Asian Journal of Assessment in Teaching and Learning
Vol 16, Issue 1, 2026 (28-45) /eISSN 2821-2916

Project-Oriented Approaches in Developing Early Number Operation Skills: A Recent Systematic Review

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Received: 23 April 2026; **Revised**: 18 May 2026
Accepted: 23 May 2026; **Published**: 07 June 2026

To link to this article: https://doi.org/10.37134/ajatel.vol16.1.3.2026

Abstract

Early number operation skills are fundamental to children's mathematical development and later academic achievement. Although innovative pedagogical practices in early childhood education continue to expand, evidence regarding the role of project approaches in supporting early number operation skills remains distributed across different educational and intervention contexts. Existing studies frequently examine project-oriented learning, early numeracy interventions, developmental factors, and assessment practices separately, limiting a comprehensive understanding of their contribution to early mathematics learning. Therefore, this study systematically reviewed literature related to project approaches in developing early number operation skills. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. Literature searches were conducted using the Scopus and ERIC databases through multiple search strings derived from keywords associated with project approaches, early numeracy, and number operation development. The review was limited to studies published between 2020 and 2026. Following identification, screening, eligibility, and quality appraisal procedures, 37 primary studies were retained for final synthesis. Findings derived from thematic synthesis revealed three major themes: (1) Project-Oriented Pedagogical Practices and Learning Contexts, (2) Early Numeracy Interventions and Instructional Approaches, and (3) Assessment, Developmental Factors and Mathematical Learning Outcomes. Overall, the findings suggest that project-oriented learning environments, supported by effective instructional and assessment practices, contribute positively to the development of early number operation skills in early childhood education.

Keywords: *Project Approach, Early Number Operation, Early Numeracy, Preschool Mathematics, Systematic Literature Review*

INTRODUCTION

Early number operation skills constitute an essential foundation in children's mathematical development because they support understanding of quantity, numerical relationships, comparison, counting principles, and early arithmetic reasoning. Foundational numerical competencies developed during early childhood have been widely recognised as important predictors of later mathematics achievement and broader academic performance. Early number sense and numerical understanding are not limited to counting procedures but involve conceptual knowledge, flexible reasoning, and meaningful interpretation of mathematical relationships, including numerical relations and magnitude understanding that contribute to broader mathematical development (Verkerk et al., 2026). Contemporary evidence increasingly recognises that foundational mathematical competencies developed during preschool years function as important predictors of later mathematics achievement

and school readiness, particularly among children at risk of mathematical learning difficulties or educational disadvantage (Beliakoff et al., 2025; Verkerk et al., 2026). Consequently, early mathematics education increasingly emphasises the development of conceptual understanding and mathematical sense-making rather than isolated procedural calculation skills.

The development of numerical understanding among young learners occurs gradually through interactions involving language, concrete experiences, symbolic representation, social participation, and meaningful learning opportunities. Contemporary early childhood education therefore increasingly advocates active, exploratory, and learner-centred approaches capable of supporting children's engagement with mathematical ideas in authentic contexts. Within this perspective, project-oriented pedagogies have increasingly attracted scholarly attention due to their emphasis on inquiry processes, contextual exploration, collaborative interaction, and experiential engagement. Project-oriented learning environments potentially create opportunities for children to develop mathematical understanding through active participation and meaningful experiences situated within real-life contexts. Evidence from recent studies suggests that project-based and experiential educational activities may strengthen logical thinking, collaborative participation, creativity, and conceptual understanding among young learners (Metin et al., 2025; Rodríguez Rodríguez et al., 2024). Similar findings have also indicated that project-oriented practices in early learning environments support opportunities for investigation, interaction, and meaningful engagement that extend beyond traditional instructional practices (Haatainen & Aksela, 2021; Ward & Damjanovic, 2020).

Previous literature has highlighted the educational importance of active and experience-based instructional practices in strengthening children's early mathematical development. Research involving multimodal and interactive instructional approaches suggests that storytelling, games, visual representations, movement-based activities, manipulatives, and collaborative experiences may contribute positively to children's understanding of number concepts and numerical relationships (Almulhim & Fujita, 2026; Jylänki et al., 2023; Perini et al., 2024). Numeracy development also appears strongly influenced by learning environments within classrooms and home contexts that shape children's opportunities for mathematical participation and conceptual growth. Meaningful numeracy experiences involving social interaction and home-supported learning activities have been shown to contribute to children's mathematical engagement and conceptual development across diverse educational settings (Besser et al., 2025; Linder et al., 2026; Luomaniemi et al., 2021). Such findings indicate that early number operation learning is influenced not only by content exposure but also by the quality of instructional experiences and the extent to which mathematical ideas are embedded within meaningful and engaging learning situations.

Despite increasing scholarly interest in project-oriented and activity-based pedagogies in early childhood education, remains relatively limited and distributed across multiple interconnected domains. Existing studies are frequently distributed across multiple but interconnected domains including number sense development, early numeracy interventions, developmental predictors, instructional practices, assessment systems, and broader pedagogical research (Beliakoff et al., 2025; Gökçe et al., 2023; Lesner et al., 2025). Although many studies do not explicitly implement project approaches as formal pedagogical models, several demonstrate characteristics aligned with project-oriented learning, including collaborative engagement, contextualised activities, and learner-centred participation (Haatainen & Aksela, 2021; Rodríguez Rodríguez et al., 2024; Ward & Damjanovic, 2020). Such fragmentation creates challenges in understanding how current evidence collectively contributes to the pedagogical foundations of project-oriented early mathematics learning. More importantly, fragmented evidence may limit the development of coherent pedagogical guidance for educators attempting to integrate project-oriented practices into early mathematics instruction.

This fragmentation also limits understanding regarding the cognitive foundations, instructional characteristics, and assessment approaches that support early number operation development in meaningful learning environments. Existing literature often examines these elements separately, resulting in limited synthesis of how these interconnected factors collectively contribute to project-oriented mathematics learning. Therefore, a systematic synthesis of current empirical evidence is necessary to identify recurring developmental patterns, instructional principles, and assessment practices associated with early number operation learning.

In response to these research gaps, the present study undertakes a Systematic Literature Review (SLR) of recent empirical research related to project approaches in developing early number operation skills among preschool and early primary learners. Guided by the PRISMA protocol, the review synthesises studies published between 2020 and 2026 and examines evidence associated with cognitive

and developmental foundations, instructional approaches, and assessment practices relevant to early mathematics learning. Rather than restricting the review exclusively to studies formally labelled as project approaches, broader evidence related to project-oriented pedagogical characteristics was also considered to establish a more comprehensive understanding of pedagogical foundations associated with meaningful early mathematics learning environments.

Figure 1 presents the conceptual framework guiding the present review. The framework was developed based on recurring patterns identified across the reviewed literature concerning the development of early number operation skills among preschool and early primary learners. The framework also served as an analytical structure guiding thematic categorisation and interpretation during evidence synthesis. Rather than positioning project approaches as a single isolated instructional method, the framework conceptualises project-oriented mathematics learning as being supported through interconnected cognitive, pedagogical, and assessment-related dimensions emerging from the synthesis of current evidence (Beliakoff et al., 2025; Haatainen & Aksela, 2021; Lesner et al., 2025). The framework should be interpreted as an analytical representation of recurring relationships identified across reviewed studies rather than a causal developmental sequence.

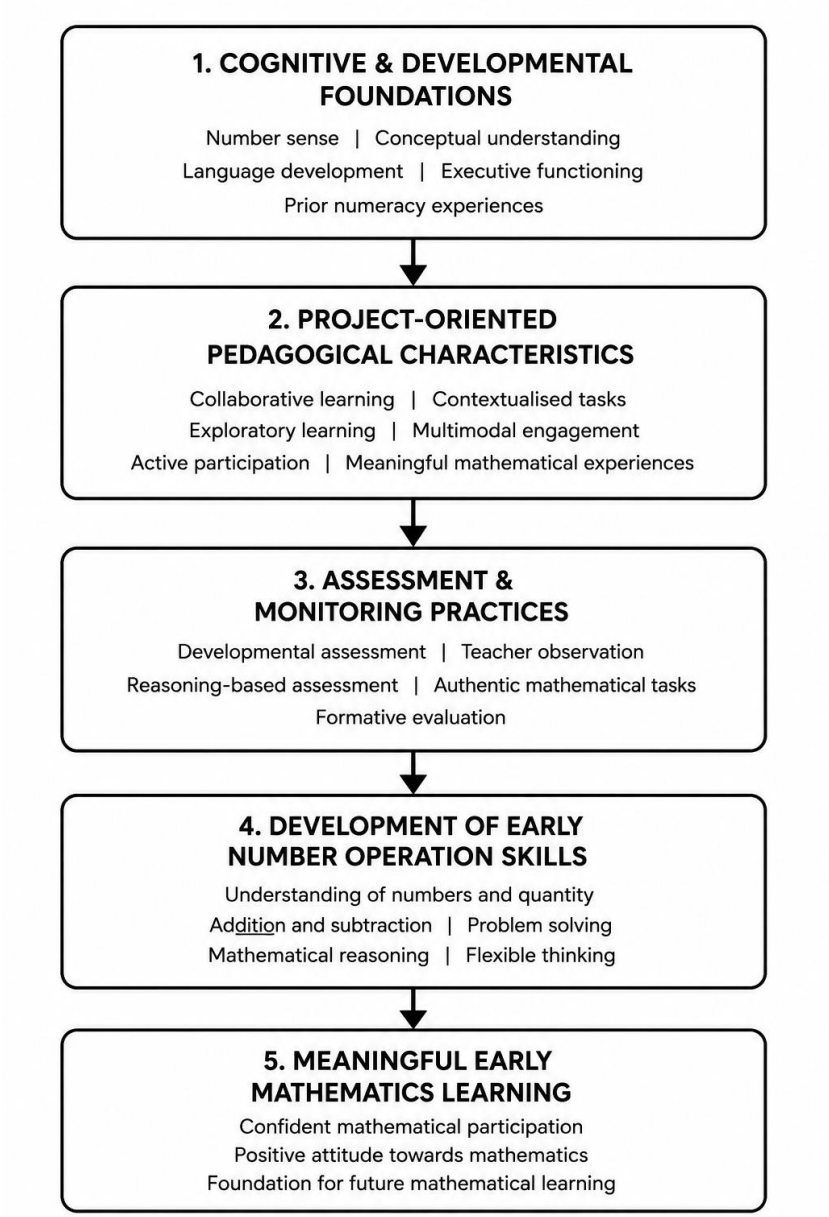

Figure 1 Conceptual framework of project-oriented learning dimensions supporting early number operation development

The first dimension involves cognitive and developmental foundations, including number sense, conceptual understanding, executive functioning, language-related processes, and prior numeracy experiences that influence children's mathematical learning readiness. Previous studies indicate that foundational numerical competencies and magnitude understanding function as important predictors of later mathematics development and intervention responsiveness (Beliakoff et al., 2025; Gökçe et al., 2023; Lesner et al., 2025). The second dimension focuses on pedagogical characteristics associated with project-oriented learning, including collaborative interaction, contextualised mathematical activity, exploratory engagement, multimodal learning experiences, and active learner participation. Such pedagogical features frequently emerge in studies examining project-oriented and inquiry-based learning environments in early childhood contexts (Haatainen & Aksela, 2021; Rodríguez Rodríguez et al., 2024; Ward & Damjanovic, 2020). The third dimension highlights the importance of assessment and monitoring practices, including developmental assessment, teacher observation, authentic mathematical tasks, and reasoning-oriented evaluation approaches that support children's mathematical

progress within meaningful learning contexts (Ellis & Davis-Kean, 2024; Gökçe et al., 2023; Park & Nelson, 2022).

Collectively, these dimensions suggest that early number operation development may emerge through the interaction between developmental readiness, pedagogical experiences, and assessment support. The framework therefore serves as an interpretative structure for understanding how existing empirical evidence may inform the pedagogical foundations of project-oriented early mathematics learning and provides a conceptual basis for organising evidence within the current evidence synthesis.

RESEARCH QUESTION

Research concerning early number operation skills is frequently distributed across multiple but interconnected domains, including cognitive development, instructional practices, intervention studies, and assessment approaches. At the same time, project-oriented learning in early childhood education increasingly emphasises meaningful engagement, collaborative exploration, contextualised learning, and learner-centred mathematical experiences. Such conceptual diversity creates challenges in understanding how existing evidence collectively contributes to the pedagogical foundations of project-oriented learning in developing early number operation skills. Consequently, a systematic review was required to synthesise current evidence and identify recurring patterns related to cognitive foundations, instructional characteristics, and assessment practices associated with meaningful early mathematics learning environments.

To guide the evidence synthesis process systematically, the Population, Interest, and Context (PICo) framework was employed in developing the research questions (Lockwood et al., 2015). The PICo framework is considered appropriate for exploratory evidence synthesis because it facilitates the identification of conceptual relationships, pedagogical characteristics, and contextual patterns across diverse educational studies. Guided by this framework, the present review addresses the following research questions:

RQ1: What cognitive and developmental factors support the development of early number operation skills among preschool and early primary learners in contexts relevant to project-oriented mathematics learning?
RQ2: What instructional approaches and pedagogical characteristics align with project-oriented learning in developing early number operation skills among young learners?
RQ3: What assessment approaches and measurement practices are used to evaluate early number operation skills within meaningful and activity-based early mathematics learning environments?

MATERIALS AND METHOD

The present systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency, methodological consistency, and systematic reporting throughout the review

process (Page et al., 2021). The use of PRISMA provides a structured and reproducible framework that supports the identification, screening, selection, and synthesis of relevant studies while reducing potential bias during evidence synthesis. Given the fragmented nature of literature concerning project approaches in developing early number operation skills, a systematic review protocol was considered essential to organise and evaluate evidence originating from diverse but conceptually related research domains. To improve the breadth and quality of evidence retrieval, two established educational databases, namely Scopus and ERIC, were employed due to their extensive coverage of peer-reviewed literature in education, early childhood studies, and instructional research.

Following PRISMA procedures, the review process consisted of four sequential stages: identification, screening, eligibility, and data extraction. During the identification stage, systematic searches were performed using multiple search strategies designed to retrieve both direct and indirect evidence relevant to project-oriented mathematics learning and early number operation development. Subsequently, predetermined inclusion and exclusion criteria were applied during screening to remove duplicate and irrelevant records. The remaining studies then underwent full-text assessment during the eligibility stage to determine conceptual relevance and methodological suitability. Finally, the data extraction stage involved the systematic organisation and synthesis of key study characteristics and findings. The staged procedure provided a more systematic structure for organising evidence retrieved from diverse educational studies and strengthened consistency during the review process.

1. Identification Stage

During the identification stage, literature searches were conducted using two established databases, namely Scopus and ERIC, due to their extensive indexing of peer-reviewed educational research and early childhood studies. Given the interdisciplinary and conceptually diverse nature of literature concerning in developing early number operation skills, multiple complementary search strategies were employed to improve conceptual coverage and retrieval sensitivity. Three search strings were developed to capture both direct and indirect evidence related to project-oriented mathematics learning, including project-based pedagogies, project-related educational practices, and broader instructional and numeracy-focused studies. This approach was intended to maximise retrieval sensitivity while reducing the likelihood of overlooking potentially relevant studies distributed across diverse educational and pedagogical contexts. The search process identified 337 records from Scopus and 35 records from ERIC, resulting in a total of 372 publications.

The use of multiple search strings was considered necessary because preliminary searches indicated that studies explicitly examining project approaches in early mathematics learning remained relatively limited. Therefore, broader pedagogical and instructional terms were incorporated to reduce the possibility of overlooking potentially relevant studies. Although not all retrieved studies explicitly implemented project approaches, many demonstrated pedagogical characteristics conceptually associated with project-oriented learning environments, including collaborative exploration, learner-centred engagement, contextualised mathematical activity, and active participation. To ensure conceptual consistency during article selection while maintaining broader evidence coverage, studies were retained if they demonstrated at least one pedagogical characteristic associated with project-oriented learning, including collaborative engagement, contextualised activities, inquiry processes, active participation, or authentic mathematical experiences. Table 1 presents the predetermined inclusion and exclusion criteria used to filter retrieved records.

Table 1 Study selection criteria

Criterion	**Inclusion**	**Exclusion**
Language	English	Non-English
Time Line	2020 – 2026	< 2020
Literature Type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject	Social Science	Besides Social Science

2. Screening Stage

Following the identification stage, duplicate records identified across databases were first examined and removed prior to screening procedures. A total of three duplicate records were identified and excluded, resulting in the remaining records proceeding to the screening stage. Subsequently, titles, abstracts,

publication information, and document characteristics were systematically examined according to predetermined inclusion and exclusion criteria. Studies published in languages other than English, published before 2020, categorised as conference proceedings, books, review articles, or identified as in-press publications were excluded to ensure consistency and focus on recent peer-reviewed empirical evidence.

Following the application of these screening criteria, a total of 284 records were excluded. Consequently, 85 studies remained for further evaluation. The substantial reduction at this stage reflects the broad and interdisciplinary nature of literature associated with early mathematics and project-oriented educational research. While broader search strategies improved retrieval sensitivity and reduced the likelihood of overlooking potentially relevant studies, they also increased the retrieval of studies sharing similar terminology but differing substantially in educational focus, pedagogical orientation, and conceptual relevance.

3. Eligibility Stage

The remaining studies subsequently proceeded to the eligibility phase, during which full-text articles were assessed to determine conceptual relevance and methodological suitability for inclusion in the review. A total of 85 full-text articles were successfully retrieved and underwent detailed assessment. This phase represented a more in-depth evaluation process because broader search strategies had intentionally retrieved literature from diverse but interconnected educational domains, including early numeracy interventions, pedagogical practices, instructional studies, and number sense development.

During the full-text assessment process, 48 studies were excluded for several reasons, including studies outside the intended scope of early mathematics education, limited conceptual relevance, research objectives not aligned with the aims of the review, and inaccessible full-text publications. The substantial reduction at this stage reflected the broad and interdisciplinary nature of literature related to project-oriented learning and early mathematics education. Although broader search strategies increased retrieval sensitivity, they also increased the likelihood of identifying studies with shared terminology but limited alignment with the specific objectives of the present review. This stage was particularly important because broader search procedures had intentionally retrieved studies from multiple educational domains, many of which shared similar terminology but differed conceptually. Following the eligibility assessment, 37 studies were retained and included in the qualitative synthesis stage.

4. Data Extraction and Analysis

The primary analytical approach employed in this review was an integrative analysis method, as it provides a systematic procedure for examining and synthesising evidence derived from diverse empirical research designs. This approach was considered appropriate due to the broad and interdisciplinary nature of literature concerning project approaches and early number operation development. Since the review intentionally incorporated broader pedagogical and instructional studies alongside direct project-oriented literature, an integrative approach enabled the synthesis of findings across multiple but conceptually interconnected educational domains. The purpose of the analysis was not merely to summarise individual study findings, but to identify recurring conceptual patterns, pedagogical characteristics, and thematic relationships relevant to the development of early number operation skills within project-oriented learning contexts.

Repeated familiarisation with selected studies was necessary to develop a deeper understanding of recurring pedagogical patterns, instructional contexts, and conceptual relationships across the literature. As illustrated in Figure 2, a detailed review of 37 selected studies was conducted, involving the extraction of relevant empirical evidence, conceptual statements, and analytical insights associated with early number operation development and project-oriented mathematics learning. Following the extraction process, initial coding categories were generated from recurring conceptual and empirical

patterns identified across the studies. Particular attention was given to instructional characteristics associated with project-oriented learning environments, including collaborative engagement,

contextualised mathematical activity, exploratory learning experiences, active participation, and learner-centred pedagogical practices.

Subsequently, thematic categories and subthemes were refined through an iterative analytical process involving continuous comparison across studies to identify similarities, variations, contradictions, and emerging conceptual relationships. An audit trail was maintained throughout the analysis process to document key analytical decisions, interpretations, and theme development. The identified themes were repeatedly reviewed and refined to minimise conceptual overlap and improve analytical coherence. Any discrepancies in interpretation were resolved through iterative discussion and consensus among the researchers to strengthen analytical consistency and improve the trustworthiness of the synthesis process.

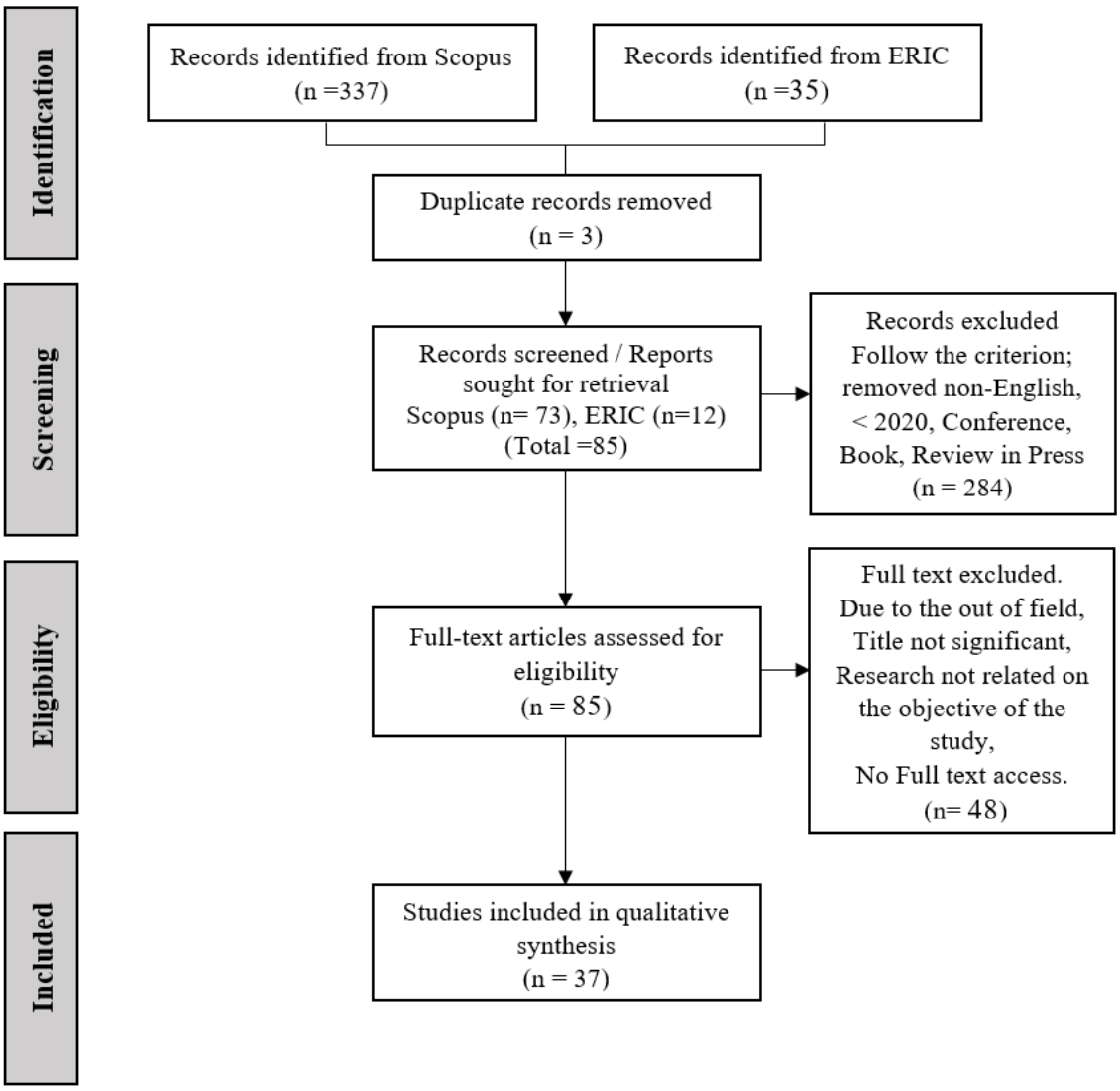

Figure 2 Flow diagram of literature selection process

5. Quality Appraisal

Following the methodological principles of systematic literature reviews, the quality of selected studies was evaluated to determine the strength, clarity, and methodological adequacy of the evidence included in the present review. To facilitate a systematic appraisal process, the quality assessment framework employed in this study was adapted from established quality evaluation procedures commonly used in

evidence synthesis research (Kitchenham & Charters, 2007; Petticrew & Roberts, 2006) and further refined according to the scope and objectives of the current review. Additional consideration was also given to appraisal structures previously employed within educational research contexts. The framework was modified to accommodate the interdisciplinary and fragmented nature of literature related to project-oriented learning and early mathematics education, where studies varied considerably in methodological design, pedagogical focus, and instructional context.

The review-specific appraisal framework consisted of six Quality Assessment (QA) criteria focusing on research clarity, methodological transparency, conceptual definition, comparative discussion, and reporting completeness:

QA1. Is the purpose of the study clearly stated?
QA2. Is the significance and contribution of the study clearly presented?
QA3. Is the study methodology adequately described?
QA4. Are the concepts and pedagogical approaches clearly defined?
QA5. Is the study discussed or compared with related research?
QA6. Are the limitations of the study clearly reported?

A standardised scoring procedure was employed to improve consistency and transparency during quality appraisal. Each criterion was evaluated using three possible ratings: "Yes" (Y) = 1 point when the criterion was fully satisfied, "Partly" (P) = 0.5 point when the criterion was partially addressed, and "No" (N) = 0 points when the criterion was not fulfilled. To minimise individual judgement bias, each study was independently assessed by three reviewers using the predefined criteria. Individual ratings were subsequently compared and aggregated to obtain an overall quality score for each study, while discrepancies in interpretation were resolved through discussion and consensus.

Studies were required to achieve a cumulative score greater than 3.0 to be retained for subsequent synthesis. This threshold functioned as a quality control mechanism to ensure that selected studies demonstrated acceptable methodological reporting and conceptual clarity. Consequently, the appraisal process strengthened the credibility of evidence synthesis and supported more reliable interpretation of findings across the selected literature. This process was considered particularly important because the review incorporated studies from diverse educational contexts and methodological traditions.

RESULT AND DISCUSSION

The quality assessment outcomes of the selected studies are presented in Table 2 based on the six predetermined Quality Assessment (QA) criteria. To provide a broader overview of the methodological characteristics of the included studies, summary statistics and quality category distributions are further presented in Table 3 and Table 4.

The quality assessment findings indicated that all 37 selected studies exceeded the minimum inclusion threshold score of 3.0 and were therefore retained for subsequent synthesis. Across the reviewed literature, methodological reporting and conceptual clarity demonstrated moderate variation. A total of 20 studies (54.1%) were categorised as high quality, while 17 studies (45.9%) were classified as moderate quality. No studies fell below the minimum inclusion threshold. The mean quality score of 4.76 indicated generally acceptable methodological transparency across the selected studies. No study achieved the maximum quality score because minor reporting limitations remained present across all selected studies, particularly in reporting study limitations and comparative discussion.

Across the included studies, variations in appraisal scores appeared to be associated with differences in research design, reporting practices, and pedagogical emphasis. Lower-scoring studies commonly demonstrated limited discussion of study limitations, insufficient conceptual clarification of pedagogical approaches, or weaker connections with previous literature. Such inconsistencies were not unexpected because the reviewed evidence originated from fragmented and interdisciplinary educational domains involving intervention studies, pedagogical investigations, project-oriented practices, and broader early numeracy research contexts. Despite these variations, the overall quality

profile of the included literature demonstrated adequate methodological credibility and conceptual relevance to support subsequent thematic synthesis and interpretation within the present review.

Table 2 Quality assessment results of selected studies

Study	QA1	QA2	QA3	QA4	QA5	QA6	Total Mark	Percentage (%)
PS1 (Haatainen & Aksela, 2021)	Y	Y	Y	Y	P	N	4.5	75.0
PS2 (Averill & Herrelko, 2023)	Y	Y	P	Y	P	N	4.0	66.7
PS3 (Ward & Damjanovic, 2020)	Y	Y	Y	Y	P	P	5.0	83.3
PS4 (Yang et al., 2025)	Y	Y	P	Y	P	N	4.0	66.7
PS5 (Erol & Ogelman, 2021)	Y	Y	Y	Y	P	P	5.0	83.3
PS6 (Plotnikova et al., 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS7 (Chen, 2024)	Y	Y	P	Y	Y	N	4.5	75.0
PS8 (Silo et al., 2025)	Y	Y	P	P	P	N	3.5	58.3
PS9 (Donegan-Ritter et al., 2023)	Y	Y	Y	Y	P	P	5.0	83.3
PS10 (Hakoon et al., 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS11 (Güley & Keskinkılıç, 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS12 (Lecusay et al., 2022)	Y	Y	P	Y	Y	N	4.5	75.0
PS13 (Brown & Jain, 2022)	Y	Y	Y	Y	P	P	5.0	83.3
PS14 (Siyu & Boon, 2022)	Y	Y	Y	Y	P	P	5.0	83.3
PS15 (Chen & Li, 2023)	Y	Y	P	Y	Y	N	4.5	75.0
PS16 (Purpura et al., 2023)	Y	Y	Y	P	Y	P	5.0	83.3
PS17 (Darnon & Fayol, 2022)	Y	Y	Y	P	P	P	4.5	75.0
PS18 (Doabler et al., 2024)	Y	Y	Y	Y	Y	P	5.5	91.7
PS19 (Beliakoff et al., 2025)	Y	Y	Y	Y	P	P	5.0	83.3
PS20 (Gökçe et al., 2023)	Y	Y	Y	P	P	N	4.0	66.7
PS21 (Jylänki et al., 2024)	Y	Y	Y	P	P	P	4.5	75.0
PS22 (Luomaniemi et al., 2021)	Y	Y	Y	P	P	P	4.5	75.0
PS23 (Perini et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS24 (Root et al., 2020)	Y	Y	Y	Y	P	P	5.0	83.3
PS25 (Besser et al., 2025)	Y	Y	Y	P	Y	P	5.0	83.3
PS26 (Ellis & Davis-Kean, 2024)	Y	Y	Y	P	P	N	4.0	66.7
PS27 (Gable et al., 2021)	Y	Y	Y	P	P	P	4.5	75.0
PS28 (Park & Nelson, 2022)	Y	Y	Y	P	Y	P	5.0	83.3
PS29 (Aunio et al., 2021)	Y	Y	Y	Y	P	P	5.0	83.3
PS30 (Linder et al., 2026)	Y	Y	Y	Y	P	P	5.0	83.3
PS31 (Lesner et al., 2025)	Y	Y	Y	P	Y	P	5.0	83.3
PS32 (Paliwal & Baroody, 2020)	Y	Y	Y	P	P	P	4.5	75.0
PS33 (Almulhim & Fujita, 2026)	Y	Y	Y	Y	P	P	5.0	83.3
PS34 (McKevett et al., 2024)	Y	Y	Y	Y	P	P	5.0	83.3
PS35 (Størksen et al., 2023)	Y	Y	Y	P	Y	P	5.0	83.3
PS36 (Jylänki et al., 2023)	Y	Y	Y	P	P	P	4.5	75.0
PS37 (Liang et al., 2020)	Y	Y	Y	Y	P	P	5.0	83.3

Table 3 Overall quality assessment statistics

Indicator	Result
Total studies assessed	37
Mean quality score	4.76
Highest score	5.5
Lowest score	3.5
Studies above threshold (>3.0)	37 (100%)

Table 4 Distribution of studies by quality category

Quality Category	Score Range	Number of Studies	Percentage (%)
High Quality	5.0 - 6.0	20	54.1
Moderate Quality	3.0 - 4.5	17	45.9
Low Quality	<3.0	0	0
Total	-	37	100

1. Project-Oriented Pedagogical Practices and Learning Contexts

Project-oriented pedagogical practices were consistently associated with the creation of active, collaborative, and child-centred learning environments across early childhood settings. Findings across several studies suggested that project approaches shifted learning away from teacher-directed transmission models toward participatory and inquiry-oriented experiences. Haatainen and Aksela (2021) reported that project-based practices commonly involved thematic inquiry, collaboration, and meaningful engagement, although implementation quality varied considerably across settings. Similar patterns were observed by Ward and Damjanovic (2020), where project work functioned as a medium through which young children developed quantitative literacy, counting, and number knowledge through authentic classroom activities. Findings by Güley and Keskinkılıç (2024) further showed that project-based science programs produced positive and sustained effects on preschool children's problem-solving abilities, indicating that project work may strengthen cognitive processes beyond content acquisition. Related evidence from Erol and Ogelman (2021) demonstrated that family-involved project programs generated stronger learning outcomes than conventional activities, suggesting that learning experiences embedded within broader social participation structures may enhance developmental outcomes. Similar observations were reported by Plotnikova et al. (2025), where creative and inquiry-based project forms generated differential socio-emotional outcomes, indicating that project structures and activity types influence learning effects differently. Collectively, these findings indicate that project-oriented learning environments frequently promote interaction, participation, and active knowledge construction; however, the effectiveness of implementation appears dependent upon pedagogical structure and contextual support mechanisms rather than project use alone.

Another recurring issue concerned teacher readiness and pedagogical implementation challenges. Although project approaches were commonly associated with positive educational outcomes, successful classroom implementation frequently appeared constrained by professional competence, curriculum demands, and contextual limitations. Haatainen and Aksela (2021) observed weaknesses in reflection practices, assessment processes, and student-centred implementation despite generally favourable teacher perceptions toward project-based learning. Similar implementation difficulties were reported by Hakoon, Tanunchaibutra and Kuroda (2025), where teachers experienced problems in lesson planning, resource identification, classroom facilitation, and management processes. Comparable findings emerged from Donegan-Ritter et al. (2023) and Brown and Jain (2022), where teacher preparation experiences improved confidence and understanding but highlighted the importance of sustained mentoring and practical support during project implementation. Siyu and Boon (2022) similarly found that preschool teachers experienced tensions when transitioning from traditional instructional beliefs toward child-centred project practices. Constraints associated with time allocation, parental expectations, institutional support, and curriculum requirements further complicated implementation processes. Related conceptual discussions by Chen and Li (2023) and Chen (2024) suggested that imported pedagogical models often experience implementation barriers due to contextual incompatibility and sociocultural differences. Findings from Hong Kong contexts indicated that hybrid implementation approaches combining local and global pedagogical elements may be more sustainable than direct adoption of foreign educational models. Overall, findings suggest that project approaches require not only instructional adaptation but also contextual responsiveness, teacher preparedness, and institutional support systems to ensure successful implementation.

The literature further demonstrated an expanding interpretation of project-oriented pedagogies beyond conventional classroom project work toward broader community,

technological, and sustainability-oriented educational contexts. Yang et al. (2025) proposed that emerging technologies such as generative artificial intelligence and robotics may extend project approaches through new forms of creative interaction and personalised learning experiences. Project approaches increasingly appeared integrated with multidisciplinary educational models, as shown by Averill and Herrelko (2023), where STREAM initiatives facilitated flexible learning structures and promoted content mastery across developmental levels. Similarly, Lecusay, Mrak and Nilsson (2022) emphasized the importance of community-oriented structures within sustainability education and highlighted how themed project work may shape collaborative learning cultures across preschool settings. Sustainability and resource-based project approaches were also observed by Silo, Kanasi and Oletile (2025), where project activities strengthened institutional capacity and enhanced teacher creativity through the production of learning materials.

Across studies, project-oriented pedagogies appeared increasingly interpreted as flexible educational frameworks capable of accommodating diverse goals and learning contexts. Nevertheless, evidence simultaneously suggested that broader pedagogical expansion increases demands for conceptual clarity and implementation consistency. Such findings may partially explain the continuing variation in project approach implementation reported across educational contexts.

2. Early Numeracy Interventions and Instructional Approaches

Early numeracy interventions across the reviewed studies show that young children's number operation skills can be supported through structured, repeated, and developmentally appropriate instructional experiences. Several studies indicate that early mathematics learning improves when numerical ideas are embedded in concrete and meaningful activities rather than delivered only through isolated practice. Purpura et al. (2023) examined picture book intervention and found that the combined use of quantitative mathematical language and numeracy instruction produced mixed effects, suggesting that mathematical language alone may not be sufficient unless it is pedagogically connected to children's numerical understanding. Darnon and Fayol (2022) similarly showed that regular playful exercises involving cardinality, ordinality, and arithmetic transformations could accelerate progress among kindergarten children, particularly those from lower socioeconomic backgrounds. Aunio et al. (2021) also found that targeted early numeracy intervention improved numerical relational skills among first graders at risk for mathematical learning difficulties, with delayed effects still observed after intervention. These findings suggest that early number operation development benefits from systematic instructional support, but outcomes are influenced by intervention design, learner background, and instructional intensity. Doabler et al. (2024) further strengthened this view through a replication study on number concepts and operations, showing positive intervention effects across several mathematics outcomes, although variation between treatment group sizes was not found. Across these studies, the evidence suggests that early numeracy learning is not dependent on one instructional technique only; rather, it develops through the interaction of structured tasks, conceptual focus, and repeated engagement with number relationships.

A second pattern concerns the role of multimodal and activity-based approaches in strengthening early numeracy development. Studies involving movement, games, stories, and digital tools suggest that young children's mathematical learning may be enhanced when instruction involves active participation and multiple representations. Jylänki et al. (2023) reported that combining early numeracy with fundamental motor skill practice improved children's early numeracy, mathematical problem solving, and motor development, indicating that embodied learning can support mathematical engagement. Gable et al. (2021) examined a physically active number learning game, but the findings did not show clear group differences over time, suggesting that active learning formats require careful alignment with children's existing number knowledge and teacher practices. Similar caution appears in McKevett et al. (2024), where a concrete-representational-abstract instructional package increased match quantity fluency for some

preschool children but did not generalise fully to number sequencing. Digital and game-based learning also appeared in Perini et al. (2024), where the Number Express game was found to be usable and engaging for preschool children, although larger intervention studies were still required to establish effectiveness. Story-based instruction provided another pathway. Root et al. (2020) showed that story-based lessons with systematic instruction supported kindergarteners with autism in building early number sense, while Almulhim and Fujita (2026) found that interactive mathematical stories had promising effects on kindergarten children's number sense. Together, these studies indicate that activity-based and multimodal instruction can support early number operation skills, but the strength of impact depends on whether activities are conceptually targeted, developmentally appropriate, and supported by explicit mathematical guidance.

The third pattern relates to instructional conditions, learner diversity, and sustainability of intervention effects. Several studies suggest that early numeracy interventions are more meaningful when they consider children's language background, socioeconomic context, teacher interaction, and home learning environment. Luomaniemi et al. (2021) found that a spontaneous focusing on numerosity-based program supported multilingual children's early numeracy and oral language skills, showing that numeracy support does not necessarily reduce attention to language development. Besser et al. (2025) highlighted the role of teacher professional development by showing that mathematical interaction training improved toddlers' numeracy and mathematical language, suggesting that teacher-child interaction quality is an important instructional mechanism. Linder et al. (2026) extended this discussion to the home context through Project MathPack, where play-based mathematics packs increased mathematical talk and caregiver-child interaction, supporting the idea that early number learning can be strengthened beyond formal classrooms. Størksen et al. (2023) showed that a playful learning curriculum improved preschool mathematics outcomes in early childhood centres, while Liang et al. (2020) found that mathematical play training based on a response-to-intervention framework improved number sense growth among low-SES preschool children, with effects persisting after training. Paliwal and Baroody (2020) added a more specific conceptual contribution by showing that subitizing ability can support understanding of the cardinality principle, a foundation for later counting and number operation learning. Collectively, these findings suggest that early numeracy interventions are most useful when they combine conceptual clarity, playful or contextualised engagement, teacher support, and sensitivity to learner diversity.

3. Assessment, Developmental Factors and Mathematical Learning Outcomes

Assessment and developmental evidence within early number learning indicates that number sense functions not only as a current indicator of mathematical ability, but also as an important predictor of later mathematical difficulties and achievement. Beliakoff et al. (2025) demonstrated that early screening using the Screener for Early Number Sense (SENS) could differentiate children at risk of later mathematics difficulties across pre-kindergarten, kindergarten and first-grade levels. This finding suggests that early numerical competencies are sufficiently stable to support early identification and targeted instructional decisions. Similarly, Gökçe et al. (2023) showed that number sense can be monitored across primary grades through vertically equated assessment tools, enabling comparison of development across grade levels. Their findings also indicated that number sense remained insufficiently developed during early schooling and varied according to school type, gender trends and maternal education. Lesner et al. (2025) further strengthened the developmental importance of number sense by showing that gains in whole number magnitude knowledge partially mediated the outcomes of a kindergarten mathematics intervention. Taken together, these studies suggest that number sense is not a single isolated skill, but a developmental foundation linked to later mathematics performance, intervention responsiveness and risk identification. For project-oriented early mathematics learning, this evidence implies that project activities should not only be designed as engaging experiences, but also connected with observable indicators of number magnitude, quantity comparison, counting, and early operational reasoning.

A second pattern concerns the quality and suitability of assessment practices used to evaluate early numeracy interventions and classroom mathematics learning. Park and Nelson (2022) found that early numeracy intervention studies generally met many quality indicators related to outcome measure reporting, but fewer studies provided sufficient evidence on multiple measures or validity information. This finding is important because intervention effectiveness can be interpreted inaccurately when outcome measures are too narrow, poorly described, or insufficiently validated. Ellis and Davis-Kean (2024) added another important dimension by examining classroom mathematics instruction through teacher audio recordings rather than relying only on self-report or video-based data. Their findings indicated that children with lower initial adaptive mathematics skills showed greater growth across the school year, but measured aspects of instruction did not predict growth in addition or counting skills. Such evidence suggests that assessing instructional influence in natural classroom settings remains complex, particularly when mathematical learning is shaped by multiple interactions, routines and contextual factors. Gökçe et al. (2023) and Beliakoff et al. (2025) also emphasised the value of reliable tools for monitoring number sense progress and identifying risk patterns. Across these studies, assessment is presented not only as a measurement activity but also as a decision-making mechanism for intervention planning, instructional adjustment and early support. In relation to project approaches, assessment should therefore move beyond final products or general participation and include evidence of children's developing numerical reasoning during project activities.

The reviewed evidence also highlights that mathematical learning outcomes are influenced by both child-level developmental factors and the quality of instructional or assessment systems. Lesner et al. (2025) identified magnitude knowledge as an active mechanism explaining part of the effect of kindergarten mathematics intervention, suggesting that improvement in early number learning depends on specific conceptual growth rather than general exposure to mathematics activities alone. Beliakoff et al. (2025) similarly showed that children's number sense profiles across early educational levels can predict later mathematics difficulties, indicating the need for assessment practices capable of detecting individual differences before formal failure becomes visible. Gökçe et al. (2023) added that number sense development differs according to demographic and schooling factors, which means that learning outcomes should be interpreted in relation to children's educational and family contexts. Ellis and Davis-Kean (2024) showed that classroom instruction remains difficult to measure ecologically, while Park and Nelson (2022) highlighted the importance of stronger reporting quality in intervention outcome measures. Collectively, these studies suggest that meaningful early mathematics learning requires stronger alignment between assessment tools, developmental indicators and instructional design. In project-oriented learning environments, such alignment is especially important because children's mathematical thinking may appear through discussion, manipulation of materials, problem solving, comparison, estimation and representation rather than through written responses only.

CONCLUSION

This systematic literature review was conducted to synthesise recent empirical evidence concerning project approaches in developing early number operation skills among preschool and early primary learners. The review was undertaken in response to the fragmented nature of literature surrounding project-oriented learning and early mathematics education, where studies were frequently distributed across multiple but interconnected domains, including instructional interventions, developmental factors, pedagogical practices, and assessment systems. Guided by the PRISMA protocol, the review examined studies published between 2020 and 2026 retrieved from the Scopus and ERIC databases. Following identification, screening, eligibility assessment, and quality appraisal procedures, 37 primary studies were retained for final qualitative synthesis. The review addressed three main research questions concerning cognitive and developmental factors, project-oriented instructional characteristics, and assessment practices associated with early number operation development. Through a systematic synthesis process, the review aimed to clarify how current empirical evidence contributes to understanding pedagogical foundations relevant to project-oriented mathematics learning. The present synthesis therefore addressed an important gap by integrating evidence previously dispersed across

separate educational discussions and providing a more coherent perspective on early number operation development within meaningful and learner-centred educational environments.

The synthesis revealed several important patterns across the reviewed literature. One recurring finding was that project-oriented pedagogical practices were consistently associated with active participation, contextualised learning experiences, collaborative engagement, and inquiry-based environments. Evidence across multiple educational contexts suggested that meaningful mathematical learning frequently emerged through exploration, interaction, and authentic experiences rather than isolated procedural instruction. Another pattern identified across the literature concerned the role of instructional design in supporting early numeracy development. Studies indicated that number operation skills developed more effectively when learning experiences were structured, developmentally appropriate, and embedded within playful and multimodal activities. A further observation emerging from the review involved assessment and developmental evidence, where number sense, conceptual understanding, and early mathematical indicators frequently functioned as predictors of later mathematics achievement and intervention responsiveness. Taken together, the reviewed evidence suggests that pedagogical practices, instructional approaches, and assessment mechanisms function as closely related elements that support children's mathematical development. The review further extends previous literature by synthesising fragmented evidence into three thematic dimensions and proposing an interpretative conceptual framework connecting cognitive foundations, project-oriented pedagogical characteristics, assessment practices, and meaningful mathematical learning outcomes. This conceptual integration provides an alternative perspective for understanding project approaches beyond narrowly defined instructional labels and offers a more comprehensive structure for future evidence interpretation.

Several practical implications emerge from the present review. The findings suggest that early childhood educators and curriculum developers should design mathematics learning environments that integrate contextual experiences, collaborative interaction, authentic mathematical tasks, and developmentally appropriate assessment practices. Educational practices focused solely on procedural learning may overlook broader developmental processes involved in early number operation acquisition. The evidence further suggests that project-oriented mathematics learning requires sufficient teacher preparation, pedagogical flexibility, and instructional support to achieve meaningful implementation outcomes. Nevertheless, several limitations should be acknowledged. The review included only studies published in English, utilised two databases, and was restricted to publications between 2020 and 2026. Relevant evidence available in additional databases, other languages, or earlier publications may therefore remain underrepresented. Furthermore, the review intentionally incorporated studies conceptually related to project-oriented learning even when formal project approaches were not directly implemented. While this decision broadened conceptual coverage, it may also have introduced variation in pedagogical interpretation. Future investigations may extend current findings by incorporating additional databases, examining longitudinal intervention evidence, conducting meta-analytical investigations, and exploring direct implementation of project approaches in early mathematics settings. Overall, systematic evidence synthesis remains essential for strengthening theoretical understanding and informing future empirical work, particularly within emerging and emerging and interdisciplinary educational fields such as project-oriented approaches in early number operation learning.

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to Universiti Pendidikan Sultan Idris (UPSI) for providing academic support throughout the completion of this study. The authors also acknowledge the contributions of researchers whose work formed the basis of the literature analysed in this review.

FUNDING

This study was not supported by any grants from funding bodies in the public, commercial, or not-for-profit sectors. The authors declare that no financial support was received for the research, authorship, and publication of this article.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are derived from publicly available peer-reviewed articles indexed in the Scopus and ERIC databases. All data analysed during this study are included within the article.

CONFLICT OF INTEREST

The authors declare that they have no known financial, personal, or professional conflicts of interest that could have influenced the research reported in this paper.

REFERENCES

Almulhim, M. G., & Fujita, T. (2026). The Enhancement of Number Sense Through the Interactive Reading of Mathematical Stories in Kindergarten. *Education Sciences*, *16*(2). https://doi.org/10.3390/educsci16020296

Aunio, P., Korhonen, J., Ragpot, L., Törmänen, M., & Henning, E. (2021). An early numeracy intervention for first-graders at risk for mathematical learning difficulties. *Early Childhood Research Quarterly*, *55*, 252–262. https://doi.org/10.1016/j.ecresq.2020.12.002

Averill, C. L., & Herrelko, J. M. (2023). STREAMing with Butterflies: A Whole School STREAM Project. *Journal of Catholic Education*, *26*(2), 144–159. https://doi.org/10.15365/joce.2602082023

Beliakoff, A., Jordan, N., Klein, A., Devlin, B., & Huang, C.-W. (2025). Stability of early number sense competencies for predicting mathematics difficulties. *Learning and Individual Differences*, *118*. https://doi.org/10.1016/j.lindif.2025.102633

Besser, N., Linberg, A., Dornheim, D., Weinert, S., Roßbach, H.-G., & Lehrl, S. (2025). Fostering toddlers' numeracy and mathematical language skills through a professional development intervention on interaction quality in toddler classrooms. *Early Childhood Research Quarterly*, *72*, 44–55. https://doi.org/10.1016/j.ecresq.2025.02.004

Brown & Jain (2022). Doing projects with young children in a field-based early childhood education course. *Educational Studies*, *48*(5), 692–707. https://doi.org/10.1080/03055698.2020.1798743

Chen, J. J. (2024). Neoliberalism and neocolonialism in the mix: Evidence of glocalization in the globalization–localization dynamics of early childhood practices in Hong Kong. *Policy Futures in Education*, *22*(6), 1053–1081. https://doi.org/10.1177/14782103231171977

Chen, J. J., & Li, H. (2023). Tian Shi (Timing) Di Li (Context) Ren He (Human Capital): A New Theoretical Framework for Analyzing the Implementability of Imported Early Childhood Practices and Making a Case for a Hybrid Model. *Journal of Research in Childhood Education*, *37*(2), 292–309. https://doi.org/10.1080/02568543.2022.2107588

Darnon, C., & Fayol, M. (2022). Can an early mathematical intervention boost the progress of children in kindergarten? A field experiment. *European Journal of Psychology of Education*, *37*(1). https://doi.org/10.1007/s10212-021-00550-4

Doabler, C. T., Clarke, B., Turtura, J. E., Sutherland, M., Gersib, J. A., Lesner, T., Cook, M., Kimmel, G. L., Smolkowski, K., & Kosty, D. (2024). Proficiency With Number Concepts and Operations: Replicating the Efficacy of a First-Grade Mathematics Intervention. *Journal of Learning Disabilities*, *57*(4), 224–241. https://doi.org/10.1177/00222194231209017

Donegan-Ritter, M., Zan, B., & Pattee, A. (2023). Reflections on Project Work in Early Childhood Teacher Education. *Early Childhood Education Journal*, *51*(3), 407–418. https://doi.org/10.1007/s10643-022-01307-4

Ellis, A., & Davis-Kean, P. E. (2024). Analyzing teacher audio: The contribution of classroom mathematics instruction to early numeracy. *Journal of Educational Research*, *117*(5), 294–307. https://doi.org/10.1080/00220671.2024.2393607

Erol, A., & Ogelman, H. G. (2021). Investigation Of The Effect Of Environmental Education Program With Involvement Based On Project Approach On 5-6 Year Old Children's The Environment. *Milli Egitim*, *50*(232), 133–160. https://doi.org/10.37669/milliegitim.737551

Gable, S., Fozi, A. M., & Moore, A. M. (2021). A Physically-Active Approach to Early Number Learning. *Early Childhood Education Journal*, *49*(3), 515–526. https://doi.org/10.1007/s10643-020-01093-x

Gökçe, S., Güner, P., & Baştuğ, M. (2023). Monitoring proficiency: Growth of number sense in primary school. *Psychology in the Schools*, *60*(3), 707–728. https://doi.org/10.1002/pits.22786

Güley, B., & Keskinkılıç, A. (2024). The effect of project approach-based science education program on problem-solving skills of preschool children. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-03444-0

Haatainen, O., & Aksela, M. (2021). Project-based learning in integrated science education: Active teachers' perceptions and practices. *Lumat*, *9*(1), 149–173. https://doi.org/10.31129/LUMAT.9.1.1392

Hakoon, V., Tanunchaibutra, P., & Kuroda, A. (2025). Training early childhood teachers integrating project approach with multicultural education in the classroom. *Journal of Education and Learning*, *19*(4), 1776–1785. https://doi.org/10.11591/edulearn.v19i4.23032

Jylänki, P., Sääkslahti, A., & Aunio, P. (2024). Intervention effects on low performing preschoolers' early mathematical skills: Adding fundamental motor skill practice as a supporting method. *Trends in Neuroscience and Education*, *35*. https://doi.org/10.1016/j.tine.2024.100227

Jylänki, P., Sipinen, E., Mbay, T., Sääkslahti, A., & Aunio, P. (2023). Combining Numerical Relational and Fundamental Motor Skills to Improve Preschoolers' Early Numeracy: A Pilot Intervention Study. *International Journal of Early Childhood*, *55*(1), 131–154. https://doi.org/10.1007/s13158-022-00329-8

Kitchenham, B., & Charters, S. (2007). *Guidelines for Performing Systematic Literature Reviews in Software Engineering*. EBSE Technical Report. Keele University.

Lecusay, R., Mrak, L., & Nilsson, M. (2022). What is Community in Early Childhood Education and Care for Sustainability? Exploring Communities of Learners in Swedish Preschool Provision. *International Journal of Early Childhood*, *54*(1), 51–74. https://doi.org/10.1007/s13158-021-00311-w

Lesner, T., Sutherland, M., Cook, M., Wilke, E., Smolkowski, K., & Clarke, B. (2025). Do Magnitude Knowledge Gains Mediate the Outcomes of a Kindergarten Mathematics Intervention? *Learning Disabilities Research and Practice*, *40*(2), 112–120. https://doi.org/10.1177/09388982251321536

Liang, Y., Zhang, L., Long, Y., Deng, Q., & Liu, Y. (2020). Promoting Effects of RtI-Based Mathematical Play Training on Number Sense Growth among Low-SES Preschool Children. *Early Education and Development*, *31*(3), 335–353. https://doi.org/10.1080/10409289.2019.1664261

Linder, S. M., Larson, D. M., Adesina, K. A., Osho, L., & Ruiz, Y. (2026). Project MathPack: Examining Play-Based Mathematics Interactions in Home Environments. *Early Childhood Education Journal*, *54*(4), 2545–2555. https://doi.org/10.1007/s10643-025-01978-9

Lockwood, C., Munn, Z., & Porritt, K. (2015). Qualitative research synthesis: Methodological guidance for systematic reviewers utilizing meta-aggregation. *International Journal of Evidence-Based Healthcare*, *13*(3), 179–187. https://doi.org/10.1097/XEB.0000000000000062

Luomaniemi, K., Mattinen, A., McMullen, J., Sorariutta, A., & Hannula-Sormunen, M. (2021). The Effects of a SFON-Based Early Numeracy Program on Multilingual Children's Early Numeracy and Oral Language Skills. *Journal of Cognitive Education and Psychology*, *20*(2), 138–160. https://doi.org/10.1891/JCEP-D-20-00006

McKevett, N. M., Codding, R. S., & Running, K. R. (2024). The Effects of Representational Instruction and The Great Race on Preschoolers' Early Numeracy Skills. *Remedial and Special Education*,

45(1), 18–29. https://doi.org/10.1177/07419325231160292

Metin, Ş., Kalyenci, D., Başaran, M., Relkin, E., & Bilir, B. (2025). Design-Based Digital Story Program: Enhancing Coding and Computational Thinking Skills in Early Childhood Education. *Early Childhood Education Journal*, *53*(6), 2255–2274. https://doi.org/10.1007/s10643-024-01728-3

Page, M. J., McKenzie, J. E., Bossuyt, P., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The prisma 2020 statement: An updated guideline for reporting systematic reviews. *Medicina Fluminensis*, *57*(4), 444–465. https://doi.org/10.21860/medflum2021_264903

Paliwal, V., & Baroody, A. J. (2020). Cardinality principle understanding: the role of focusing on the subitizing ability. *ZDM - Mathematics Education*, *52*(4), 649–661. https://doi.org/10.1007/s11858-020-01150-0

Park, S., & Nelson, G. (2022). The quality of outcome measure reporting in early numeracy intervention studies. *Psychology in the Schools*, *59*(9), 1721–1736. https://doi.org/10.1002/pits.22726

Petticrew, M., & Roberts, H. (2006). *Systematic Reviews in the Social Sciences: A Practical Guide*. Blackwell Publishing.

Perini, N., Porru, A., Moeller, K., Jay, T., Lucangeli, D., & Sella, F. (2024). Number Express: A Digital Game to Improve Early Numeracy. *Electronic Journal of E-Learning*, *22*(10), 37–51. https://doi.org/10.34190/ejel.22.10.3522

Plotnikova, V. A., Veraksa, A. N., Veraksa, N. E., & Nikolaeva, N. S. (2025). Project-Based Activity as a Means of Socio-Emotional Development in Preschool Children | Проектная деятельность как средство социально-эмоционального развития дошкольников. *Integration of Education*, *29*(2), 339–354. https://doi.org/10.15507/1991-9468.029.202502.339-354

Purpura, D. J., O'Rear, C. D., Ellis, A., Logan, J. A. R., Westerberg, L., Ehrman, P., King, Y. A., Tuin, M. V, Nordgren, I., Anderson, K., Cosso, J., Zippert, E., Napoli, A. R., Hornburg, C. B., Schmitt, S. A., & Dobbs-Oates, J. (2023). Unique and Combined Effects of Quantitative Mathematical Language and Numeracy Instruction Within a Picture Book Intervention: A Registered Report. *Journal of Educational Psychology*, *116*(1), 1–19. https://doi.org/10.1037/edu0000820

Rodríguez Rodríguez, D. I., Diaz Quichimbo, D. M., Guillén Eduardo, D. E., & Curay Correa, X. P. (2024). Mobile Adventure: RIAMOS to Strengthen the Development of Mathematical Logic and Language in Early Education in Rural Contexts. *Journal of Ecohumanism*, *3*(7), 4112–4124. https://doi.org/10.62754/joe.v3i7.4530

Root, J. R., Henning, B., & Jimenez, B. (2020). Building the Early Number Sense of Kindergarteners With Autism: A Replication Study. *Remedial and Special Education*, *41*(6), 378–388. https://doi.org/10.1177/0741932519873121

Silo, N., Kanasi, T., & Oletile, J. (2025). Appropriating Waste into Teaching Learning Materials for Early Childhood Education – A Sustainability Starts with Teachers approach. *Southern African Journal of Environmental Education*, *40*(2). https://doi.org/10.4314/sajee.v40SI2.03

Siyu, W., & Boon, N. S. (2022). Project Approach: Is It Feasible in Chinese Preschool? *Malaysian Journal of Qualitative Research*, *8*(2), 63–74. https://doi.org/10.61211/mjqr080206

Størksen, I., Rege, M., Solli, I. F., ten Braak, D., Lenes, R., & Geldhof, G. J. (2023). The playful learning curriculum: A randomized controlled trial. *Early Childhood Research Quarterly*, *64*, 36–46. https://doi.org/10.1016/j.ecresq.2023.01.015

Verkerk, J. C., van de Rijt, B., & van Viersen, S. (2026). Development of numerical relational and counting skills as components of early numeracy. *Learning and Instruction*, *102*(December 2025), 102313. https://doi.org/10.1016/j.learninstruc.2025.102313

Ward, J., & Damjanovic, V. J. (2020). Planting seeds of numeracy: Supporting quantitative literacy in young children. *Numeracy*, *13*(1), 1–14. https://doi.org/10.5038/1936-4660.13.1.5

Yang, W., Li, H., & Lee, J. C.-K. (2025). Tailoring AI agents for early learning: The Creative Project Approach. *Computers and Education Artificial Intelligence*, *9*. https://doi.org/10.1016/j.caeai.2025.100473