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REVIEW AND SYNTHESIS

Review of Education BERA

Insights into science, technology, engineering and mathematics (STEM) achievement: A comprehensive review of factors and methodologies

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Abstract

In the past decade, numerous literature reviews have delved into understanding the factors influencing STEM achievement. While prior studies have concentrated on specific associations, a holistic synthesis of diverse factors is crucial for comprehensive comprehension. This review, guided by Bronfenbrenner's Ecological Systems Theory, offers an overview of factors associated with secondary school students' STEM achievement by scrutinising literature from 2019 to 2023 through content analysis. Within the myriad associations and subfactors, 15 factors across four ecological levels (i.e., individual characteristics, psychological factors, learning abilities, learning approaches and educational involvement at the self-level; classroom characteristics and culture, teacher characteristics and instructional practices, family support and influence, and access to resources and technology at the microsystem level; teacher-parent interaction at the mesosystem level; school characteristics and culture, school leadership and practices, school resources and technology, educational policies, and local environment at the exosystem level) emerged. Methodologically, the reviewed studies predominantly employed quantitative analyses, often utilising statistical and variable-centred approaches, concentrating on science and mathematics domains of STEM, and employing achievement tests. This review sheds light on the current landscape and provides valuable insights for future policies, practices and research directions.

KEYWORDS
achievement factors, Bronfenbrenner's Ecological Systems Theory, secondary school, STEM, systematic review

Context and implications

Rationale for this study

Numerous reviews have explored specific factors influencing STEM achievement, emphasising the need for a holistic synthesis of available factors to achieve a comprehensive understanding of the complex interaction between these influences and how they collectively impact student outcomes in STEM education.

Why the new findings matter

Students' achievement in STEM is influenced by various factors, suggesting that attributing success solely to minimal number of factors may oversimplify the complex nature of the factors that influence achievement.

Implications for policy makers, practitioners, the public and researchers

A thorough understanding of the factors influencing success in STEM achievement can inform the development of educational policies and investments across different levels, from local schools to national initiatives. Educators can use this knowledge to implement tailored early interventions that enhance student achievement and foster better prospects in STEM careers. Additionally, students and parents can benefit from valuable insights to make informed decisions about educational and career pathways. This review also sheds light on future research directions.

INTRODUCTION

Science, technology, engineering and mathematics (STEM) education prepares students for the competitive job market and offers a pathway to high-demand STEM careers, ensuring a secure and promising future (UNESCO, 2017). However, there is a concerning dropout rate within the STEM pipeline at various stages of a student's academic journey, allowing for transitions from STEM to non-STEM fields (van den Hurk et al., 2019). Secondary STEM education lays the groundwork for entry into post-secondary STEM education and, ultimately, for securing STEM-related jobs (National Science Board, 2022). Yet, it is also viewed as the initial segment of the STEM leaky pipeline, crucial in determining which individuals will eventually emerge as qualified STEM personnel (OECD, 2016). Extensive big data analysis reveals that the most substantial drop in the STEM pipeline occurs during the transition from secondary school STEM education to non-STEM disciplines in higher education (Nitzan-Tamar & Kohen, 2022). In today's knowledge-based economy, where the demand for STEM professionals is high and STEM knowledge and skills promise bright futures, it is disheartening that many potentially qualified students are ‘leaked’ from the pipeline during their school years (van den Hurk et al., 2019). Several factors have been found to influence STEM persistence, such as gender (Kao et al., 2024), science identity (Chang et al., 2023), students' perceived ability in science and mathematics (Zhao & Perez-Felkner, 2022), interest in