Mapping Philippine Mathematics-Education Research in the PISA Era: A Bibliometric and Content Analysis of Proximate and Structural Explanations

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Abstract

The Philippines has ranked among the lowest-performing participants in the Programme for International Student Assessment (PISA), scoring 355 in mathematics in 2022 against an OECD average of 472, with only about 16% of students reaching baseline (Level 2) proficiency. This study maps the research literature that has grown around Filipino students' mathematics performance and identifies the explanatory factors foregrounded by this body of work. A corpus of 2,070 records (2000–2025) was retrieved from OpenAlex and screened to 1,556 relevant Philippine mathematics-education studies through a triple-gate filter (Philippine locus, mathematics signal, and education signal). Bibliometric indicators were computed in Python, and the explanatory factors were identified through deductive lexical coding of titles and abstracts against a nineteen-category vocabulary, followed by co-occurrence, thematic-map, and temporal analysis. The field is young, expanding rapidly (18.22% annual growth), and highly fragmented across 584 sources and 3,379 authors, with production concentrated in teacher-education universities. The literature emphasizes proximate and affective factors—technology, teaching strategies, curriculum, engagement, and attitudes—while structural determinants implicated by PISA and the national literature—socioeconomic status, language of instruction, school-resource, and teacher quality—remain peripheral and internally underdeveloped. Research has recently pivoted toward foundational numeracy and engagement, mirroring post-pandemic learning-recovery policy. The central contribution is the demonstration of a proximate–structural asymmetry that marks a priority gap for future research and policy. For policy makers, the evidence map suggests that improving mathematics performance requires not only better classroom strategies, technologies, and curricula, but also coordinated attention to poverty, language access, teacher preparation, and school-resource inequality.

Keywords: mathematics education; Philippines; PISA; bibliometric analysis; content analysis; science mapping; OpenAlex

1. Introduction

Mathematics achievement has become a focal concern of Philippine education policy since the country first joined the Programme for International Student Assessment (PISA) in 2018. In PISA 2022 the Philippines recorded a mean mathematics score of 355, far below the OECD average of 472, with only about 16% of 15-year-olds reaching the baseline Level 2 proficiency compared with the 69% OECD average, placing the country among the lowest-performing participants (OECD, 2023; Department of Education, 2019). Results were essentially unchanged from 2018, confirming that the weakness is structural rather than incidental, and prompting reform initiatives such as the National Learning Recovery Program and the MATATAG curriculum (Department of Education, 2023).

These assessments catalyzed a rapid expansion of research attempting to explain, measure, and remedy Filipino learners' difficulties in mathematics. Yet this literature has grown without synthesis. It is dispersed across local and international outlets, produced by a broad and largely non-recurring author base, and has never been mapped as a field. The gap is consequential: without a synthesis of what Philippine mathematics-education studies actually foreground, policy debate over underperformance risks being guided by the most visible classroom-level interventions while deeper structural conditions remain underexamined. Two questions therefore remain unanswered: what is the structure and trajectory of this research, and what does it collectively identify as the reasons Filipino students struggle in mathematics?

This study addresses both questions through a combined bibliometric and content analysis. Bibliometric science mapping characterizes the volume, growth, sources, actors, and intellectual base of the field, while a lexical content analysis of abstracts surfaces the explanatory factors the literature foregrounds. The contribution is not a causal account of underachievement—which bibliometric data cannot provide—but an evidence-based map of how the research community has framed the problem, and of where that framing is concentrated and where it is thin. The study does not claim that the most frequently studied factors are the strongest determinants of achievement; it examines which explanations have received scholarly attention and which remain comparatively neglected.

2. Research Questions

The study is guided by two research questions.

1. What is the structure, growth, and intellectual base of research on Filipino students' mathematics performance from 2000 to 2025?
2. Which explanatory factors does this literature foreground, and how are those factors organized and how have they evolved over time?

3. Methodology

3.1 Data source and retrieval

Bibliographic records were drawn from OpenAlex, an open and comprehensive index of scholarly works (Priem, Piwowar, & Orr, 2022). OpenAlex was selected for its open licensing, broad coverage of regional and open-access outlets relevant to Philippine scholarship, and full programmatic access. Records were retrieved through the OpenAlex API using a Python script with cursor-based pagination. To balance recall against precision, the query was decomposed into five title-and-abstract searches, each bounded to publication years 2000–2025: (1) “philippine mathematics”; (2) “filipino mathematics”; (3) “philippines numeracy”; (4) “filipino students mathematics performance”; and (5) “philippines PISA mathematics”. Running the Philippine and Filipino variants as separate searches and pooling them captured both spellings; the pooled results were then de-duplicated by OpenAlex identifier and subsequently by DOI, yielding 2,070 unique records.

3.2 Corpus refinement

Two screening steps followed. Document types were restricted to articles, reviews, book chapters, and preprints; other types (editorials, errata, datasets, and paratext) were excluded. A triple-gate relevance filter was then applied to each record’s title and abstract, retaining only works that simultaneously carried a Philippine locus (a Philippine institutional affiliation or the terms Philippine or Filipino), a mathematics signal, and an education signal. Inclusion thus required an eligible document type and the joint satisfaction of all three gates. This step removed false positives in which the search terms matched only incidentally—most commonly mathematical modelling in medicine, ecology, and the geosciences that named the Philippines as a study site. Screening reduced the corpus from 2,070 to the 1,556 documents analysed below.

3.3 ***Analysis***

Bibliometric indicators—annual production, sources, authors, institutions, citation counts, and growth rate—were computed in Python (pandas, matplotlib, networkx). Explanatory factors were identified through deductive lexical coding: each title and abstract was searched against a vocabulary of nineteen factor categories grounded in the mathematics-education literature (for example, mathematics anxiety, self-efficacy, language of instruction, socioeconomic status, teacher quality, problem solving, and curriculum). The presence of any category’s terms tagged the document with that factor. The full coding scheme, with example terms, is given in Table 1. A factor co-occurrence network was constructed and partitioned with greedy modularity community detection; for each resulting cluster, Callon centrality and density were computed and plotted as a thematic map (Callon, Courtial, & Laville, 1991; Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011). Temporal emergence was summarized by each factor’s median publication year. Coding was applied automatically and uniformly to all abstracts; the scheme is deductive and was not subjected to manual inter-coder validation, a constraint revisited in the Limitations

Factor category	Example lexical terms
Mathematics anxiety	math anxiety, mathematics anxiety, anxiety, fear of mathematics
Self-efficacy	self-efficacy, self efficacy
Motivation	motivation, motivational
Attitudes	attitude, disposition toward mathematics
Language / MTB-MLE	language of instruction, mother tongue, MTB-MLE, medium of instruction, bilingual, multilingual
Socioeconomic status	socioeconomic, socio-economic, poverty, low-income, disadvantaged
Teacher quality	teacher quality, teacher competence, teacher preparation, pedagogical content, teacher efficacy
Teaching strategy	intervention, manipulative, collaborative/cooperative learning, problem-based, inquiry-based, differentiated, scaffolding, game-based, strategy
Problem solving	problem solving, problem-solving

Factor category	Example lexical terms
ICT / technology	ICT, technology, digital, gamification, e-learning, online learning, mobile learning, GeoGebra
Curriculum / K-12	curriculum, K-12, K to 12, spiral progression
Numeracy / foundational	numeracy, foundational skills, number sense
Gender	gender, sex difference
Self-regulation / metacognition	self-regulation, metacognition
Engagement	engagement, engaged
Conceptual understanding	conceptual understanding, misconception
Study habits	study habits, study skills
Readiness / prior knowledge	readiness, prior knowledge, prerequisite
School resources	school resources, facilities, class size, learning materials, textbooks, infrastructure, internet access, devices

Table 1. Deductive coding scheme: factor categories and example lexical terms.

4. Results

4.1 Volume and growth

The screened corpus comprises 1,556 documents published between 2000 and 2025, with an annual growth rate of 18.22% (Table 2). Output was negligible before 2006, rose steadily from 2013, and accelerated sharply after the Philippines' first PISA cycle in 2018, climbing from 51 documents that year to well over 150 annually by 2023–2024; roughly four-fifths of the entire corpus appeared from 2018 onward (Figure 1). The 2025 count is elevated and should be read with caution, as it partly reflects the rapid indexing of recent and preprint records rather than a single-year surge. Because of this, growth was checked against a series excluding 2025: the rate falls from 18.22% to 14.84%, and about 72% of output still postdates 2017, so the post-PISA acceleration is robust to the exclusion.

Indicator	Value
Documents (after screening)	1,556
Timespan	2000–2025
Sources	584
Unique authors	3,379
Unique institutions	440
Average citations per document	4.08
Annual growth rate	18.22%

Table 2. Main information for the screened corpus (2000–2025).

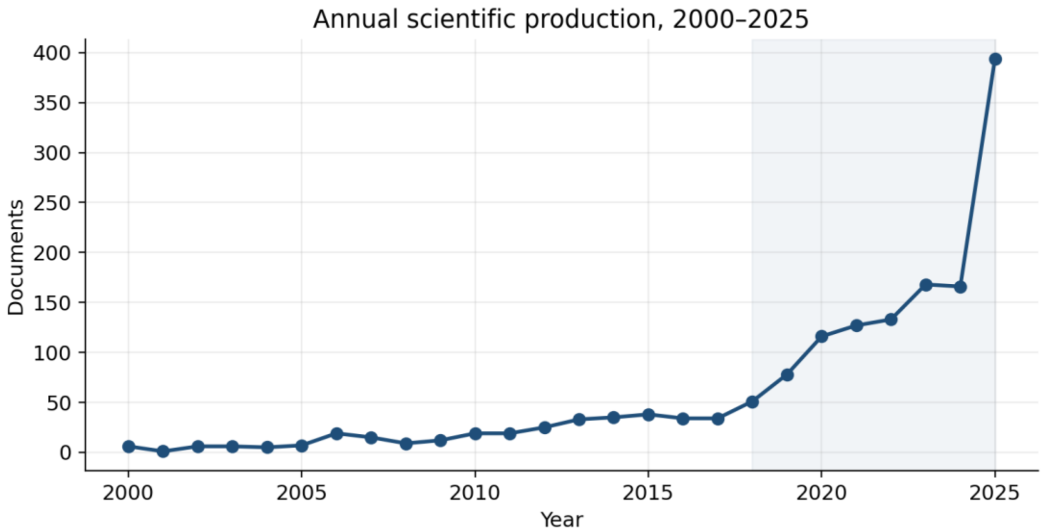

Figure 1. Annual scientific production. Shading marks the post-2018 PISA period.

4.2 Sources and dispersion

The 1,556 documents are spread across 584 sources, an average of about 2.7 documents per outlet, indicating a highly dispersed field with no dominant venue. The most frequent sources are repositories (Zenodo, SSRN) and local or regional multidisciplinary open-access journals; established mathematics-education journals such as the International Electronic Journal of Mathematics Education and The Normal Lights appear only further down the list (Table 3). Taken together, these patterns indicate a field that is active but institutionally scattered, with little consolidation around stable disciplinary journals.

Source	Documents
Zenodo (repository)	85
SSRN Electronic Journal (repository)	33
Int. J. of Research and Innovation in Social Science	30
EPRA Int. J. of Multidisciplinary Research	27
Asian J. of Education and Social Studies	26
Int. Multidisciplinary Research Journal	24
Psychology and Education: A Multidisciplinary J.	20
Int. J. of Multidisciplinary Applied Business and Education Research	19
Journal of Interdisciplinary Perspectives	16
Int. J. of Research Publications	15

Table 3. Ten most frequent sources.

4.3 Authors and institutions

Authorship is fragmented: 3,379 unique authors contributed the 1,556 documents, and even the most prolific authors account for only a dozen works each, indicating few sustained research programmes. Production is concentrated in teacher-education institutions, led by Philippine Normal University—the country's National Center for Teacher Education—followed by Cebu Technological University, De La Salle

University, and the University of Eastern Philippines (Table 4). This institutional pattern reinforces the field's practitioner-facing character, and it may also help explain its emphasis on classroom interventions over structural determinants.

Institution	Documents
Philippine Normal University	55
Cebu Technological University	46
De La Salle University	45
University of Eastern Philippines	29
Laguna State Polytechnic University	24
Ateneo de Manila University	20
Visayas State University	19
Bukidnon State University	19
Univ. of Science and Technology of Southern Philippines	17
Bicol University	17

Table 4. Ten most productive institutions.

4.4 Intellectual base: most-cited works

Average citation impact is modest (4.08 per document), consistent with a young and locally focused literature. The most-cited works (Table 5) are a mix of international comparative studies (Clarke, Keitel, & Shimizu, 2006; Howie & Plomp, 2006), affective and self-regulation research (Ahn et al., 2015; Camahalan, 2006), and a cluster of Philippine-anchored studies on attitudes, bilingual problem solving, online-learning anxiety, and the socioeconomic moderation of mindset using PISA 2018 Philippine data (Etcuban et al., 2019; Bernardo, 2002, 2020; Mamolo, 2022). The presence of equity- and language-oriented landmark papers is notable given how thinly those topics are represented across the corpus as a whole (Section 3.5).

Title	Authors	Year	Cited
Mathematics Classrooms in Twelve Countries	Clarke, Keitel & Shimizu	2006	213
Decolonizing methodologies and indigenous knowledge	Chinn	2007	186
Cultural differences in modelling and feedback (self-efficacy)	Ahn et al.	2015	122
Attitudes, Study Habits, and Academic Performance in Mathematics	Etcuban et al.	2019	121
Self-Regulated Learning on Mathematics Achievement (SE Asia)	Camahalan	2006	98
Meta-analysis of thinking-skills approaches	Higgins et al.	2005	81
Contexts of Learning Mathematics and Science (TIMSS)	Howie & Plomp	2006	80

Title	Authors	Year	Cited
Online Learning and Mathematics Motivation, Self-Efficacy, Anxiety	Mamolo	2022	78
SES moderates growth mindset and learning: PISA 2018 PH data	Bernardo	2020	66
Language and Mathematical Problem Solving Among Bilinguals	Bernardo	2002	64

Table 5. Ten most-cited documents.

4.5 Factors foregrounded by the literature

Lexical coding of the 1,556 abstracts produced a clear hierarchy of emphasis (Figure 2, Table 6). The literature is dominated by proximate, classroom-level factors—information and communication technology, teaching strategies, and curriculum—together with affective and motivational constructs such as engagement, attitudes, and motivation. By contrast, the structural determinants highlighted by PISA and the national literature sit lower in the ranking. The magnitude of the gap is the point: ICT/technology appears in 645 documents, teaching strategy in 368, and curriculum in 300, whereas socioeconomic status appears in only 64, language of instruction and mother-tongue policy in 58, and teacher quality in just 31. School resources drew moderate attention (134 documents), but much of this is bound up with pandemic-era concern over devices and connectivity rather than systemic resource inequality. This imbalance suggests that research on Filipino mathematics performance tends to frame underachievement as a problem of instruction, engagement, and tools rather than as one also shaped by poverty, language access, teacher preparation, and resource inequality.

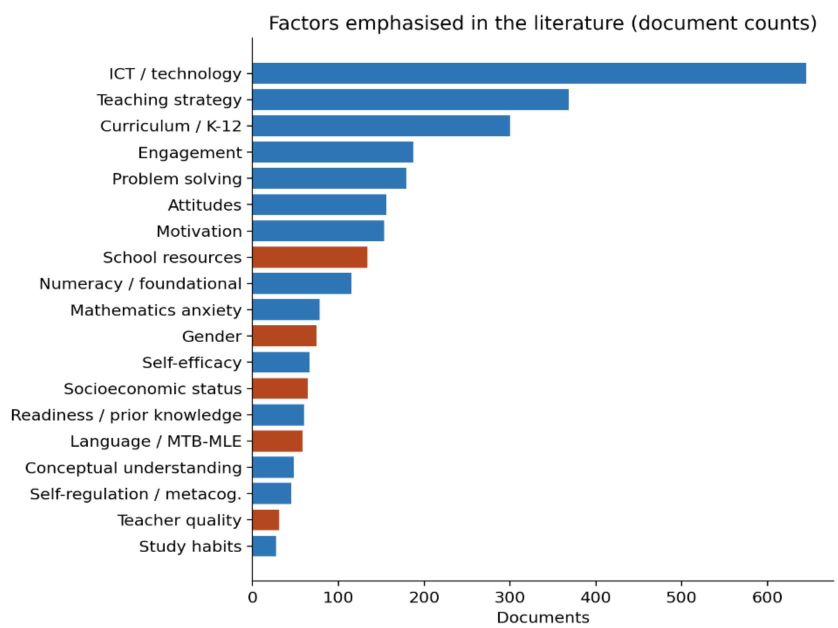

Figure 2. Factors emphasised in the literature, by number of documents. (The ICT/technology category is broad; see Limitations.)

Factor	Documents
ICT / technology	645
Teaching strategy	368
Curriculum / K-12	300
Engagement	187
Problem solving	179
Attitudes	156
Motivation	153
School resources	134
Numeracy / foundational	115
Mathematics anxiety	78
Gender	74
Self-efficacy	66
Socioeconomic status	64
Readiness / prior knowledge	60
Language / MTB-MLE	58
Conceptual understanding	48
Self-regulation / metacognition	45
Teacher quality	31
Study habits	27

Table 6. Frequency of explanatory factors across the corpus.

4.6 Thematic structure

Clustering the factor co-occurrence network resolved it into two communities (Figure 3). The larger community is a dense instructional-and-contextual core linking technology, teaching strategy, curriculum, engagement, and problem solving; the structural determinants—socioeconomic status, language of instruction, teacher quality, and school resources—fall within this community only as peripheral, low-frequency nodes rather than forming a coherent cluster of their own. The second community is a compact affective–self-regulatory group comprising attitudes, motivation, mathematics anxiety, self-efficacy, and self-regulation. The absence of a distinct structural or equity theme indicates that these determinants have not yet been organised into a connected research programme.

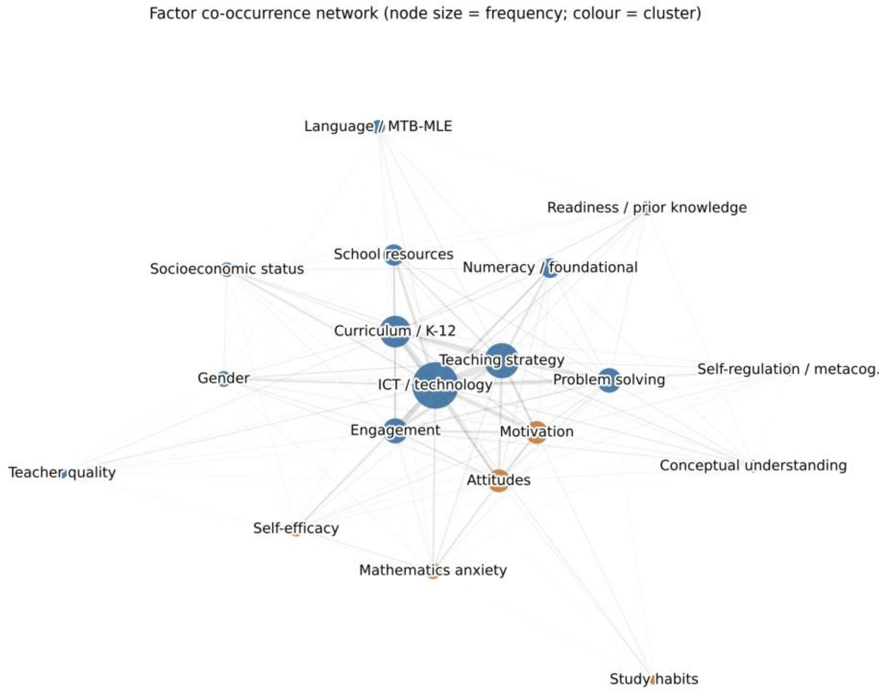

Figure 3. Factor co-occurrence network. Node size is proportional to frequency and colour denotes cluster; the structural determinants appear as peripheral nodes within the dominant instructional cluster.

4.7 Temporal evolution

The factors emerged in a discernible sequence (Figure 4). Language of instruction and mother-tongue concerns appeared earliest (median year 2019), tracking the K-12 mother-tongue policy debate (Republic Act No. 10533, 2013); socioeconomic status, curriculum, and gender followed in 2021–2022; a broad wave of teaching strategy, technology, and affective constructs crested in 2023 amid the shift to online learning; and the most recent attention has turned to foundational numeracy and engagement in 2024–2025. This late pivot toward foundational skills aligns with post-pandemic, post-PISA learning-recovery priorities (Department of Education, 2023).

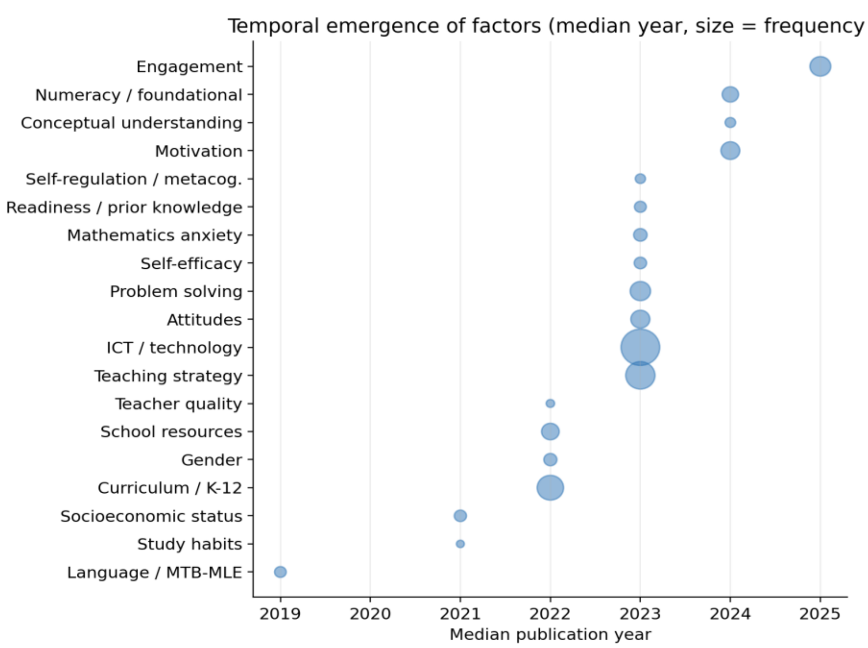

Figure 4. Temporal emergence of factors by median publication year.

5. Discussion

Three findings stand out. First, research on Filipino students' mathematics performance is a young, fast-growing, but markedly fragmented field. Its acceleration after 2018 identifies the PISA results as a catalysing event, but its dispersion across hundreds of sources, its largely non-recurring authorship, its modest citation impact, and its reliance on repositories and local multidisciplinary journals describe a literature that has expanded faster than it has consolidated. The concentration of output in teacher-education universities further suggests a practitioner-facing field oriented toward classroom application rather than cumulative theory-building.

Second, and most consequentially, the field exhibits a proximate–structural asymmetry. The factors it foregrounds are overwhelmingly proximate—instructional tools, teaching strategies, curriculum, and learner affect—while the structural determinants that PISA and the national literature highlight are peripheral. PISA 2022 documented a strong socioeconomic gradient in Philippine performance (OECD, 2023; Trinidad, 2020), and national policy has long foregrounded language of instruction and teacher preparation as further structural concerns (Republic Act No. 10533, 2013; Ogena, Ubiña-Balagtas, & Diaz, 2018); yet socioeconomic status, mother-tongue policy, and teacher quality are among the least-studied factors in the corpus, and the co-occurrence network places them as peripheral nodes rather than an integrated equity theme. The literature thus tends to ask how to teach mathematics better while underexamining the conditions—poverty, language, and teacher capacity—that shape whether better teaching can take hold (Figure 5).

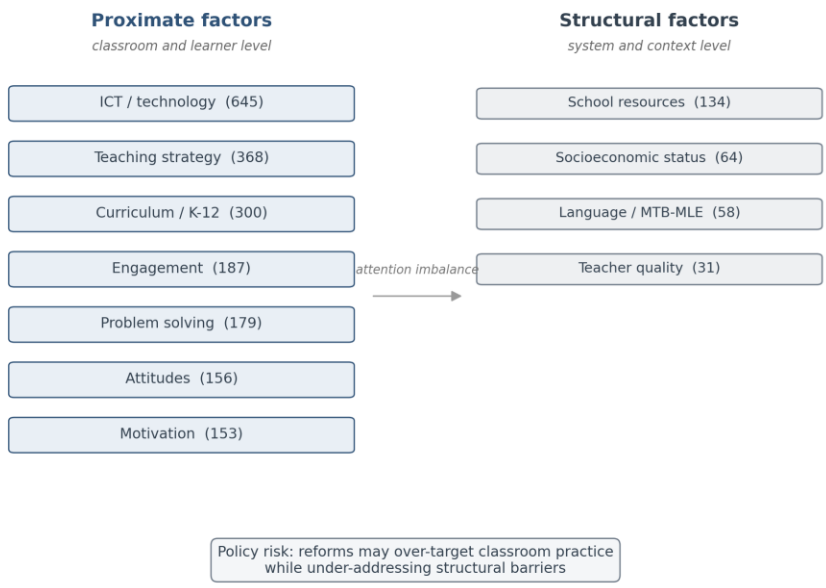

Figure 5. Research-attention map showing high scholarly attention to proximate, classroom-level factors and comparatively lower attention to structural determinants. The map highlights a policy risk: mathematics reforms may over-target classroom practice while under-addressing poverty, language access, teacher preparation, and school-resource inequality.

Third, the field is reorienting. The recent emergence of foundational numeracy and engagement mirrors the policy turn toward learning recovery and foundational skills following the pandemic and successive PISA cycles. This suggests a research community responsive to national priorities, and an opening for studies that connect foundational-skills work to the structural factors currently underrepresented.

For research, these results argue for a deliberate shift toward structural and equity-focused inquiry—socioeconomic disparity, language of instruction, and teacher preparation—and toward consolidation in established, indexed venues that would raise the visibility and cumulative weight of Philippine scholarship. For policy, the map indicates that interventions targeting only classroom practice address one part of a larger system; sustained gains in mathematics performance will likely require parallel attention to the structural conditions the literature has so far left at its margins.

More concretely, future studies should examine how classroom interventions interact with the structural conditions surrounding them. Technology-based interventions, for instance, should ask not only whether digital tools raise performance but whether they do so equally for learners with uneven access to devices, connectivity, home support, and language resources; analogous interaction questions apply to teaching strategies under differing levels of teacher preparation and to curriculum reform across schools with unequal resources. Reframing the research agenda around for whom, and under what conditions, classroom innovations work would directly close the asymmetry this map exposes.

6. Policy Implications

The findings carry a direct implication for Philippine education reform: mathematics underperformance should not be treated as a classroom problem alone. The dominance of technology, teaching strategies, curriculum, engagement, and motivation in the literature shows that the field has generated substantial knowledge on school-level responses. However, the thinner and more fragmented attention to socioeconomic status, language of instruction, teacher quality, and resource inequality suggests that system-level constraints remain insufficiently integrated into the research and policy agenda.

For policy makers, this argues for moving from an intervention-only model to an equity-conditioned model. Programmes on foundational numeracy, curriculum implementation, digital learning, and teaching strategies should be judged not only by whether they raise achievement on average, but by whether they work for learners in poverty, learners navigating language transitions, learners in under-resourced schools, and learners taught by teachers with uneven preparation in mathematics pedagogy.

Three priorities follow. First, the Department of Education, the Commission on Higher Education, state universities and colleges, and teacher-education institutions, together with research-funding bodies, should support a national research agenda on the structural determinants of mathematics performance—socioeconomic disparity, language of instruction, teacher preparation, and school resources. Second, mathematics intervention studies should routinely report the learner, language, teacher, and school-resource conditions under which they are implemented, so that evidence can speak to equity and not only to average effects. Third, learning-recovery policy should connect foundational-numeracy programmes with targeted support for disadvantaged learners, language-responsive instruction, and sustained teacher professional development.

The message is not that classroom interventions are unimportant. Rather, the evidence map indicates that classroom reform is more likely to yield durable gains when poverty, language access, teacher capacity, and school-resource inequality are addressed at the same time.

7. Limitations and Conclusion

Several limitations qualify these findings. Coverage and metadata depend on OpenAlex, which, though comprehensive, indexes uneven gray literature and may misattribute some fields. Factor identification is lexical, so a document that mentions a factor is not necessarily about it; the ICT/technology category in particular is broad and partly captures generic references to technology, which inflates its count. Coding was applied automatically and was not validated by manual inter-coder review; a manual audit of a stratified sample of abstracts would strengthen confidence in the factor counts. The factor vocabulary is a deductive frame and may omit constructs an inductive approach would surface. The 2025 production figure reflects indexing dynamics and should not be read as a single-year jump. Finally, the analysis is descriptive: it maps how the literature frames Filipino students' mathematics difficulties, not the causal weight of any factor. The policy implications should therefore be read as evidence-informed agenda-setting recommendations rather than direct estimates of which interventions will produce the largest achievement gains.

Within these limits, the study offers the first systematic map of research on Filipino students' mathematics performance. The field is expanding rapidly under the impetus of PISA but remains fragmented and locally bounded. It explains underachievement principally through proximate instructional and affective lenses, while the structural determinants that international evidence most strongly implicates—socioeconomic status, language of instruction, and teacher quality—remain peripheral and underdeveloped. The next phase of Philippine mathematics-education research must therefore move beyond asking which classroom strategies work, toward asking for whom they work, under what structural conditions, and with what supports for equity and sustained learning recovery. For policy, the implication is direct: improving mathematics performance requires not only better classroom methods, but a coordinated system response that addresses learner poverty, language access, teacher preparation, and resource inequality alongside curriculum and instructional reform.

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