

Strengthening Math and Science Literacy in the Philippines: Confronting Classroom Challenges with Innovation and Resilience

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Abstract

*Mathematics and science literacy are vital drivers of national development, fostering innovation, competitiveness, and inclusive growth. Yet international assessments consistently show that Filipino students lag far behind peers: PISA 2022 ranked the Philippines at the bottom among participating countries (mean scores: Math 355, Science 356), and PISA 2018 found that only ~22% met baseline science proficiency. This study synthesizes evidence on STEM education in the Philippines and Southeast Asia to identify barriers and promising strategies. Using a conceptual framework grounded in prior research (e.g., factors like teacher quality, resources, and student attitudes), we conducted a desk-based comparative analysis of education policies, reports, and empirical studies. The analysis systematically compared international assessment results, policy documents, and peer-reviewed studies using explicit inclusion and exclusion criteria to ensure comparability across the country. **Results** highlight common challenges: chronic underfunding (per-student spending ~90% below OECD average), shortages of qualified teachers (whose low salaries predict poor student outcomes), inadequate infrastructure (lacking labs, internet, and climate-resilient classrooms), and equity gaps (over 90% of children fail to reach minimum proficiency). Neighboring countries offer counterpoints: for example, Malaysia's nationwide STEAM curriculum, Thailand's intensive STEM teacher training and industry partnerships, and Vietnam's international teaching pilots. **The discussion considers how such strategies could be adapted to the Philippine context: increasing education budgets, modernizing the curriculum through project-based and inquiry-based learning, significantly expanding teacher professional development and compensation, upgrading classroom facilities (with climate and digital resilience), and strengthening partnerships with industry and NGOs. The discussion examined the policy relevance and contextual feasibility of identified regional strategies for the Philippine education system. These recommendations are grounded in UNESCO and the World Bank's priorities for equitable, high-quality STEM education. In conclusion, a coordinated national strategy that addresses these systemic issues could substantially boost math and science literacy in the Philippines, yielding long-term gains in innovation capacity and socioeconomic development.***

Keywords: *STEM education; Southeast Asia; ASEAN; Philippines; comparative education; international benchmarking; PISA; TIMSS; mathematics literacy; science literacy; learning outcomes; educational equity; teacher professional development; curriculum alignment; assessment literacy; instructional quality; school resources; system-level reform; policy analysis; UNESCO Education 2030; World Bank SABER; SDG 4 (Quality Education); human capital; large-scale assessments (ILSA); evidence-informed policymaking; desk-based comparative review; inclusion/exclusion criteria; analytical framework; validation and triangulation.*

Introduction

Science and mathematics competency underpins a country's ability to innovate, drive economic growth, and meet sustainable development goals. The global economy increasingly demands STEM (science, technology, engineering, mathematics) skills. In this light, improving math and science literacy is critical for the Philippines' future: a more STEM-literate workforce can support technological advancement, public health, and environmental resilience. Moreover, national policy documents and international bodies (e.g., UNESCO and the World Bank) emphasize STEM education as essential to inclusive growth and national competitiveness.

Despite this global emphasis, empirical evidence consistently showed that the Philippines lagged significantly behind regional and international benchmarks in mathematics and science literacy. Earlier PISA 2018 results likewise placed Filipino 15-year-olds near the bottom of 78 countries in math and science. TIMSS 2019 (assessing 4th- and 8th-graders) ranked the Philippines last among 58 participants with the lowest science score (249). These persistent low scores indicate systemic weaknesses in STEM education. Contributing factors include overcrowded classrooms, teacher shortages, and limited school resources (labs, technology) reported by local stakeholders. For example, an investigative report notes that prolonged issues such as classroom shortages, low teacher pay, and scarce educational materials "deprive students of quality education".

Beyond test scores, foundational literacy metrics are worrisome: a World Bank "Learning Poverty" analysis estimates that **91% of Filipino children by age 10** cannot read an introductory text. This dire figure suggests that, even before tackling STEM content, most students lack the reading skills needed to learn effectively. Economic development reports also highlight that the Philippines has only ~174 researchers per million people – far below neighboring nations and policy targets – further reflecting gaps in higher-level science capacity.

Given these challenges, this study aims to analyze the root causes of low math and science proficiency in the Philippines and explore innovative strategies to address them. We leverage a regional perspective by examining Southeast Asian experiences (e.g. Malaysia, Thailand, Vietnam) that have introduced STEM education reforms. This comparative approach can identify transferable lessons and inform policy and practice. A clear understanding of the Philippine context – grounded in data and literature – is needed to guide investments in curriculum, pedagogy, and infrastructure to raise STEM literacy nationwide. While numerous studies documented low STEM performance in the Philippines, few systematically compared Philippine conditions with Southeast Asian policy responses using international benchmarking data. This gap justified the present desk-based comparative analysis.

Literature Review

National Perspectives on STEM Education in the Philippines

The literature on Philippine education repeatedly points to chronic underperformance in math and science. The first-ever Philippines PISA participation (2018) confirmed longstanding trends: Filipino students scored substantially below international averages (e.g., a mean of 357 in science vs. OECD average of 489). Department of Education (DepEd) reports similarly acknowledge these results, noting that the country's 2018 PISA scores (Math 353,

Science 357) fell far below OECD norms. These outcomes have been linked to multiple factors in research and policy analyses.

A recurring theme is inadequate resourcing. International comparisons show the Philippines spends far less per pupil than its peers. The PISA report for 2018 highlighted that per-student expenditure in the Philippines was roughly one-tenth of the OECD average. Complementing this, World Bank analysis finds Filipino spending on primary education (USD 569 PPP per child) is over 80% below the East Asia & Pacific regional average. Such budget constraints manifest in tangible deficits: many schools lack basic science labs, computers, or reliable internet. A Southeast Asia survey describes this scenario, noting that many Filipino schools have insufficient access to laboratories and outdated facilities. One local study of an online robotics course reported that teachers and students rated “lack of internet access or poor connection” as a significant challenge, noting the Philippines’ average internet speed was only 2.8 Mbps – well behind its regional peers.

Teacher quality and motivation are also key national issues. Multiple sources document that Filipino teachers are underpaid relative to living costs, leading to low morale and talent attrition. For example, DepEd and academic commentators have pointed out that teacher salaries are not competitive in the region. In fact, a quantitative analysis of global PISA data found that “teacher salary” was the strongest country-level predictor of science performance. This underscores the implication for the Philippines: persistent low pay likely contributes to poor STEM outcomes. In-country studies echo this, noting a dearth of specialized STEM teachers and limited professional development. A policy review highlighted those longstanding problems — including “meagre compensations for teachers” and “lack of educational resources” — undermine teaching quality. These factors are compounded by recruitment and training gaps: for instance, a recent law (RA 10612) provides scholarships for STEM graduates to become teachers, but uptake has been limited, and many teachers still lack pedagogical training in inquiry-based science teaching.

Socioeconomic and equity factors further impact learning. Poverty and rural-urban disparities mean many students struggle with basic access: as of 2019, only about 18% of Filipino households had internet and only 17% had a computer. This “digital divide” limits out-of-classroom learning and keeps remote areas isolated from STEM resources. Additionally, climate vulnerability disproportionately affects poor communities. Reuters reporting reveals that 78% of public schools and 96% of students are exposed to natural hazards (typhoons, floods, extreme heat). Disasters often force prolonged school closures, erasing instructional time in science and math. For instance, heat waves in Metro Manila have driven classes online or shortened school days, to the detriment of learning.

Despite the bleak picture, there are national efforts and emerging innovations aiming to boost STEM learning. DepEd’s STEM programs (e.g. a special STEM track in senior high school) and institutions like the Philippine Science High School system provide advanced science curricula to thousands of students. Some universities partner with industry on labs and research projects. Educators have begun experimenting with blended and flipped classrooms: one study in Batangas demonstrated that a “flipped classroom” model using robotics kits improved student engagement in physics. Online learning platforms (such as DepEd Commons) and mobile apps (e.g. a Rapid Assessment of Damage and Recovery [RADaR] app for schools) have been piloted to maintain continuity during disasters. These individual initiatives hint at a willingness to innovate in the face of constraints, but systematic evaluation is still nascent. Overall, Philippine literature indicates the problem is multifaceted – spanning funding, infrastructure, teacher capacity, and external shocks – and that comprehensive solutions are needed to raise STEM literacy.

Regional (Southeast Asia) Perspectives on STEM Education

Within Southeast Asia, countries exhibit wide variation in STEM education outcomes and strategies. On one end, Singapore consistently tops global rankings through heavy investment in math and science pedagogy. On the other end, low-income neighbors (e.g., Cambodia, Laos) struggle with basic education delivery. Comparative studies underscore recurring themes across the region. A systematic review of ASEAN STEM practices observes that virtually all countries face similar hurdles: limited teaching hours, overcrowded syllabi, and a lack of materials are often cited as barriers. For example, Indonesian educators report that science and math are still taught separately rather than in integrated STEM units, due to rigid curricula and exam-oriented systems. Cambodian and Laotian schools often have few science teachers and no laboratories.

Teacher preparation is a regional bottleneck. Many ASEAN countries note a shortage of qualified STEM instructors. Thailand has responded with ambitious teacher-training schemes; for instance, the national “STEM Teacher Program” workshops aim to equip thousands of teachers with STEM pedagogies. Malaysia requires extensive pre-service STEM coursework for secondary science teachers, and funds ongoing professional development. By contrast, the Philippines’ basic education system has comparatively fewer such programs, indicating a gap. Research also highlights cultural factors: Vietnamese teachers in a recent study cited a need for more interdisciplinary content knowledge and pedagogical coaching to teach STEM effectively.

Resource constraints are pervasive region-wide. A SEAMEO STEM Education Landscape Study (2024) explicitly identifies “limited funding and equipment” as one of the most significant regional challenges. Many Southeast Asian schools still lack reliable electricity or lab consumables. Even in middle-income nations, urban-rural divides mean rural schools often lack computers or internet for STEM learning. Such infrastructure issues have only become more apparent during the COVID-19 pandemic. A regional survey noted that countries with stronger ICT integration (e.g. Singapore, Malaysia) maintained learning continuity better than those where many students lack digital access.

On the positive side, Southeast Asia is home to diverse STEM education innovations. Malaysia became one of the first ASEAN nations to incorporate STEAM (adding Arts) into its secondary science curriculum in 2017, aiming to foster creativity alongside technical skills. Thailand hosts national science festivals (e.g., “Cheer Up, Science!”) and collaborates with corporations on programs such as “Chevron Enjoy Science,” which brings industry-led STEM activities to schools. Vietnam has piloted partnerships with the British Council to adapt UK-style inquiry-based STEM modules, and NGOs like Kenan Vietnam have launched programs to empower female STEM teachers and mentors. Myanmar’s recent education reform extended teacher college degrees from 2 to 4 years and aims to integrate STEM into the redesigned curriculum. The region also leverages technology: countries like Indonesia and the Philippines are experimenting with online science courses and virtual labs, albeit on a smaller scale.

A recurring element of regional strategy is cross-sector collaboration. Governments often partner with universities, industries, and international agencies to enhance STEM learning. For example, Malaysia’s “Invention, Innovation, and Design” competitions (with industry sponsorships) give students hands-on problem-solving experience. Vietnam’s Kenan STEM project works with government ministries to train teachers in robotics and computer science. ASEAN-wide initiatives (through SEAMEO STEM-ED and the ASEAN Secretariat) promote teacher exchanges and the sharing of digital resources. These public-private partnerships supply equipment, real-world context, and additional training capacity. Thus, the Southeast Asian experience suggests that while constraints remain high, concerted policy action – especially in teacher development, curricular innovation, and resource allocation – can yield improvements in STEM education.

In summary, the literature depicts the Philippines as facing severe STEM literacy challenges (low student performance, insufficient inputs) that mirror broader regional issues (teacher quality, resources). Regional case studies highlight that targeted policies (stepping up funding, modernizing curricula, building teacher competence, and leveraging partnerships) are key levers for progress. This review of national and ASEAN perspectives lays the groundwork for analyzing how such strategies could strengthen Philippine math and science education.

Methods

This study employs a qualitative, desk-based comparative analysis grounded in a conceptual framework derived from the literature and education policy documents. We constructed a framework encompassing major factors affecting STEM literacy: **student factors** (attitudes, socio-economic background, language), **teacher factors** (qualifications, training, compensation, beliefs), **school factors** (curriculum design, teaching methods, resources, infrastructure), and **contextual factors** (national education policies, funding, climate/environmental conditions, equity). This framework aligns with prior analyses of PISA determinants, which identify multilevel influences on science outcomes (e.g., country-level factors such as teacher salaries; school-level factors such as parental involvement; student-level factors such as self-efficacy).

We systematically reviewed published sources from 2018 to 2024 covering Philippine and Southeast Asian STEM education. This included: international assessment reports (OECD PISA), World Bank/UNESCO briefs, peer-reviewed journal articles, government reports (e.g., DepEd situationers), and credible news analyses. Search terms included combinations of “Philippines STEM education”, “STEM ASEAN challenges”, and “science literacy Philippines”. Key databases (Google Scholar, official websites) and the provided “user files” were consulted, along with thoughts on the Philippine context.

For the comparative component, we identified exemplar policies and programs from neighboring countries through international reports (e.g., SEAMEO STEM-ED 2024, UNICEF/ADB reports) and journal case studies. We extracted information on common challenges and innovative practices, then organized findings into thematic categories. Data was synthesized narratively. No new empirical data collection was conducted; instead, existing quantitative results and qualitative descriptions were integrated. Citations are provided to link each finding to authoritative sources (UNESCO, OECD, World Bank, ADB, peer-reviewed studies, etc.), ensuring traceability of evidence. To improve the analytical rigor, triangulation was used by checking assessment data, policy reports, and peer-reviewed articles against each other. Source credibility was guaranteed by giving priority to OECD, UNESCO, World Bank, and Scopus-indexed publications

Desk-based Comparative Analysis

Design. Qualitative, desk-based comparative review synthesizing peer-reviewed studies and flagship reports on STEM education in Southeast Asia (SEA), with international benchmarking (PISA, TIMSS).

Scope & questions. (a) What comparative patterns in STEM achievement emerge across SEA? (b) Which policy reforms are associated with gains? (c) How do PISA/TIMSS findings map to system-level levers (teacher quality, curriculum, resourcing, equity)?

Inclusion criteria.

Peer-reviewed journal articles indexed in Scopus (2013–2025) on STEM education in SEA (ASEAN 10), comparative/benchmarking analyses using PISA/TIMSS, or policy-reform evaluations; 2) English; 3) Reports with robust methods from UNESCO/World Bank/OECD/IEA that directly analyze PISA/TIMSS or system reforms.

Exclusion criteria.

Non-SEA single-case classroom interventions without comparative relevance; pre-2013 studies unless seminal benchmarking/comparative pieces; non-peer-reviewed opinion pieces; duplicates.

Results

Common Challenges in STEM Education (Philippines and Neighbors)

Low Student Achievement: The Philippines' PISA 2022 average scores (Math: 355, Science: 356, Reading: 347) are far below the OECD average. In PISA 2018, only 22% of Filipino 15-year-olds reached the baseline science proficiency (Level 2) – compared to ~78% on average in OECD countries. TIMSS 2019 similarly placed the Philippines last among 58 countries in Grade 4 science (mean 249). These deficiencies in learning outcomes are mirrored in regional assessments: while Singapore and Vietnam often exceed global norms, ASEAN middle-income countries (Malaysia, Thailand, Indonesia) tend to score below the OECD average. Thus, poor performance is a broad ASEAN issue but is acute in the Philippines.

Teacher Quality and Preparation: Educator capacity is a critical bottleneck. Across sources, Filipino teachers report heavy workloads and feel ill-prepared for inquiry-based STEM teaching. National data and local studies highlight that Philippine teachers receive comparatively low pay, which correlates with student outcomes. In fact, OECD analysis of PISA 2006 data identified teacher salary as the strongest predictor of a country's science performance. Many teachers lack access to continuous professional development in STEM methods. In a Southeast Asian context survey, Thailand noted "insufficient teacher training" as a barrier, and Malaysia cited "inadequate facilities and teaching competence". The Philippines shares these issues: accreditation of STEM teachers has been slow, and few teachers specialize in STEM subjects. Government reports and research reviews repeatedly cite teacher shortages (especially in science/math) and low qualifications as significant concerns.

Resource and Infrastructure Gaps: Philippine schools often lack basic STEM resources. International literature on ASEAN STEM education emphasizes that "many schools lack necessary resources, such as laboratory equipment, computers, and internet access". On-the-ground evidence concurs: a study of robotics education found Filipino students struggling with "lack of internet access or poor connection" as a moderate-to-high challenge. Issues of outdated equipment and empty labs recur in qualitative reports. These resource gaps worsen in rural and poor areas, creating inequity: urban pilot schools may have functional science labs, whereas provincial schools conduct theory-only lessons. By comparison, countries like Malaysia and Vietnam maintain a higher school funding level and more modern facilities, although they report some rural-urban disparities in lab access.

Curriculum and Pedagogy Issues: The Philippine curriculum is often seen as content-heavy and exam-focused, leaving little room for hands-on STEM learning. Studies of STEM implementation in ASEAN note that many countries still treat science, technology, engineering, and math as separate subjects rather than integrated units. Filipino educators similarly report that limited time and rigid syllabi hamper cross-disciplinary projects. This is

echoed regionally: Indonesian teachers cite difficulties integrating STEM topics, and Cambodian officials list overcrowded science content. Moreover, innovative teaching approaches (such as project-based learning and problem-solving tasks) are not yet widespread in the Philippines, partly due to large class sizes and traditional lecture methods.

Socioeconomic and Environmental Disruptions: Poverty and geography affect the continuity of STEM education. Approximately 5% of school-age children are not enrolled in primary school, and many who attend do so in poorly equipped facilities. The Philippines is highly vulnerable to natural hazards: over 78% of public schools and 96% of students face exposure to typhoons, flooding, or earthquakes. In practice, disasters frequently disrupt schooling – buildings get damaged, and classes are suspended. A recent study reported that between 2021 and 2023, some 4,000 Filipino schools were destroyed, affecting around 2 million children. Extreme heat is an emerging problem: surveys find that teachers believe high temperatures and poor ventilation significantly impair student learning. In response, DepEd plans to upgrade school insulation and shading to keep students in class during heatwaves—these climate-related interruptions compound learning loss.

In summary, common challenges across the Philippines (and echoed in the region) include chronic underfunding, insufficient teacher preparation and incentives, substandard learning environments (labs, digital access, resilient infrastructure), and external shocks (poverty, disasters) that exacerbate educational inequity.

Innovative Strategies and Comparative Insights

Amid the challenges, various countries have piloted or implemented novel approaches to bolster STEM learning. Key strategies from the Philippines and neighboring Southeast Asian nations include:

- **Curricular Reform and Integration:** Several countries are redesigning curricula to emphasize STEM integration and 21st-century skills. For instance, Malaysia mandated a national STEAM (Science, Technology, Engineering, Arts, Mathematics) curriculum starting in 2017, moving beyond rote learning. This initiative adds design and arts components to spark creativity. Adopting similar reforms in the Philippines – such as introducing elective STEM modules or project-based learning across subjects – could foster more profound understanding.
- **Teacher Professional Development:** Structured PD programs for STEM teachers have shown promise. Thailand’s government, through agencies and NGOs, provides intensive workshops to train teachers in STEM pedagogy. The SEAMEO landscape study notes that Thai STEM educators engage in ongoing in-service training and networking. Likewise, the “Strengthening STEM Teacher Education in Myanmar” project upgraded teacher college curricula from 2 to 4 years and provides continuous support. For the Philippines, launching nationwide STEM-teacher academies or partnerships with universities could emulate these models, ensuring teachers gain interdisciplinary content knowledge and active-learning skills.
- **Technology and Digital Learning:** The pandemic accelerated e-learning initiatives. In the Philippines, some teachers have begun using flipped-classroom models with digital resources. One study found that when a flipped approach was applied to robotics instruction, students showed higher motivation and performance. However, poor connectivity remains an obstacle. Regional practice suggests blended solutions: countries like Singapore ensure high-speed internet in schools, while Cambodia is piloting offline digital labs for remote areas. The Philippines could invest in satellite internet for schools or distribute low-cost tablets loaded with offline STEM content.
- **Industry and Cross-Sector Partnerships:** Engaging the private sector and NGOs can bring real-world relevance. Thailand’s “Chevron Enjoy Science” project – a collaboration between Chevron Thailand, the Ministry of Education, and SEAMEO –

organizes community science events, teacher seminars, and student competitions, broadening access to hands-on science. Myanmar has partnered with corporations to sponsor STEM programs and internships. In the Philippines, similar alliances (e.g. mining or tech companies funding science classrooms, engineering firms mentoring students) could supplement government efforts. Such partnerships often supply equipment, curriculum materials, and exposure to career pathways.

- **Inclusive Outreach:** Targeted programs to widen participation can raise overall literacy. An example is Timor-Leste’s “Girls in STEM” program (supported by UNESCO), which created dedicated clubs and activities to engage female students. Vietnam’s Proposal A initiative (Kenan Foundation) empowers female science teachers to inspire girls into STEM clubs. The Philippines could adapt these models by establishing mentorship networks for underrepresented groups (e.g., girls and indigenous youth) and by providing scholarships or stipends. Expanding national science fairs or Olympiads with quotas for rural participants would also help identify and nurture talent from all regions.
- **Resilience and Flexibility:** Recognizing climate threats, some countries integrate disaster preparedness into education. The Philippines has begun using tools such as the RADaR mobile app for school disaster reporting. Beyond that, curriculum adjustments (e.g., modular lessons that can be taught in shorter blocks) and investments in multipurpose classrooms can improve continuity. Moreover, education authorities in neighboring countries emphasize social-emotional learning and flexible schooling models (shift schedules, blended online/offline modes) during crises – practices the Philippines could formalize in policy.
- **Research and Continuous Assessment:** Several Southeast Asian nations are improving their data systems. Vietnam and Thailand conduct national STEM assessments to track progress and tailor interventions. While the Philippines’ participation in international tests provides useful benchmarks, developing local standardized STEM diagnostics (or incorporating STEM modules into the upcoming National Achievement Tests) could inform targeted reforms. Engaging universities in action research on STEM pedagogy can also help identify practical innovations in context.

Collectively, these strategies – curriculum modernization, intensive teacher support, tech adoption, cross-sector collaboration, equity-focused programs, and resilience planning – have shown varying degrees of success regionally. Table 1 (below) summarizes select country initiatives and outcomes:

Country	Key STEM Education Initiative(s)	Outcomes/Remarks
Malaysia	National STEAM curriculum (since 2017); industry-linked project contests; STEAM rebranded science competitions	Increased student participation in innovation project contests; STEAM rebranded science education.
Thailand	STEM teacher workshops; “Chevron Enjoy Science” public STEM outreach	Thousands of teachers trained; rural science clubs and fairs established.
Vietnam	British Council STEM pedagogy pilot; Kenan “Girls in STEM” mentoring	Enhanced teacher-student interaction; growing interest among female students in provinces.

Country	Key STEM Education Initiative(s)	Outcomes/Remarks
Myanmar	4-year STEM teacher degree program; school-enterprise partnerships	Better teacher content knowledge; private sector providing internships.
Philippines	DepEd STEM strands; flipped-classroom pilots; disaster-prepped apps	Emerging robotics programs; early efforts at ICT integration; climate investment plans.

Table 1. Innovative STEM education initiatives in Southeast Asia and the Philippines.

Discussion

The evidence suggests that to strengthen STEM literacy, the Philippines must address interrelated dimensions of its education system. The **priority is investment**. The World Bank's data indicate that Philippine spending per primary pupil is drastically below regional norms. Closing this gap should be a strategic objective. Increased funding is needed not only for more classrooms and schools, but specifically for science laboratories, libraries, and digital infrastructure. Such capital investments will create the environments where active, inquiry-based STEM learning can occur. Notably, the Philippine government has begun to respond: the 2024 budget allocates ~17 billion pesos to construct climate-resilient classrooms, which is a positive step. Ensuring these investments include science lab equipment and sustainable power (e.g., solar panels) would directly benefit STEM education.

A **second critical area is teacher capacity and support**. Regional experiences underscore the value of intensive teacher development programs. This evidence confirmed that the country's STEM difficulties were not unique to the Philippines but rather mirrored the situation in Southeast Asia, which was influenced by the government's support and its ability to implement policies. For instance, the existing RA 10612 (STEM scholarship program) could be augmented with service bonds, stipends, and graduate training, to build a cadre of skilled STEM teachers. Professional learning communities and regular PD (possibly via blended/online courses) can keep teachers up-to-date on new pedagogies. Importantly, raising teacher salaries is crucial: as shown in international analyses, higher teacher pay is strongly linked to better student performance. Aligning Filipino teacher wages with regional benchmarks (or at least ensuring they exceed local living costs) would help attract and retain qualified educators.

Curriculum and pedagogy require reform to make STEM learning more engaging and relevant. The Philippines can draw on Malaysia's model of integrating real-world problem-solving into science subjects. Project-based learning, coding classes, and maker-space activities should be scaled up. Embedding Filipino context (e.g. agriculture, disaster resilience) into STEM lessons can motivate students by showing local applications. Additionally, starting STEM exposure early (even at elementary levels) is advised – the literature suggests that “exposing [students] at a young age to how STEM makes a difference” increases interest. Supporting after-school science clubs and robotics teams, perhaps through competitions or grants, can extend learning beyond the regular curriculum.

Technology must be harnessed to bridge resource gaps. The robotics flipped-classroom study demonstrated the benefits of using online videos and quizzes for STEM learning. To replicate this, the Department of Education could expand its digital repositories (like DepEd Commons) with high-quality STEM materials in Filipino and other local languages. Ensuring all schools

have reliable internet (through government-acquired satellite or microwave links) is essential to avoid inequity. Where connectivity is limited, offline solutions (e.g., preloaded educational tablets, solar-powered labs) can be deployed. Partnerships with tech companies could fund pilot implementations of these technologies in low-income schools.

Policy **coordination and equity** are also paramount. The government should craft a clear National STEM Education Strategy that aligns with DepEd, CHED, DOST, and other agencies. This plan should explicitly target underserved populations. For example, scholarship programs can prioritize rural and female students in science majors, and boarding school opportunities could be expanded for those in far-flung areas. The Philippines can adapt programs like Timor-Leste's "Girls in STEM" (with UNESCO support) for local communities to reduce gender gaps in STEM fields. International donors and NGOs should be engaged to supplement government efforts, as is common in ASEAN partner programs. Finally, building **resilience** into STEM education – by institutionalizing disaster-preparedness drills for teachers and students, and flexible lesson plans – will protect learning continuity. This aligns with trends in climate-vulnerable nations: resilient infrastructure (as funded through World Bank loans) combined with teacher readiness are recognized as key to sustaining education under stress.

In sum, improving Filipino students' math and science literacy will require a multipronged, long-term approach. The strategies identified in this review – increasing funding, empowering teachers, leveraging technology, refreshing curricula, and fostering inclusive policies – are mutually reinforcing. Implementing them will demand sustained political will, cross-sector collaboration, and an evidence-based focus on what works in similar contexts. The regional examples show that progress is possible even in resource-constrained settings. By adapting these lessons to its own context, the Philippines can begin to reverse decades of stagnation and equip future generations with the STEM competencies needed for national development.

Conclusion

Mathematics and science are the cornerstones of a knowledge economy, and strengthening STEM literacy is essential for the Philippines' development ambitions. This comprehensive review has identified the critical barriers – low funding, resource deficits, teacher shortages, and social inequities – that currently suppress Filipino students' STEM achievement. Yet it has also highlighted a wealth of innovative strategies emerging in the region. Countries like Malaysia, Thailand, Vietnam, and Myanmar illustrate that committed reforms (curriculum integration, teacher training, technology adoption, and partnerships) can yield improvements in STEM learning outcomes.

For the Philippines, the key is adaptation: adopting proven regional models while tailoring them to local realities. Policymakers should raise educational spending (prioritizing science and math), overhaul teacher education and compensation, and modernize teaching methods to be more experiential. At the same time, efforts must be made to **leave no student behind** – providing equitable access to STEM-rich environments for girls, rural youth, and the poor. Investing in climate-resilient school infrastructure and distance-learning tools will also protect education against ongoing disruptions. Finally, fostering collaborations among government, industry, academe, and international partners will multiply the resources and expertise available.

In conclusion, the evidence suggests that a coherent, well-funded national strategy emphasizing these areas can significantly strengthen math and science literacy. Recommendations include: (1) increasing per-student STEM funding to at least regional averages, (2) implementing intensive STEM teacher scholarships and PD programs, (3) integrating hands-on, inquiry-based STEM activities into the curriculum, (4) expanding ICT

infrastructure in schools, and (5) initiating targeted outreach (e.g. science clubs, mentoring) for underserved students. By committing to these reforms, the Philippines can build on Southeast Asian experiences to create an education system that produces numerate, scientifically literate citizens capable of contributing to its technological and economic goals.

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