

A Longitudinal Evaluation of Data-Based Planning (PBD) Effectiveness in Improving Numeracy Skills

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ABSTRACT

Trends in numeracy skills across different content areas and cognitive levels continue to pose a considerable challenge in integrated Islamic elementary schools, affecting students' overall academic achievement. This longitudinal study assesses the effectiveness of Data-Based Planning (Perencanaan Berbasis Data/PBD) in bridging these gaps and improving numeracy skills among students at SDIT Al-Khoiriyah Al Husna during the period from 2023 to 2025. The study utilizes a mixed-methods explanatory sequential design, combining quantitative growth and gap analyses of students' numeracy achievement across various content domains (Number, Algebra, Geometry) and cognitive levels (Knowing, Applying, Reasoning) with qualitative document analysis of PBD implementation cycles. Results indicate significant enhancements in basic numeracy skills, especially in minimal competency and the Number domain, during the initial stage of PBD implementation. However, enduring disparities exist among cognitive levels, especially in higher-order reasoning skills, which demonstrated slower advancement despite focused interventions. This underscores the persistent difficulty of properly cultivating higher-order thinking in numeracy skills. The research highlights the essential importance of teacher competence and adaptable, data-driven techniques in maintaining significant development. These findings provide significant implications for enhancing educational quality assurance processes in integrated Islamic elementary schools.

Keywords data-based planning; educational quality assurance; institutional evaluation; school improvement; numeracy skills.

I. Introduction

Given the critical role of numeracy skills, foundational education provides the essential groundwork for cultivating key competencies in students. Numeracy serves not only as a cognitive skill but also as a crucial indicator within the national framework for ensuring educational quality. This significantly influences achievement across various fields and aids learners in honing their analytical and decision-making abilities (Buljan et al., 2019; Kemendikbudristek, 2023; Peters et al., 2017). The Indonesian government emphasizes the importance of numeracy on the Rapor Pendidikan platform, aligning it with its broader national agenda aimed at enhancing overall educational quality.

Data-Based Planning (Perencanaan Berbasis Data, PBD) serves as a crucial element within integrated Islamic elementary schools (Sekolah Dasar Islam Terpadu, SDIT), such as SDIT Al-Khoiriyah Al Husna, Sistem Penciuman Mutu Pendidikan, Sistem Penciuman Al Husna, and Sistem Penciuman Al Husna. PBD tackles learning gaps through a systematic cycle of identification, reflection, and intervention, thereby promoting structured and continuous enhancement. Through the analysis of assessment data, it informs decisions regarding instructional strategies across various domains—Number, Algebra, Geometry—and cognitive levels—Knowing, Applying, Reasoning (Busyairi & Kusuma, 2024; Indrawatiningsih et al., 2024; Kemendikbud, 2016).

Despite this commitment, various challenges in implementation remain. According to Syah et al. (2023), significant obstacles in the implementation of PBD in Islamic educational settings include the preparedness of teachers and their understanding of assessment practices. Successful educational reforms rely on cohesive strategies throughout curriculum

development, institutional management, and assessment design, as highlighted by Zakariyah (2024). Similarly, Suprawata and Riastini (2022) emphasize the importance of professional development in enhancing teachers' numeracy skills, which has a direct impact on student performance.

In the context of strategy development, recent findings advocate for the incorporation of differentiated instruction within PBD. According to Indrawatiningsih et al. (2024), tailored instruction significantly enhances outcomes in both literacy and numeracy. Moreover, treatments grounded in values—like those explored by Peters et al. (2017)—highlight the importance of contextually relevant learning that connects numeracy with real-world decision-making. These findings align with the observations made by Qadri et al. (2023), who found that interactive, video-assisted learning tools could effectively enhance numeracy skills in elementary school students.

In the wider context of Islamic education, longitudinal studies on PBD remain quite uncommon. Investigations focusing on long-term, process-oriented outcomes are infrequent, despite the validation of short-term effects of structured interventions by frameworks established by Suprpto et al. (2024) and Busyairi and Kusuma (2024). This results in a lack of understanding regarding the impact of consistent PBD implementation on the evolution of numeracy over multiple years. Moreover, highlighted by Lusa et al. (2023) and Marhefka et al. (2021), methodological challenges such as participant consistency and intervention adaptation warrant significant consideration in longitudinal assessments. Given this context, this study seeks to: (1) Examine the trends in the improvement of numeracy skills among students at SDIT Al-Khoiriyah Al Husna from 2023 to 2025. (2) Assess the effectiveness of the Data-Based Planning (PBD) process in mitigating gaps in numeracy achievement across topic domains and cognitive levels.

This investigation offers a distinctive contribution by monitoring PBD implementation across three successive years within an Islamic school context through a longitudinal mixed-methods approach. This study presents empirical evidence on the potential of PBD as a systematic quality assurance mechanism, integrating quantitative growth and gap analysis with qualitative document reviews. This study prioritizes the implementation process, contextual dynamics, and long-term instructional adaptation, distinguishing itself from many current studies that focus primarily on outcomes or isolated interventions. This offers a scalable approach to enhancing numeracy in diverse educational contexts and aids in the refinement of PBD-based policies and practices within Islamic educational frameworks.

2. Method

This study employed a mixed-methods explanatory sequential design, intentionally omitting interviews, to thoroughly examine the effectiveness of Data-Based Planning (Perencanaan Berbasis Data/PBD) in improving students' numeracy skills at SDIT Al-Khoiriyah Al Husna. The design commenced with a quantitative phase, subsequently incorporating a qualitative document analysis to provide contextual information and rationale for the quantitative findings. This integration was chosen to merge reflective and process-oriented insights from the school's quality assurance operations with objective performance data.

During the period from 2023 to 2025, the quantitative phase utilized secondary data sourced from the Education Report Card (Rapor Pendidikan) released by the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek). The statistics encompass three cognitive levels (Knowing/L1, Applying/L2, Reasoning/L3) along with three curriculum domains related to numeracy achievement. Numerical analysis, algebraic structures, geometric principles. The investigation encompassed Gap Analysis to pinpoint discrepancies between domains and cognitive levels, as well as Growth Analysis to assess

year-over-year progress. The findings informed the prioritization of intervention areas for PBD.

The qualitative phase involved a thorough examination of official PBD records related to the Identification, Reflection, and Improvement cycle during the specified timeframe. Thematic Analysis revealed significant trends related to implementation challenges and effective practices, while Content Analysis facilitated the extraction of relevant strategies, action plans, and insights. Triangulation, peer validation with the Internal Quality Assurance Team (TPMI), and repeated conferences among colleagues ensured the validity of the data. The effectiveness categories proposed by Pereira et al. (2022) were utilized to assess the impact of PBD interventions, focusing on target achievement and the extent of improvement in numeracy performance.

Table 1: Effectiveness Categories

Categories	Criteria	Description
Highly Effective	Achievement of targets at or above 85%	The intervention demonstrates significant efficacy and exerts considerable impact.
Effective	Achievement levels ranging from 70% to 84%	The intervention functions effectively, demonstrating a clear positive impact.
Moderately Effective	Achievement levels ranging from 50% to 69%	The Intervention is currently functioning, although it faces certain deficiencies or obstacles.
Less Effective	Achievement levels ranging from 30% to 49%	The intervention demonstrates a lack of effectiveness or produces minimal outcomes.
Ineffective	Target attainment below 30%	The intervention was either not implemented or led to negative outcomes.

The categories presented in Table 1 serve as a benchmark for evaluating the impact of the PBD intervention on students' numeracy performance.

3. Results and Discussion

a) Growth Analysis of Numeracy Skills (2023–2025)

To evaluate the effectiveness of data-based planning (PBD) in improving students' numeracy skills, a longitudinal growth analysis was conducted over a three-year period (2023–2025). The analysis focuses on key indicators: minimum competency achievement, performance across the core mathematical domains (Numbers, Algebra, and Geometry), and progression at different cognitive levels (Knowing, Applying, and Reasoning). Table 2 summarizes the year-by-year progression, total gains, average annual growth rates, and the categorization of growth velocity.

Table 2: Growth Analysis Results

Indicator	2023	2024	2025	Δ (2023-2024)	Δ (2024-2025)	Δ (2023-2025)	Average Annual Growth Rate	Growth Category
Minimum Competency Achievement	60%	96.67%	100%	↑36.67%	↑3.33%	↑40%	↑20%/year	Very Fast
Numbers Domain	38.22	69.51	73.46	↑31.29	↑3.95	↑35.24	↑17.62/ year	Fast
Algebra Domain	42.87	52.92	66.71	↑10.05	↑13.79	↑23.84	↑11.92/ year	Moderate
Geometry Domain	42.29	56.00	65.81	↑13.71	↑9.81	↑23.52	↑11.76/ year	Moderate
L1 (Knowing)	49.87	62.69	72.60	↑12.82	↑9.91	↑22.73	↑11.37/ year	Moderate
L2 (Applying)	38.34	60.24	70.05	↑21.90	↑9.81	↑31.71	↑15.86/ year	Fast
L3 (Reasoning)	37.19	58.53	61.19	↑21.34	↑2.66	↑23.75	↑11.88/ year	Moderate

The findings presented in Table 2 indicate a significant increase in numeracy skills over the three-year period. The most significant finding is the increase in minimum competency achievement, which is projected to reach 100% in 2025, indicating that every student meets the national standards. The rapid advancement, marked by a 20% average annual growth, underscores the potential of data-driven planning as a means to accelerate learning outcomes and demonstrates the effectiveness of targeted instructional interventions.

In terms of content domains, the Numbers domain showed the most rapid early growth, suggesting that essential arithmetic skills were prioritized and successfully tackled. Nonetheless, the slower progress observed in the past year indicates the challenges associated with sustaining momentum in the absence of adaptive learning assistance. Highlighting the importance of scaffolding and the reinforcement of concepts over time, particularly as the complexity of content increases, the fields of algebra and geometry demonstrated steady yet modest growth.

At the cognitive level, the Applying (L2) indicator exhibited significant growth, indicating an enhanced ability among students to transfer and apply mathematical knowledge in various contexts—an essential skill for effective problem-solving and reasoning in real-world situations. Initially promising, the growth in Reasoning (L3) experienced a significant deceleration in 2025. This outcome highlights the necessity for more targeted and ongoing initiatives to cultivate advanced cognitive skills such as abstraction, justification, and argumentation.

From a scientific perspective, particularly in the realm of competency-based learning and assessment, these findings contribute to the growing collection of evidence advocating for longitudinal evaluation systems in education. The observed differences in growth patterns across various cognitive levels and domains provide a valuable examination of the complex nature of mathematical development in elementary education. This study functions as a diagnostic resource for educational leaders and policymakers, emphasizing the importance of preserving essential skill development while also fostering a deeper grasp of concepts and enhancing reasoning capabilities.

b) Gap Analysis of Numeracy Skills (2023–2025)

The Gap Analysis results presented in Table 3 reveal important shifts in the relative performance of students across different content domains and cognitive levels over the three-year period. By examining these gaps, the study identifies areas where disparities in achievement persist, narrow, or widen, offering critical insight into the uneven development of numeracy skills within the school context.

Table 3: Gap Analysis Results

	Comparison	2023	2024	2025	Gap	Interpretation
Between Content Domains	Number compared to Algebra	-4.65	+16.59	+6.75	+11.40	Gap reversed from Algebra dominance to Number dominance
	Number compared to Geometry	-4.07	+13.51	+7.65	+11.72	Geometry initially dominant but overtaken by Number
	Algebra compared to Geometry	+0.58	-3.08	+0.90	+0.32	Gap relatively stable
Between Cognitive Levels	L1 compared to L3	+12.68	+4.16	+11.41	-1.27	Gap narrowed but remains significant
	L2 compared to L3	+1.15	+1.71	+8.86	+7.71	Gap widened significantly

Throughout the three years, the gap analysis reveals dynamic and intriguing trends in student performance across various content areas and cognitive levels. In the early part of 2023, the Algebra and Geometry domains showed superior performance compared to the Number domain. However, by 2024, there was a significant improvement in Number skills

that changed the trajectory, allowing the Number domain to maintain its leading position through 2025, even though the gap narrowed slightly. This change suggests that the slower progress in Algebra and Geometry highlights the necessity for targeted improvement initiatives in these subjects, while interventions based on data-driven planning have proven particularly effective in boosting students' proficiency in numerical skills. The achievement gap between Algebra and Geometry remained notably stable and narrow throughout the period, consistently within a four-point difference. This suggests persistent instructional challenges related to content complexity and the effectiveness of teaching methods. This stability indicates that improvement methods for Algebra and Geometry may be integrated, thereby tackling their common learning obstacles in a comprehensive manner.

The study indicates a notable enhancement in the development of higher-order thinking, evidenced by a positive reduction in the gap between Knowing (L1) and Reasoning (L3). The increasing gap between Applying (L2) and Reasoning (L3) underscores a significant challenge: while students are improving in their ability to apply knowledge, enhancing their reasoning skills remains a struggle. The findings underscore the significant necessity for instructional strategies specifically designed to enhance reasoning skills, thereby ensuring a well-rounded cognitive development in conjunction with fundamental and applied competencies.

These trends collectively present a nuanced understanding of the areas experiencing growth and those with ongoing disparities, thereby providing educators and policymakers with critical insights to enhance curriculum design, instructional methods, and professional development focused on both subject-specific knowledge and cognitive skill advancement.

c) Analysis of the Impact of PBD Interventions on Numeracy Achievement

Longitudinally, the efficacy of Data-Based Planning (PBD) interventions in increasing numeracy abilities is assessed and shows varying progress depending on cognitive level and numeracy domain. These interventions were executed using the cycle of Identification–Reflection–Improvement so that schools may respond to outcomes in the Education Report Card with context-specific and targeted projects.

Although other aspects of numeracy exhibited slower advances or even stagnation, generally the evaluation results demonstrate considerable increases in several of them. This implies that internal school elements, teacher preparedness, and the quality of the produced interventions greatly determine the success of interventions; it is not homogeneous. Table 4 summarizes the success degree in every area and cognitive level of numeracy, the proof of their impact on instructors and students, and the effectiveness of several PBD treatments.

Table 4: Effectiveness of PBD Interventions on Numeracy Enhancement (2023–2025)

Numeracy Aspect	Key Findings from Education Report Card	PBD Improvement Interventions	Evidence of Impact on Students	Evidence of Impact on Teachers	Effectiveness
Minimum Competency Achievement	Surge from 60% to 100% (2023-25)	AKM socialization, Basic training, Regular remedial	100% students passed AKM 2025, 40% score increase	90% teachers mastered AKM modules, 85% active in remedial sessions	Highly Effective
Number Domain	Rapid growth (↑31.29, 2023-24), then slowed (↑3.95, 2024-25)	Number workshops, Number kits	73.46% students mastered concepts	60% teachers skilled in teaching aids, 45% skilled in advanced applications	Effective
Algebra Domain	Steady growth (↑23.84, 2023-25), peak in 2025 (66.71)	Applied modules, STEM projects	78% students succeeded in projects	70% teachers skilled in STEM, 65% creative in question design	Moderately Effective

Numeracy Aspect	Key Findings from Education Report Card	PBD Improvement Interventions	Evidence of Impact on Students	Evidence of Impact on Teachers	Effectiveness
Geometry Domain	Stable increase (↑23.52, 2023-25) but lagging behind Number	GeoGebra training, Spatial exploration	65.81% students understood concepts	50% teachers proficient with digital tools, 40% skilled in visualization	Less Effective
Cognitive Level L1 (Knowing)	Consistent growth (↑22.73, 2023-25)	Interactive quizzes, Basic concept reviews	85% students active in quizzes, 72.60% mastered basic knowledge	80% teachers creative with media, 75% skilled in assessment	Very Effective
Cognitive Level L2 (Applying)	Good growth (↑31.71, 2023-25), tending to stagnate at the end	Contextual questions, Simulations	70.05% students achievement, 65% able to apply concepts	60% teachers skilled in L2 question design, 55% active in simulations	Effective
Cognitive Level L3 (Reasoning/HOTS)	Initial surge (↑21.34, 2023-24), stagnation in 2025 (↑2.66)	HOTS training, Development of analytical question banks	61.19% student achievement, 19% students demonstrated mastery of HOTS	20% teachers equipped in higher order thinking skills instruction, 15% proficient in the formulation of innovative analytical inquiries	Ineffective

The results in Table 4 indicate a significant enhancement, with the attainment of minimum competency criteria increasing from 60% to 100% during the 2023–2025 period. This achievement suggests that essential interventions—like AKM socialization, foundational teacher training, and consistent remedial programs—can yield extensive and noticeable outcomes. This highlights the significance of establishing a solid groundwork for enhancing numeracy through a clear understanding of national assessments and a strong commitment to remediation.

The effectiveness of treatments varied based on the specific area of study and the cognitive abilities involved. For instance, while there has been a promising rise, the number and algebra domains began to plateau in the past year. This suggests that both stable and adaptive measures are essential to maintain progress and prevent setbacks. The geometry domain has remained relatively underdeveloped, possibly due to insufficient teacher expertise with visual tools and digital platforms such as GeoGebra.

Cognitively, foundational (L1: Knowing) and practical (L2: Applying) skills demonstrated steady growth; however, higher-order thinking skills (L3: Reasoning/HOTS) experienced a significant stagnation in 2025. Only 15–20% of educators were prepared to develop innovative analytical tasks, while merely 19% of learners demonstrated mastery of higher-order thinking skills. This highlights a significant need for comprehensive teacher training that focuses on open-ended problem solving, reasoning, and analytical skills.

From an academic perspective, these findings bolster the hypothesis that instructional readiness and the sustainability of implementation play a crucial role in the effectiveness of educational interventions. This data-driven analysis further adds to the growing collection of studies emphasizing the importance of formative and adaptive assessments in fostering cognitive development across various levels of numeracy.

The findings serve as a valuable asset for lawmakers, educational institutions, and schools aiming to develop more context-sensitive and targeted numeracy initiatives. There needs to be a greater emphasis on improving teacher capabilities in education that prioritizes higher-order thinking skills, alongside the integration of digital tools. This approach will ensure

that the transformation in numeracy extends beyond fundamental competencies to foster the development of critical and logical thinking in Indonesian students.

Discussion

This study highlights significant progress in the development of essential numeracy skills among SDIT Al-Khoiriyah Al Husna students in the Number domain at the minimum competency level during the 2023–2025 period. The research integrates quantitative growth analysis with qualitative document evaluation through a mixed-methods explanatory sequential design to explore the dynamics of numeracy across various content domains (Number, Algebra, Geometry) and cognitive levels (Knowing, Applying, Reasoning). The observed improvements correspond with the implementation of structured, evidence-based strategies, such as ongoing remedial initiatives, AKM socialization, and educator training. The findings enhance broader national initiatives such as Kampus Mengajar, which have demonstrated measurable impacts on literacy and numeracy in primary education (Busyairi & Kusuma, 2024; Telaumbanua et al., 2024). They also reinforce previous studies highlighting the effectiveness of targeted, evidence-driven teaching methods in improving students' foundational skills (Guskey, 2014; Hattie, 2009).

However, as the program progressed, particularly in the Number domain and in Level 3 Reasoning (HOTS) competencies, the rate of improvement began to decline. Often observed in consistent learning trajectories, this potential plateau phenomenon highlights the necessity for more innovative, distinctive, and intellectually stimulating teaching approaches. The advancement of higher order thinking skills necessitates robust professional development, engaging problem-solving tasks, and ongoing instructional support (Anderson et al., 2001; Marzano & Kendall, 2007). Especially in advanced cognitive areas, deficiencies in educators' ability to create and execute such instruction exacerbate this issue.

The gap analysis reveals an instructional inconsistency: while the number domain has received the most consistent focus, progress in Algebra and Geometry remains limited. The observed differences likely stem from variations in instructional methods and the complexity of the content involved. Kilpatrick et al. (2001) argue that proficiency in numeracy requires tailored, content-specific strategies that address the conceptual demands of each discipline. This suggests that future PBD treatments must be more attuned to context, integrated, and responsive to both cognitive complexity and content.

Furthermore, it underscores the importance of teacher competency in the effectiveness of interventions, as highlighted by the qualitative study of PBD implementation cycles. Although structured methods—like interactive quizzes and AKM-related training—demonstrated effectiveness for foundational skills, more complex endeavors, such as HOTS training and the development of analytical item banks, produced less significant outcomes. This disparity underscores the argument that the effectiveness of PBD is largely contingent upon the capacity of human resources, particularly in terms of teachers' pedagogical and content knowledge. Literature indicates that the ability of practitioners to foster deeper learning outcomes (Darling-Hammond et al., 2017; Suprawata & Riastini, 2022) relies on ongoing professional development grounded in practice.

Moreover, the current stagnation in reasoning skills necessitates a renewed emphasis on active learning strategies, particularly problem-based learning (PBL). In HOTS domains (Qadri et al., 2023), integrating PBL and real-world problem-solving environments into numeracy education enhances student engagement and fosters cognitive growth. These pedagogies align with constructivist principles and are supported by empirical evidence regarding their impact on the advancement of higher order thinking skills.

The findings of this longitudinal study have practical implications for ensuring educational quality in integrated Islamic elementary schools. Prioritizing the development of educators is essential, particularly in equipping them with the necessary tools for fostering

higher-order thinking and effectively utilizing digital learning technologies. Secondly, employing a variety of innovative and flexible approaches, PBD interventions ought to be tailored to meet the specific needs of each numeracy domain and cognitive level. Third, recognizing emerging issues and adapting treatments requires the consistent implementation of monitoring, evaluation, and reflection cycles.

4. Conclusions

The execution of Data-Based Planning (PBD) at SDIT Al-Khoiriyah Al Husna throughout the 2023-2025 period has effectively facilitated notable advancements in students' numeracy skills, particularly in minimum competency attainment and the Number domain during the initial phase. Nonetheless, disparities in numeracy achievement persist across various content domains and cognitive levels, with the Number domain remaining predominant and an increasing gap observed between the Applying (L2) and Reasoning (L3) levels. This underscores the necessity for focused instructional approaches to enhance higher-order thinking skills (HOTS). The effectiveness of PBD interventions varies; straightforward and structured interventions yield notably effective outcomes, whereas those requiring significant pedagogical transformations, such as HOTS training, tend to be less effective.

To improve the effectiveness of PBD at SDIT Al-Khoiriyah Al Husna, several strategic recommendations are proposed. First, prioritizing teacher professional development is essential by strengthening teacher capacity through comprehensive training, ongoing mentoring, and skill enhancement, especially in HOTS instruction and the integration of educational technology. Second, PBD interventions should be enhanced by developing more targeted and cohesive strategies aligned with the distinct characteristics of content domains and cognitive levels, employing innovative and diverse methodologies. Third, ongoing evaluation and reflection are crucial; regular and systematic quality assessments must be conducted to identify obstacles and facilitate adaptive modifications to intervention strategies. Finally, creating adaptive and responsive PBD models that consider local contexts and learner characteristics is vital for maintaining relevance and sustainability in integrated Islamic elementary schools.

Limitation

The study was confined to a single educational institution, concentrating on the internally analyzed PBD data. Consequently, the results are not applicable to other educational contexts that possess varying attributes. Further research could focus on comparative studies between similar educational units in both private and public schools, as well as quantitative studies that integrate the analysis of Education Report cards with data on the learning process in the classroom. It is recommended that future investigations examine the incorporation of HOTS-based formative assessment methodologies within PBD documents to promote more effective advancements in Level 3 numeracy.

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