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Promoting Self-Regulation and Behavioral Discipline in Preschoolers Through Structured Number-Block Play

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ABSTRACT

Behavioral discipline and early self-regulation are foundational for young children's socio-emotional and cognitive development. Although block play is widely recognized for fostering early numeracy, its precise cognitive-behavioral mechanisms in enhancing behavioral discipline remain underexplored. This study investigates how structured number-block play fosters behavioral discipline and self-regulation among preschoolers through a collaborative Classroom Action Research (CAR) framework based on the Kemmis and McTaggart model. Conducted across two instructional cycles involving 19 preschool children (aged 4-5 years), the intervention systematically integrated spatial-mathematical tasks with small-group social scaffolding. Data were collected via structured behavioral observation protocols, semi-structured teacher interviews, and qualitative field notes. Rigorous psychometric evaluation, including inter-rater reliability testing using Cohen's Kappa ($\kappa = 0.86$), confirmed high observational fidelity. Results revealed a progressive increase in classical mastery of behavioral discipline indicators, rising from 36.84% ($n=7$) at baseline to 68.42% ($n=13$) in Cycle I, and reaching 89.47% ($n=17$) in Cycle II. The most pronounced growth was observed in frustration tolerance and turn-taking behavior, which surged following the transition from large-group to small-group instructional configurations. These findings demonstrate that structured block play serves as a cognitive bridge linking spatial-mathematical manipulation, inhibitory control, and executive function. This research provides pedagogical implications for early childhood educators seeking play-based, non-coercive interventions to cultivate self-regulation in early educational settings.

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1. INTRODUCTION

Self-regulation and behavioral discipline in early childhood constitute critical developmental milestones that function as robust predictors of long-term academic trajectories, socio-emotional competence, and adaptive functioning across the life course (Edossa et al., 2018; Nelson & Gabard-Durnam, 2020; Schmitt et al., 2025).

During the critical window of the preschool years, children experience accelerated neurodevelopmental reorganizations, particularly within the prefrontal cortex networks that govern executive functions (EF)—encompassing inhibitory control, working memory, and cognitive flexibility (Muir et al., 2023). Within contemporary early childhood education, behavioral discipline is conceptualized not as passive compliance or authoritarian subordination, but as the progressive internalization of autonomous self-regulation, task persistence, cooperative rule adherence, and emotional impulse modulation (Alam, 2022; Day et al., 2022; Dutta, 2026). Establishing these foundational self-regulatory capacities early in life provides a cognitive buffer that mitigates future learning vulnerabilities and promotes optimal psychological adjustment (Robson et al., 2020; Stucke & Doebel, 2024).

Despite the recognized significance of self-regulation, systematic classroom observations frequently reveal pervasive disparities in children's self-regulatory proficiencies upon entry into formal schooling environments. Preschool educators consistently report substantial behavioral management hurdles, including low impulse thresholds, profound difficulties in maintaining turn-taking equity, heightened peer friction over shared learning materials, and premature task abandonment under mild cognitive strain (Van den Akker et al., 2024). Traditional pedagogical responses have historically relied on extrinsic behavior modification systems, such as token economies, direct verbal reprimands, and teacher-centric disciplinary edicts (Drake & Nelson, 2021). However, mounting empirical consensus indicates that purely coercive or externally enforced behavioral controls fail to foster genuine self-regulation internalization and may inadvertently exacerbate frustration intolerance and diminish intrinsic motivation among young learners (Bartholomew et al., 2018; Harma et al., 2025).

To bridge this pedagogical divide, play-based learning paradigms have emerged as developmentally appropriate, ecologically valid mechanisms for cultivating early regulatory competence (Lunga et al., 2022; Mohammed et al., 2026). Among diverse instructional modalities, block play has historically been lauded for its profound efficacy in advancing spatial cognition, geometry comprehension, and early mathematical reasoning (Schmitt et al., 2025; Şeker, 2020). Nevertheless, a critical conceptual and empirical blind spot persists within the contemporary literature: while extensive scholarship has robustly documented the cognitive and numerical outcomes of general block play (Cai et al., 2022; Schmitt et al., 2025), significantly fewer investigations have systematically unpacked the precise micro-level cognitive-behavioral mechanisms through which structured number-block play directly recruits executive functions to restructure and fortify classroom behavioral discipline.

Number blocks occupy a distinctive pedagogical niche as a hybrid manipulative that seamlessly bridges concrete mathematical symbolism with physical, constructive engineering tasks (Munif et al., 2022; Schmitt et al., 2018). Engaging in structured number-block activities requires young children to actively encode numerical parameters in working memory, suppress impulsive urges to disrupt construction sequences, plan multi-step architectural blueprints, and negotiate shared physical space

with peers (Schmitt et al., 2025; Trawick-Smith et al., 2017; Yang et al., 2022). This intersection suggests that structured number-block engagement transcends isolated mathematical instruction; rather, it functions as a dynamic cognitive-behavioral crucible that demands high-level inhibitory control, delay of gratification, and rule-governed action. Consequently, the structural constraints inherent in number-block tasks serve as an organic scaffold for transforming external regulatory expectations into internal psychological self-control.

Methodologically and theoretically, addressing this developmental phenomenon necessitates an integrated synthesis of classical learning paradigms and modern cognitive theories. Rooted in a triad of Piagetian constructivism (Waite-Stupiansky, 2022), Vygotskian socio-cultural scaffolding (Peker et al., 2024), and refined behavioral reinforcement frameworks (Narvekar et al., 2020), this research conceptualizes self-regulation as a socially mediated and constructed achievement. Vygotsky's zone of proximal development (ZPD) posits that peer collaboration and adult mediation during structured play provide the necessary scaffolding for children to internalize external behavioral norms (Eun, 2019; Vu Huy Tran, 2022). Concurrently, constructivist perspectives emphasize that children must actively manipulate physical objects to organize internal cognitive schemas, making structured manipulatives an ideal medium for translating abstract disciplinary expectations into concrete, habituated behavioral patterns (Beloluts kaya et al., 2020).

Driven by these theoretical imperatives and empirical gaps, this study aims to examine the implementation and efficacy of structured number-block play as a targeted pedagogical intervention for fostering early behavioral discipline. By deploying a rigorous methodological design, this research systematically evaluates how mediated, small-group number-block activities impact five distinct operational indicators of classroom discipline:

1. rigorous adherence to activity rules,
2. accurate responsiveness to instructional directives,
3. sustained patience during turn-taking sequences,
4. robust persistence through task completion challenges, and
5. conscientious stewardship over shared educational media and resources.

Ultimately, this study seeks to advance both theoretical models of executive function development and practical intervention strategies for early childhood educators.

2. METHOD

This study employed a collaborative Classroom Action Research (CAR) framework based on the iterative model developed by Kemmis et al. (2014). The CAR paradigm was selected because it enables practitioners to systematically evaluate, reflect upon, and refine instructional interventions within real-world classroom settings (Francisco et al., 2024). The research was conducted in an established preschool classroom over two distinct instructional cycles during the 2025/2026 academic year. Each cycle comprised four interrelated phases: planning, acting, observing, and reflecting.

The study involved a cohort of 19 preschool children ($N = 19$; 9 boys and 10 girls, aged 4–5 years) enrolled in Group A at TK Komunitas Menara, Gowa, South Sulawesi, Indonesia. Baseline diagnostic observations indicated widespread challenges in behavioral self-regulation, peer sharing, and rule adherence. Institutional approval was secured prior to study commencement, and informed consent was obtained from parents/guardians alongside verbal assent from all participating children.

The intervention systematically replaced unstructured play sessions with structured number-block learning tasks designed to engage executive functioning skills. The five-stage pedagogical sequence was structured as follows:

- Preparation Phase: Selection and hygienic organization of multi-colored, concrete number blocks containing distinct numerical and spatial representations.
- Orienting Phase: Concrete teacher-led demonstrations linking physical block attributes to explicit social rules (e.g., rules of sharing, turn-taking sequences).
- Action Phase: Interactive play where children perform tasks requiring numerical matching, block stacking, and cooperative pattern completion under specific behavioral constraints.
- Scaffolding Phase: Guided teacher intervention providing behavior-specific praise (Drake & Nelson, 2021) and mediated problem-solving when peer conflicts or frustration arose (Montoya et al., 2023).
- Evaluation & Consolidation Phase: Structured post-activity reflection and collective stewardship routines (e.g., sorting and storing media collaboratively).

In Cycle I, activities were implemented in large-group settings ($n=19$). Based on Cycle I reflections, Cycle II refined the intervention by reconfiguring children into small cooperative learning clusters (3–4 children per group) to minimize resource competition and shorten waiting periods.

Data were gathered through a multi-method diagnostic framework:

- Observational Protocols: Systematic rubrics measuring five operational indicators of discipline on a 4-point scale: 1 = Not Yet Developed (BB), 2 = Starting to Develop (MB), 3 = Developing as Expected (BSH), and 4 = Developing Very Well (BSB).
- Inter-Rater Reliability: To control for potential observer bias, independent simultaneous observations were conducted by the lead teacher-researcher and an independent peer observer (St. Ramlah). Inter-rater agreement was calculated using Cohen's Kappa, yielding an empirical estimate of $\kappa = 0.86$, indicating high inter-observer consistency.
- Qualitative Artifacts: Semi-structured educator interviews, qualitative field vignettes capturing real-time behavioral shifts, and pedagogical documentation logs.

Quantitative observational data were evaluated by calculating percentage mastery per indicator and classical group mastery (PK), where mastery was defined as achieving category BSH or BSB (score ≥ 3). The classical mastery benchmark was established at $\geq 80\%$. Qualitative data from field notes and interviews underwent thematic condensation, data display, and triangulated member-checking.

3. RESULTS AND DISCUSSION

Results

Baseline Diagnostics (Pre-Intervention Phase)

Initial baseline diagnostic assessments conducted during the pre-intervention phase revealed profound self-regulatory deficits pervasive across the entire cohort. As synthesized in Table 1, a mere 7 out of 19 participants (36.84%) successfully met the established empirical threshold for classical behavioral discipline mastery. Qualitative and quantitative observational metrics further demonstrated that the cohort suffered from pronounced executive functioning impairments, characterized predominantly by diminished inhibitory control, frequent disruptions during pedagogical delivery, and an acute reluctance to cooperate or equitably share limited physical manipulative resources.

These baseline pathologies underscore a critical developmental vulnerability in early self-regulatory competence, corroborating prior literature emphasizing that unstructured environments exacerbate peer-to-peer friction and pedagogical disengagement. The exceptionally low mastery rate (36.84%) establishes a robust empirical floor, confirming that conventional classroom management strategies are inadequate for cultivating sustained behavioral regulation without targeted, evidence-based intervention architectures. Consequently, these findings validate the exigency of a structured, longitudinal pedagogical framework designed to systematically scaffold impulse control and prosocial peer negotiation skills.

Tabel 1. Pre-Intervention Phase

No.	Operational Indicator	Pre-Intervention (n, %)
1	Adhering to Activity Rules	6 (31.58%)
2	Following Instructional Directives	8 (42.11%)
3	Displaying Turn-Taking Patience	5 (26.32%)
4	Demonstrating Task Persistence	8 (42.11%)
5	Shared Media Stewardship	7 (36.84%)
Total	Classical Mastery Threshold ($\geq$ BSH)	7 (36.84%)

Note. $N = 19$ represents the total cohort of 4-year-old participants. BSH (*Berkembang Sesuai Harapan*) denotes the benchmark threshold for developmental and behavioral mastery in early childhood education frameworks.

Cycle I Implementation Outcomes

During Cycle I, structured number-block activities were introduced within whole-class configurations. Observational data indicated notable progress, with classical mastery increasing to 68.42% ($n=13$). As outlined in Table 1, indicators such as "Following Instructional Directives" and "Task Completion Persistence" demonstrated rapid gains, reaching 73.68%. However, "Turn-Taking Patience" lagged at 57.89%, primarily due to long waiting times inherent in large-group formats which exceeded the frustration tolerance thresholds of 4-year-olds.

Table 2. Summary of Behavioral Indicators and Mastery Levels During Cycle I

Performance Indicator / Behavioral Metric	Achievement (%)	Participant Proportion	Observational Context & Pedagogical Notes
Classical Behavioral Discipline Mastery	68.42%	13/19	Achieved through structured number-block activities within whole-class configurations.
Following Instructional Directives	73.68%	—	Demonstrated rapid progressive gains in compliance with teacher-led instructions.
Task Completion Persistence	73.68%	—	Exhibited extended focus duration during foundational mathematical tasks.
Turn-Taking Patience	57.89%	—	Lagged due to prolonged waiting times in large-group formats, exceeding the frustration thresholds of 4-year-olds.

Note. $N = 19$ represents the total cohort of 4-year-old participants. Percentages reflect observational evaluations recorded at the culmination of the Cycle I intervention phase.

Cycle II Implementation Outcomes and Small-Group Optimization

Cycle II addressed the structural limitations of Cycle I by transitioning to small-group learning clusters (3–4 children per cluster) and enhancing behavior-specific praise. This modification resulted in dramatic improvements across all behavioral metrics, raising classical mastery to 89.47% ($n=17$) and exceeding the 80% success benchmark.

Table 3. Cross-Cycle Evaluation of Behavioral Discipline Indicators ($N = 19$)

No.	Operational Indicator	Pre-Intervention (n, %)	Cycle I (n, %)	Cycle II (n, %)
1	Adhering to Activity Rules	6 (31.58%)	13 (68.42%)	18 (94.74%)
2	Following Instructional Directives	8 (42.11%)	14 (73.68%)	17 (89.47%)
3	Displaying Turn-Taking Patience	5 (26.32%)	11 (57.89%)	17 (89.47%)
4	Demonstrating Task Persistence	8 (42.11%)	14 (73.68%)	18 (94.74%)
5	Shared Media Stewardship	7 (36.84%)	12 (63.16%)	17 (89.47%)
Total	Classical Mastery Threshold ($\geq$ BSH)	7 (36.84%)	13 (68.42%)	17 (89.47%)

Overall, the implementation of small-group-based interventions and behavior-specific praise proved highly effective in overcoming self-regulatory deficits in early childhood, as reflected by the surge in classical mastery rates from a pre-intervention baseline of 36.84% ($n = 7$) to 89.47% ($n = 17$) by Cycle II. This transformation in instructional configuration successfully surpassed the established 80% success benchmark while simultaneously demonstrating that restructuring the classroom from large-group formats into small clusters (3–4 children) significantly mitigates frustration, enhances turn-taking patience, and optimizes the attainment of all behavioral discipline indicators.

Qualitative Field Vignettes: Behavioral Transformation Patterns

Qualitative observation records across the intervention cycles vividly illustrate profound behavioral transitions in the participants' self-regulatory capacities. Vignette A details the developmental trajectory of Child AR, who initially exhibited severe self-regulatory challenges during baseline assessments by aggressively grabbing blocks from peers and experiencing emotional meltdowns when instructed to wait. Although AR continued to struggle with large-group distribution during Cycle I, the structural shift to a four-child block-building cluster requiring sequential number matching in Cycle II yielded a striking transformation. Specifically, AR was observed calmly observing a peer place block '3' before patiently picking up block '4' and verbalizing, "My turn now for four!", thereby demonstrating advanced executive function, impulse control, and internalized turn-taking patience.

Complementing individual cognitive-behavioral shifts, Vignette B highlights collective internalization and media stewardship achieved by the broader cohort during the culmination of Cycle II. Upon hearing the designated transition signal, 17 out of the 19 children autonomously ceased construction, systematically sorted the blocks according to color and number sequences, and independently returned the materials to storage bins without requiring individual teacher prompts. This collective behavioral mastery underscores how scaffolded small-group environments effectively foster generalized prosocial habits, transforming classroom management from external coercion into self-directed executive routines that satisfy rigorous international early childhood education benchmarks.

Discussion

The empirical findings confirm that structured number-block play substantially improves early childhood behavioral discipline and self-regulation. The trajectory of classical mastery—rising from 36.84% to 68.42% in Cycle I and culminating in 89.47% in Cycle II—provides convincing evidence of the intervention's efficacy. More importantly, this study elucidates the cognitive-behavioral mechanisms underlying this growth.

Cognitive Mechanisms: Block Play as an Executive Function Trainer

The observed improvements robustly support constructivist and neurodevelopmental frameworks asserting that concrete manipulative play builds executive functioning (Nelson & Gabard-Durnam, 2020). Unlike abstract worksheets, number blocks require children to operate simultaneously in physical, spatial, and rule-governed domains (Şeker, 2020). Inhibitory control—the core component of behavioral discipline—is directly engaged when a child must hold back the impulse to knock over a tower or snatch a block, aligning with recent empirical trials by Schmitt et al. (2025) and Cai et al. (2022).

Furthermore, holding the numerical goal in working memory while suppressing impulsive actions provides continuous operational practice for prefrontal neural networks (Muir et al., 2023). This sustained dual-processing demand activates core

regulatory loops, ensuring that young learners constantly negotiate between physical manipulation and structural rules. Consequently, the act of balancing and sorting blocks moves beyond mere physical recreation to serve as a rigorous mental workout for developing cognitive control systems.

Ultimately, this dual-processing cognitive demand bridges the gap between tactile engagement and structural self-regulation, demonstrating how concrete pedagogical tools effectively fortify the neural architecture underlying early childhood behavioral control. By systematically merging tactile interaction with deliberate goal maintenance, block play establishes a foundational framework that optimizes long-term neurocognitive development and academic readiness.

Socio-Behavioral Mechanisms: Scaffolding and Environmental Structuring

The substantial surge in turn-taking patience (from 57.89% to 89.47%) following the shift to small-group structures in Cycle II highlights the critical role of environmental moderation and Vygotskian social scaffolding (Puntambekar, 2022). Large-group settings place excessive demands on early self-regulation by extending delay-of-gratification periods far beyond normal developmental limits for young learners. In contrast, small cooperative groups optimize the "Zone of Proximal Development" by providing frequent turns, intense peer modeling, and immediate feedback (Montoya et al., 2023).

Furthermore, structuring these intimate peer interactions alters the interpersonal dynamic, turning shared play spaces into collective regulatory platforms. Within these settings, children actively monitor each other's compliance and internalize social norms through observational learning, which significantly lowers the cognitive load associated with impulse control and delay management.

Building upon this social dynamic, teacher delivery of behavior-specific praise provided positive reinforcement that cemented rule-governed behaviors, effectively validating behaviorist paradigms regarding consistent environmental feedback (Drake & Nelson, 2021; Van den Akker et al., 2024). Ultimately, this socio-behavioral alignment demonstrates that systematically structuring physical and social classroom environments reduces cognitive friction, enabling young learners to successfully meet rigorous behavioral expectations.

Study Limitations

Several methodological constraints warrant explicit acknowledgment when interpreting these findings. First, as a Classroom Action Research study conducted with a single cohort ($N = 19$), external validity and statistical generalizability remain inherently bounded to similar early childhood educational settings. Second, although inter-rater reliability was tightly controlled ($\kappa = 0.86$), the dual role of the primary author as both instructor and researcher introduces potential halo or Hawthorne effects that must be considered when evaluating behavioral shifts.

Furthermore, the short-term nature of the action research cycles precludes evaluating the longitudinal retention of these self-regulatory gains over extended developmental

timeframes. Future investigations should address these limitations by employing larger, more diverse quasi-experimental samples, utilizing independent observers to mitigate researcher bias, and incorporating longitudinal follow-ups to verify the sustained impact of block-play interventions.

4. CONCLUSION

This study provides robust empirical evidence that structured number-block play functions as a transformative pedagogical intervention, significantly advancing self-regulation and behavioral discipline among young learners. By transcending conventional paradigms that position block play exclusively as a tool for mathematical cognition, this research demonstrates that mediated manipulative activities actively stimulate executive function networks, fortify inhibitory control, and foster cooperative peer dynamics. The intentional transition from traditional whole-class instruction to scaffolded small-group play clusters—coupled with targeted teacher guidance and behavior-specific reinforcement—proves instrumental in cultivating children's frustration tolerance, impulse modulation, and turn-taking capabilities. These findings validate a socio-cultural constructivist framework, underscoring that internalized discipline emerges organically when external behavioral expectations are embedded within meaningful, socially mediated problem-solving contexts.

Building upon these insights, future implementation requires a strategic paradigm shift across policy, practice, and institutional leadership within early childhood education. Educators should systematically integrate structured manipulative play into daily classroom routines, replacing punitive disciplinary models or passive compliance measures with play-based self-regulation strategies. Concurrently, school administrators must invest in high-quality educational resources while prioritizing professional development programs that equip teachers with advanced scaffolding techniques. To build upon these foundational contributions, subsequent investigations should utilize rigorous experimental or quasi-experimental designs with larger, demographically diverse samples ($N > 100$), incorporate randomized control groups, and implement longitudinal tracking to examine the long-term retention of executive function gains as children transition into formal primary schooling.

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