MATHEMATICS AS A GATEWAY TO STEM CAREERS: EVIDENCE FROM INTERNATIONAL AND PHILIPPINE CONTEXTS

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Mathematics plays a foundational role in equipping students with the cognitive tools needed for science, technology, engineering, and mathematics (STEM) careers. In the Philippines, the preparation of learners for these fields remains a national concern, particularly given the stagnation in international achievement metrics. Recent studies reinforce the long-term value of secondary mathematics while exposing persistent performance gaps that may constrain the country's capacity to meet its STEM workforce needs.

The 2022 Programme for International Student Assessment (PISA) revealed that Filipino students averaged a score of 355 in mathematics, well below the OECD average of 472. Only 16% reached the minimum level of proficiency necessary for functional mathematical reasoning, while fewer than 1% demonstrated high-level competence (OECD, 2023a). These results mirror those from 2018, indicating limited progress over four years.

In a comparative study, Acido and Caballes (2024) confirmed this trend, stating that mathematics and reading scores in the Philippines showed only slight shifts between PISA 2018 and 2022, with science declining marginally. Their statistical analysis revealed a significant difference between the Philippines' scores and the global mean scores of other PISA participants. Moreover, the study established a strong positive correlation between the Human Development Index (HDI) and PISA performance, suggesting that poor educational outcomes may reflect broader developmental constraints. Their

findings imply that the quality of mathematics education has implications not only for workforce readiness but for national development as a whole.

The long-term importance of secondary school mathematics is supported by international longitudinal studies. Black et al. (2021) found that students who completed advanced mathematics in high school were more likely to pursue and persist in STEM careers. These individuals also earned higher wages, even in non-STEM fields, demonstrating that mathematical competence yields wide-ranging economic advantages. Notably, these outcomes held even after controlling for initial ability and socio-economic status, highlighting the lasting value of exposure to higher-level math.

A similar study by Nitzan-Tamar and Kohen (2022), based on more than half a million student records, identified eight distinct educational pathways from secondary school to postsecondary education. The most effective route to STEM degrees involves taking advanced mathematics and majoring in science-related subjects such as physics and computer science. The study emphasized that the greatest loss in STEM participation occurred between secondary school and college. This finding suggests that students may lack sufficient preparation or support to continue on a STEM trajectory beyond high school.

Within the Philippine context, these insights hold particular relevance. The country has implemented a spiral curriculum through the K to 12 reform, but performance gaps persist. PISA 2022 also reported a growing shortage of qualified math teachers in Philippine schools, with 43% of school leaders citing this as a concern (OECD, 2023a). Limited access to quality instruction constrains student engagement and mastery, especially in underserved regions.

Mathematics instruction in secondary schools must move beyond procedural fluency and emphasize application, reasoning, and relevance. As Nitzan-Tamar and Kohen (2022) showed, students are more likely to pursue STEM when mathematics is

embedded in multidisciplinary learning and linked to real-world problems. In the Philippines, integrating data literacy, financial numeracy, and computational thinking into high school instruction can align mathematics with emerging STEM demands.

In addition, systems for academic guidance and early tracking influence the likelihood of students sustaining interest in STEM. When course selection is based on long-term planning rather than short-term convenience, students are better positioned to meet the quantitative requirements of tertiary education and future careers. Findings from both Black et al. (2021) and Nitzan-Tamar and Kohen (2022) emphasize that early academic achievement and course rigor have a measurable effect on STEM participation at later life stages.

Mathematics continues to serve as a reliable predictor of long-term professional and economic success. In the Philippines, the consistently low performance in PISA assessments underscores the need for renewed investment in secondary mathematics education, not only to expand the STEM pipeline but to contribute to broader developmental outcomes. Without substantial changes to curriculum implementation, teacher training, and student support, the country may struggle to produce a workforce capable of advancing in an increasingly knowledge-driven global economy.

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