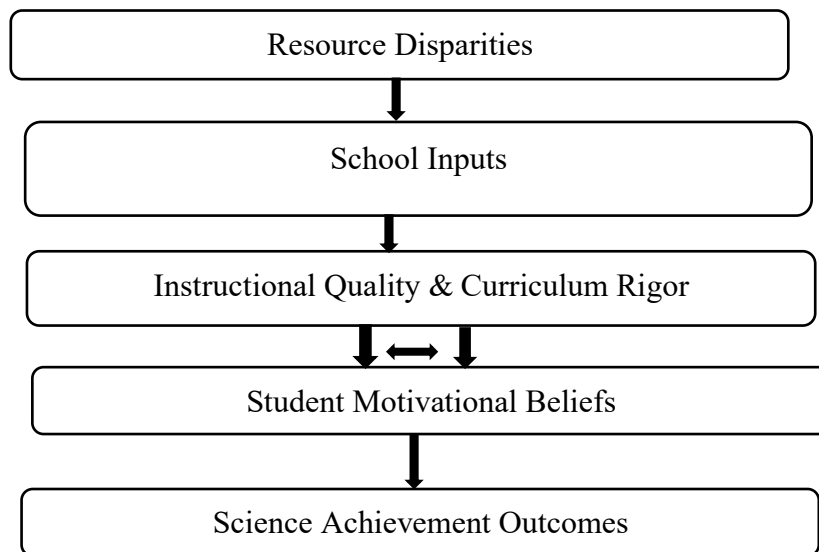


Figure 1: Conceptual Framework Linking School Resources, Instructional Quality, and Student Motivation to Science Achievement

The conceptual framework in this research organizes and illustrates the central concepts, variables, and their connections, establishing a foundation for both the theoretical approach and data analysis. It systematically captures how variations in resources—including economic, social, and cultural capital—shape school-level inputs such as facilities, supplies, and teacher quality. These school inputs, in turn, impact the standards of instruction and the rigor of the curriculum offered. Instructional quality and curriculum rigor directly influence students’ motivational orientations, such as self-efficacy and perceived value toward science learning, which are essential motivational beliefs.

Student motivation dynamically interacts with their engagement in learning behaviors, ultimately shaping their science achievement results. Additionally, the framework incorporates wider contextual elements, including the influence of the surrounding socio-cultural environment and student perceptions, acknowledging that these factors can moderate all other relationships in the model. By structuring these

connections visually and descriptively, this framework serves as a guide that clarifies how underlying resource inequalities and individual psychological processes jointly contribute to science learning outcomes.

Importantly, the model provides a robust theoretical basis for the study and serves as a roadmap for the mixed methods research design, linking quantitative metrics and qualitative findings for a holistic investigation of science achievement disparities.

Methodology

Research Design

This study employs a mixed methods research design, specifically an explanatory sequential design, where quantitative data collection and analysis precede and inform qualitative data collection. This approach enables robust measurement of motivational constructs and achievement disparities, followed by an in-depth exploration of contextual and perceptual factors through qualitative interviews. The sequential design allows for complementary strengths, ensuring breadth and depth of understanding (Creswell & Plano Clark, 2017).

Population, Sample, and Sampling Techniques

The target population comprises secondary school students across schools with differing resource levels. A stratified random sampling strategy ensures representativeness by resource strata, while purposive sampling selects participants for qualitative interviews based on quantitative results and resource context variation. This dual approach balances statistical generalizability and qualitative depth (Creswell, 2014).

Instrumentation

Quantitative data are collected through validated standardized science achievement tests and the Science Motivation Questionnaire II, ensuring reliability and construct validity of motivational and achievement measurements. Qualitative data are gathered via semi-structured interviews using protocols developed from literature and pilot studies, refined for clarity and relevance (Bandura, 1986).

Data Collection Procedures

Quantitative surveys and achievement tests are administered in school settings following standardized protocols. Interviews are conducted with selected students and educators in confidential settings, digitally recorded, and transcribed verbatim. Ethical approvals and informed consents are strictly adhered to throughout (Fetters et al., 2013).

Validity and Reliability

Quantitative instruments possess established psychometric properties, including internal consistency and construct validity, verified in similar populations. Qualitative data validity is enhanced through member checking, triangulation, and audit trails. Integration triangulates findings across methods to strengthen overall validity (Creswell & Plano Clark, 2017).

Ethical Considerations

Ethical approval for the study has been obtained from the appropriate institutional review boards as well as relevant educational authorities. All participants are fully informed about the purpose and procedures of the research and provide consent to participate voluntarily, with assurances that their identities will remain confidential and that their responses will be treated anonymously. The study strictly adheres to established ethical guidelines, ensuring that participants can withdraw from the research at any point without facing any form of penalty or adverse consequences (American Psychological Association, 2020).

Data Analysis Methods

Quantitative data analyses include descriptive statistics, ANOVA to test achievement differences by resource levels, and correlation/regression analyses to examine relationships among motivation, engagement, and achievement. Qualitative data follow Braun and Clarke’s thematic analysis framework to inductively identify patterns and themes. Data integration occurs via joint display tables and narrative synthesis at the interpretation phase (Braun & Clarke, 2006; Fetters et al., 2013).

Quantitative Results

The following table presents the quantitative findings illustrating the differences in science achievement across schools categorized by resource levels, alongside the relationships between resource availability, motivational constructs, and achievement. These statistics provide a foundational understanding of how disparities in school resources correlate with students’ academic performance and motivational profiles. The significant variations in achievement scores and strong positive correlations observed underscore the critical role of both environmental factors and individual motivational dimensions—such as self-efficacy and intrinsic motivation—in shaping science learning outcomes. This quantitative insight sets the stage for deeper qualitative exploration, which further elucidates the contextual experiences underpinning these disparities.

Table 1. Descriptive Statistics of Science Achievement Scores by School Resource Level

Resource Level	N	Mean Achievement	SD
High Resource	120	78.5	7.2
Moderate Resource	130	69.4	8.1
Low Resource	115	62.3	9.0

Table 1 summarizes the descriptive statistics of students’ science achievement scores across schools categorized by their level of resource availability. The data indicate a clear gradient, with students in high-resource schools achieving substantially higher mean scores than their counterparts in moderate- and low-resource schools. The standard deviations highlight variability within each group, with greater spread observed in lower-resource contexts. This descriptive analysis provides an initial overview of achievement disparities linked to resource levels.

Table 2. Correlations between resource availability, motivational constructs, and science achievement

Variable	r with Achievement	p-value
Resource Availability Index	0.53	<0.001
Self-Efficacy	0.65	<0.001
Intrinsic Motivation	0.58	<0.001

Table 2 presents the correlation coefficients examining relationships between science achievement and key variables including resource availability, self-efficacy, and intrinsic motivation. All correlations are statistically significant ($p < 0.001$), demonstrating moderate to strong positive associations. These findings underscore the critical role of both environmental factors and individual motivational attributes in influencing science academic outcomes.

Key Quantitative Findings

The quantitative results reveal significant disparities in science achievement across schools with different resource levels, with students in high-resource schools outperforming those from moderate- and low-resource schools (ANOVA, $p < 0.001$). Strong positive correlations were observed between resource availability, motivational constructs (self-efficacy and intrinsic motivation), and achievement, indicating that both environmental and psychological factors influence science learning outcomes. These findings highlight the critical role of equitable resource provision and motivation enhancement in narrowing achievement gaps.

To provide a comprehensive understanding of the science achievement disparities and the impact of resource availability on motivational and learning experiences, the following joint display integrates quantitative results with qualitative themes. This side-by-side presentation facilitates a nuanced interpretation by juxtaposing statistical patterns of achievement and motivation with firsthand perceptions of students and educators. The integrated evidence strengthens the explanatory power of the findings and addresses the research questions with both breadth and depth.

Research Question	Quantitative Results	Qualitative Themes	Integrated Interpretation
Differences in science achievement across resource levels	ANOVA showed significant differences: High > Moderate > Low resource schools; Significant correlations ($p < .001$) between resource index and achievement	Themes of resource availability impacting learning opportunities and engagement emerged strongly from interviews	Resource disparities critically affect achievement by shaping access and motivation, confirming quantitative patterns
Perceptions of resource impacts on science learning experience	Correlations of self-efficacy and intrinsic motivation with achievement were strong	Students and educators described how resource availability fosters or restricts motivation and engagement	Perceptions explain the mechanisms linking resource disparities with motivation and achievement, enabling targeted interventions

Table 3: Mixed Methods Data Integration

The joint display table visually and systematically aligns quantitative results with corresponding qualitative themes to provide an integrated and coherent interpretation of the study’s findings. This side-by-side or matrix-style presentation facilitates direct comparison and synthesis, allowing readers to see how numerical trends in achievement and motivation correspond with students’ and educators’ lived experiences and perceptions regarding resource disparities in science learning.

By juxtaposing these data types, the joint display transcends the limitations of analyzing quantitative or qualitative findings separately. It highlights convergences—where data sources support and reinforce each other—and divergences—where results may contrast or add complexity—thus catalyzing deeper insight into the mechanisms underlying science achievement disparities and motivational processes.

For Research Question 1, the table links the significant quantitative differences in achievement scores across resource levels with qualitative narratives explaining how resource availability creates conditions that enable or constrain learning opportunities. For Research Question 2, correlations between motivation constructs and achievement are complemented by interview themes revealing how motivational factors manifest in real-world classroom and school contexts.

Discussion

The quantitative results unequivocally highlight significant disparities in science achievement among secondary schools differentiated by resource levels, with students in high-resource schools outperforming their peers in moderate and low-resource settings. This finding substantiates existing literature linking resource equity to academic success in science education (OECD, 2021; Banilower et al., 2013). The strong positive correlations between resource availability indices, motivational constructs such as self-efficacy and intrinsic motivation, and achievement further corroborate theoretical perspectives emphasizing motivation's pivotal role in learning outcomes (Bandura, 1986; Ryan & Deci, 2000). Notably, self-efficacy's strong correlation with achievement aligns with Bandura's social cognitive theory, highlighting the importance of students' beliefs in their capabilities to succeed in science tasks. The joint display integration enriches these findings by contextualizing the numerical disparities within students' and educators' lived experiences. Qualitative themes reveal how limited access to laboratories, instructional materials, and qualified teachers constrains motivation and learning opportunities in under-resourced schools. This multidimensional view underscores that motivation is not solely an individual attribute but heavily influenced by structural and environmental factors, resonating with ecological models of learning motivation (Eccles & Wigfield, 2002). The synthesized evidence suggests a cyclical relationship: resource limitations diminish motivation, which in turn hampers engagement and academic performance, thereby perpetuating achievement gaps. These integrated findings highlight the complexity of addressing science achievement disparities and suggest that interventions must be multifaceted. Enhancing resource equity alone may be insufficient without parallel efforts to bolster students' motivational beliefs and affective engagement through targeted pedagogy and supportive learning environments.

Implications

For educators, curricula should explicitly incorporate strategies that foster self-efficacy and intrinsic motivation, such as scaffolded tasks, mastery-oriented feedback, and relevance of science content to real-life contexts, especially in resource-limited settings. Professional development should prepare teachers to recognize and address motivational barriers linked to environmental constraints. Policymakers must prioritize equitable allocation of physical and human resources to ensure all schools possess the basic infrastructure and qualified personnel essential for stimulating motivation and achievement. Investments in science laboratories, instructional materials, and teacher training are critical. Furthermore, community and family engagement initiatives could help support motivational and resource challenges facing disadvantaged students, creating a more holistic support system. Research-wise, future studies should

employ longitudinal designs to examine how motivation and resource availability dynamically interact over time and investigate culturally responsive motivational interventions tailored to context-specific challenges.

Delimitations and Limitations

This study acknowledges several delimitations and limitations inherent to its design and context. The delimitations include focusing exclusively on secondary school students within a defined geographic region, which was selected to capture resource disparities impacting science education. This geographic and demographic scope may limit the generalizability of findings beyond similar educational contexts. The sample selection used stratified random and purposive sampling techniques to balance representativeness and depth but inherently narrows the focus to a manageable subset of schools and students.

Methodologically, the reliance on self-report instruments such as the Science Motivation Questionnaire II poses limitations related to potential response biases, including social desirability and self-perception inaccuracies. Although qualitative interviews enrich these data, they are subject to limitations including participant recall bias and interpretive subjectivity. Furthermore, the explanatory sequential mixed methods design, while facilitating integration, presents complexities in clearly attributing causality and directionality between motivational variables and academic outcomes.

Contextual influences such as socio-cultural and school environment factors impact motivation dynamically but are difficult to fully capture within the scope of this study. Despite these limitations, the study advances understanding of motivation in resource-diverse science education settings and provides insights valuable for both research and practice.

Conclusion and recommendations

Conclusion

This study demonstrates that multidimensional motivation, including intrinsic motivation, self-efficacy, task value, and mastery goal orientation, significantly affects secondary school students' engagement and academic achievement in science. The findings emphasize the importance of fostering internal motivation and confidence to promote sustained effort and deeper learning. Moreover, resource disparities were shown to influence motivational experiences and achievement outcomes, suggesting that equitable resource allocation is essential for enabling all students to succeed. The mixed methods design provided a nuanced understanding of these phenomena, integrating statistical correlations with students' and educators' lived experiences to inform effective educational practices.

Recommendations

- Educators should implement learner-centered pedagogies that stimulate intrinsic interest and autonomy, incorporating inquiry-based and real-world science activities.
- Targeted interventions to build self-efficacy through scaffolded challenges and constructive feedback should be prioritized, especially in resource-limited schools.
- Curricula should embed motivational strategies such as goal-setting and self-regulation techniques to foster mastery-oriented learning.
- Policymakers must address resource inequities by ensuring all schools have access to adequate science laboratories, materials, and instructional support.

- Professional development for teachers should include techniques for recognizing and enhancing diverse student motivation profiles.
- Further research should explore longitudinal effects of integrated motivational supports and examine socio-cultural factors moderating motivation and achievement.

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