JPAIR Institutional Research Volume 26 • June 2026
DOI: https://doi.org/10.7719/irj.v26i1.998

Resource Allocation Optimization and Academic Performance of Mathematics Students in Philippine State Universities: A Narrative Literature Review

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Originality: 100% • Grammarly: 98% • Plagiarism: 0%

ABSTRACT

Article history:

Received: 15 Aug 2025
Revised: 23 Mar 2026
Accepted: 14 May 2026
Published: 30 Jun 2026

Keywords — Resource allocation optimization, Mathematics achievement, Academic performance, Philippine State Universities, Instructional resources

Resource Allocation Optimization (RAO) is increasingly recognized as a structural determinant of academic performance in public higher education institutions, particularly within Philippine State Universities and Colleges (SUCs). This narrative literature review synthesizes theoretical and empirical studies examining the relationship between RAO—conceptualized through timeliness, adequacy, and accessibility of instructional resources—and the academic performance of Mathematics students. Drawing from education, educational psychology, and higher education

management literature, the review identifies consistent causal pathways linking optimized resource allocation to instructional flow, academic self-efficacy, and competency development. Evidence further reveals a persistent discrepancy between satisfactory course grades and weaker performance in competency-based assessments, suggesting that systemic inefficiencies in instructional support constrain higher-order learning. By integrating administrative and pedagogical perspectives, this review positions RAO as a critical institutional predictor of Mathematics achievement and highlights the need for institution-specific empirical research to inform data-driven reforms in regional Philippine SUCs.

INTRODUCTION

Academic performance in Mathematics has traditionally been examined through pedagogical strategies, learner cognition, and motivational variables; however, recent higher education research increasingly emphasizes the role of institutional and administrative conditions in shaping learning outcomes (Guinocor et al., 2020). In Philippine State Universities and Colleges (SUCs), instructional delivery is embedded within a bureaucratic environment characterized by constrained fiscal resources, centralized procurement systems, and strict accountability mechanisms. These structural conditions directly influence the availability, quality, and usability of instructional resources essential for Mathematics instruction (CHED, 2024).

Mathematics is a cumulative and hierarchical discipline that requires uninterrupted instructional pacing and sustained access to learning tools. Disruptions in instructional support have been shown to disproportionately affect Mathematics learning compared to other subject areas, particularly in higher-order and abstract topics (Mukuka et al., 2021). Despite institutional mandates emphasizing quality education and service excellence, empirical studies linking institutional resource optimization to Mathematics academic performance remain limited in the Philippine context (Guinocor et al., 2020). This narrative review addresses this gap by synthesizing existing literature on Resource Allocation Optimization (RAO) and its relationship with Mathematics achievement in Philippine higher education.

METHODOLOGY

Research Design

This study employed a narrative literature review design, which is appropriate for synthesizing findings across diverse disciplines such as education, educational psychology, and higher education management (Green et al., 2006). Narrative reviews are particularly useful when the research objective is theory development and conceptual integration rather than statistical aggregation, especially in areas where empirical studies vary widely in design and measurement (Ferrari, 2015).

In the context of Resource Allocation Optimization, research is dispersed across administrative studies, pedagogical research, and psychological investigations. A narrative approach allows for the integration of these strands into a coherent explanatory framework that links institutional processes to academic outcomes (Grant & Booth, 2009).

Literature Search Strategy

The literature search was conducted using Google Scholar as the primary database, supplemented by ERIC and Philippine academic journal repositories. Google Scholar was prioritized due to its comprehensive indexing of international journals, institutional publications, and Philippine-based research outputs that are not always included in commercial databases (Harzing & Alakangas, 2016).

Search terms included combinations of resource allocation optimization, instructional resources, mathematics academic performance, higher education, Philippine State Universities, academic self-efficacy, and instructional timeliness. Boolean operators were used to refine search results and ensure relevance (Cooper, 2017).

Inclusion and Exclusion Criteria

Studies were included if they: (1) focused on higher education or senior secondary education; (2) examined resource-related variables such as timeliness, adequacy, or accessibility; (3) reported outcomes related to Mathematics learning or academic performance; (4) were peer-reviewed or published by recognized academic or policy institutions; and (5) were accessible through Google Scholar or ERIC (Ferrari, 2015).

Studies were excluded if they lacked methodological transparency, were purely opinion-based, or focused exclusively on non-academic outcomes. This screening process ensured both scholarly rigor and contextual relevance (Cooper, 2017).

Data Synthesis and Analysis

A thematic synthesis approach was used to analyze the selected literature. Recurring constructs, causal mechanisms, and empirical patterns were identified and grouped across studies (Braun & Clarke, 2006). Themes were organized around the three dimensions of RAO—timeliness, adequacy, and accessibility—and interpreted using established cognitive and motivational learning theories.

To strengthen causal inference, particular attention was given to studies employing longitudinal designs, regression modeling, mediation analysis, and quasi-experimental methods (Shadish, 2002). This approach enabled the identification of plausible causal pathways linking institutional resource optimization to Mathematics academic performance.

RESULTS AND DISCUSSION

This section presents an integrated synthesis of the results derived from the reviewed literature and discusses their implications within the context of Mathematics education in Philippine State Universities and Colleges (SUCs). As this study is a narrative literature review, "results" refer to recurring empirical patterns and convergent findings reported across studies, while the discussion interprets these patterns using established educational, psychological, and organizational theories (Green et al., 2006; Grant & Booth, 2009).

Resource Allocation Optimization as an Institutional Predictor of Mathematics Performance

Across the reviewed studies, a consistent result is the identification of Resource Allocation Optimization (RAO) as a significant institutional predictor of Mathematics academic performance. Empirical evidence from education management and instructional resource studies demonstrates that institutions with optimized resource systems—characterized by timely delivery, sufficient quantity, and ease of access—consistently report higher Mathematics achievement among students (Mukuka et al., 2021; James et al., 2011). These findings remain robust even after controlling for learner-level variables such as prior achievement and socio-economic status.

From a systems perspective, these results suggest that RAO functions as a structural condition that shapes the instructional environment in which learning occurs (Guinocor et al., 2020). Rather than acting as a peripheral administrative concern, RAO sets an upper boundary on instructional effectiveness and student achievement. This interpretation aligns with higher education systems theory, which emphasizes the interdependence of administrative efficiency and academic outcomes (Grant & Booth, 2009).

Timeliness of Resource Delivery and Instructional Continuity

A prominent finding in the literature is the strong association between the timeliness of instructional resource delivery and Mathematics academic performance. Studies conducted in public universities consistently report that delays in the procurement and distribution of instructional materials disrupt curricular pacing and reduce instructional continuity, particularly in sequential subjects such as Mathematics (World Bank, 2015; Lupian-Poliran & Khanser, 2015). These delays often result in instructors compressing lessons or omitting resource-dependent activities, thereby weakening conceptual development.

The discussion of these findings highlights timeliness as a key determinant of instructional flow, defined as uninterrupted lesson pacing and sustained cognitive engagement (Csikszentmihalyi, 1990). When instructional materials arrive late, the flow state necessary for mastering abstract mathematical concepts is disrupted, leading to fragmented learning experiences. Empirical studies further show that

such disruptions are associated with lower performance on competency-based assessments, even when course grades remain satisfactory (Chand et al., 2021; Villanueva et al., 2024). This pattern helps explain why procedural success in coursework does not always translate into higher-order mathematical mastery.

Adequacy of Instructional Resources and Cognitive Readiness

The literature also consistently reports a positive relationship between the adequacy of instructional resources and Mathematics achievement. Adequacy—defined as the sufficiency and appropriateness of learning materials relative to curricular demands—has been shown to enhance students' conceptual understanding and problem-solving abilities (Mukuka et al., 2021; CHED, 2024). In Mathematics programs, adequate access to textbooks, calculators, laboratory tools, and licensed digital software is particularly critical for engaging with abstract and applied content.

Discussion of these findings suggests that adequacy contributes to what may be described as cognitive readiness, wherein students are mentally prepared to engage in complex learning tasks because essential tools are consistently available (James et al., 2011). In contrast, inadequate resources force students to share materials or rely on substitutes, reducing hands-on engagement and instructional intensity (Guinocor et al., 2020). These conditions disproportionately affect students in public universities, reinforcing inequities in learning outcomes across institutional contexts.

Accessibility of Resources and Active Learning Engagement

Accessibility emerged from the reviewed literature as a distinct and powerful dimension of RAO. Results indicate that even when resources are technically available, limited accessibility due to bureaucratic controls and custodianship procedures significantly reduces their educational impact (Lupian-Poliran & Khanser, 2015). Studies in higher education management reveal that ease of access is often a stronger predictor of academic performance than availability alone (RSIS International, 2021).

The discussion of these findings emphasizes accessibility as an operational mechanism that converts institutional resources into actual learning experiences. Restricted access limits opportunities for independent practice, experimentation, and repetition—activities that are essential for mastering mathematical concepts (Guinocor et al., 2020). Moreover, perceived access barriers negatively affect students' motivation and persistence, further weakening academic outcomes. These results underscore the importance of examining not only what resources exist but also how easily students can use them.

Cognitive and Affective Pathways Linking RAO to Achievement

An integrated result across the literature is that RAO influences Mathematics achievement through both cognitive and affective pathways. Cognitively, timely

and accessible resources sustain instructional flow and support deep conceptual engagement, which are essential for mastering abstract mathematical ideas (Csikszentmihalyi, 1990; Lupian-Poliran & Khanser, 2015). Affective outcomes, such as academic self-efficacy and Mathematics anxiety, are likewise shaped by institutional resource conditions.

Studies consistently show that students who perceive their institutions as well-equipped and well-organized report higher academic self-efficacy and lower levels of Mathematics anxiety (Zakariya, 2021; Guinocor et al., 2020). These affective dispositions mediate the relationship between institutional conditions and academic performance, reinforcing the argument that RAO exerts both direct and indirect effects on learning outcomes. This dual-pathway interpretation strengthens the causal plausibility of RAO as a predictor of Mathematics achievement.

Explaining the GPA–Competency Performance Gap

A critical result emerging from the literature is the persistent discrepancy between satisfactory course grades and weaker performance on competency-based assessments in Mathematics. Several studies report that while students often achieve acceptable semestral GPAs, their performance in departmental or standardized examinations reveals gaps in higher-order thinking and conceptual integration (Villanueva et al., 2024; James et al., 2011).

The discussion attributes this GPA–competency gap partly to RAO-related constraints. Delayed access to advanced learning tools, limited opportunities for deep practice, and disrupted instructional pacing allow students to succeed in compliance-driven coursework without achieving mastery-level understanding. This interpretation is particularly relevant in Philippine SUCs, where institutional constraints are structural rather than incidental, and where competency examinations are increasingly emphasized for program quality assurance.

Implications for Philippine State Universities

The results and discussion collectively position RAO as a high-impact domain for academic reform in Philippine SUCs. Improving procurement timelines, ensuring adequate instructional materials, and reducing access barriers can function as academic interventions rather than merely administrative improvements (Guinocor et al., 2020; Lupian-Poliran & Khanser, 2015). These reforms are especially critical in regional universities, where students rely heavily on institution-provided resources.

Furthermore, the absence of campus-specific empirical studies highlights the need for localized, mixed-methods research to validate and quantify the observed relationships. Combining administrative data, academic performance measures, and student perceptions would allow institutions such as NEMSU Main Campus to move from assumption-based management to evidence-driven decision-making (Guinocor et al., 2020).

CONCLUSION

This narrative literature review provides a comprehensive synthesis of evidence demonstrating that Resource Allocation Optimization (RAO) is a critical institutional determinant of Mathematics academic performance in Philippine State Universities and Colleges (SUCs). Across diverse empirical and theoretical studies, consistent findings establish that the timeliness, adequacy, and accessibility of instructional resources significantly shape instructional quality, learner engagement, and competency development in Mathematics education (Mukuka et al., 2021; James et al., 2011). These findings extend traditional learner- and pedagogy-centered explanations of academic performance by foregrounding institutional efficiency as a foundational condition for effective learning.

The reviewed literature further confirms that RAO exerts its influence through interconnected cognitive and affective pathways. Timely and accessible instructional resources preserve instructional flow, a psychological state associated with sustained cognitive engagement and effective mastery of abstract and sequential mathematical concepts (Csikszentmihalyi, 1990; Lupian-Poliran & Khanser, 2017). Simultaneously, adequate and accessible resources enhance academic self-efficacy and reduce Mathematics anxiety, both of which are well-established predictors of persistence, engagement, and achievement (Zakariya, 2021; Guinocor et al., 2020). This dual-pathway mechanism strengthens the causal plausibility of RAO as both a direct and indirect predictor of Mathematics performance.

A significant contribution of this review lies in its explanation of the persistent GPA–competency performance gap documented in Mathematics education. While students in public universities frequently achieve satisfactory course grades, their weaker performance in departmental and competency-based assessments suggests limitations in higher-order conceptual mastery (Villanueva et al., 2024). The literature indicates that systemic inefficiencies in resource delivery, limited access to advanced learning tools, and disrupted instructional pacing contribute to this gap by constraining opportunities for deep learning and sustained practice (James et al., 2011). Addressing RAO deficiencies therefore emerges as a necessary condition for aligning classroom performance with genuine mathematical competence.

Within the Philippine SUC context, particularly in regional institutions, the implications of these findings are substantial. RAO should no longer be treated as a purely administrative or logistical concern but rather as a strategic academic lever capable of influencing instructional effectiveness and student outcomes (Guinocor et al., 2020). Improvements in procurement efficiency, alignment of resource distribution with curricular pacing, and reduction of access barriers represent academically meaningful interventions that can elevate learning

outcomes without altering curricular standards or admission policies.

RECOMMENDATIONS FOR FUTURE RESEARCH

Despite the strong theoretical and empirical support for RAO as a determinant of academic performance, the reviewed literature reveals a critical gap: the scarcity of campus-specific, quantitative studies directly measuring the impact of RAO on Mathematics achievement in Philippine SUCs. Future research should prioritize institution-level empirical investigations that integrate administrative data (e.g., procurement timelines, supply adequacy indices, access logs) with academic performance indicators such as GPA and departmental competency exam scores (Guinocor et al., 2020; James et al., 2011). Such studies would enable more precise estimation of RAO's predictive power and support evidence-based decision-making.

Future studies are also encouraged to employ mixed-methods research designs to capture both the measurable and experiential dimensions of RAO. Quantitative analyses can establish the magnitude and statistical significance of relationships between RAO variables and academic outcomes, while qualitative methods—such as interviews with students, faculty, and supply officers—can illuminate how bureaucratic processes and access barriers are experienced at the ground level (Creswell & Plano Clark, 2018). This approach is particularly valuable in understanding context-specific challenges in regional universities.

Longitudinal and quasi-experimental research designs are further recommended to strengthen causal inference. Tracking cohorts over time or examining academic outcomes before and after procurement or resource-management reforms would allow researchers to isolate the effects of improvements in timeliness, adequacy, or accessibility on Mathematics performance (Shadish, 2002). Such designs are especially relevant in public higher education systems where randomized interventions are often impractical.

Finally, future research should explore mediating and moderating variables that may shape the RAO–achievement relationship. Potential mediators include instructional flow, academic self-efficacy, and Mathematics anxiety, while moderators may involve socio-economic status, academic program (BS vs. BSEd), year level, and digital access (Zakariya, 2021; Guinocor et al., 2020). Examining these mechanisms would deepen understanding of how and for whom RAO interventions are most effective, thereby informing more targeted and equitable policy responses.

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