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Research Article

Early Childhood Numeracy Performance as Predicted by Parental Involvement and Children's Social Interaction: Inter-rated by Education Practitioners and Perceived by Parents

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Abstract
Early numeracy skills are essential for children's academic success and long-term educational development. However, limited evidence exists regarding the relative contributions of parental involvement and children's social interaction to numeracy performance in rural Philippine contexts. This study examined the predictive influence of parental involvement and children's social interaction on early childhood numeracy performance among kindergarten learners in a rural elementary school in Banaybanay District, Davao Oriental, Philippines. Guided by Sociocultural Theory, the study employed a predictive quantitative research design involving 78 kindergarten learners and their parents. Data were collected using adapted instruments and analyzed through descriptive statistics, Pearson correlation, and multiple linear regression. Results revealed that parental involvement and children's social interaction were both significantly associated with numeracy performance. However, regression analysis showed that only children's social interaction significantly predicted numeracy performance ($\beta = .413$, $p < .001$), whereas parental involvement did not demonstrate a significant unique contribution ($\beta = .152$, $p = .154$). The regression model was statistically significant, $F(2,75) = 10.942$, $p < .001$, explaining 22.6% of the variance in numeracy performance. The findings highlight the importance of social interaction as a key mechanism supporting early numeracy development. The study contributes to the literature by identifying the relative predictive strength of social interaction in a rural Philippine setting and suggests the need for classroom strategies that promote collaborative learning and meaningful peer engagement.

Keywords
Early childhood numeracy; Parental involvement; social interaction; kindergarten learners; predictive research

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This study was conducted in accordance with ethical standards.

INTRODUCTION

Early numeracy skills are fundamental to children's cognitive development and serve as strong predictors of later academic achievement, particularly in mathematics. Research consistently demonstrates that early mathematical knowledge significantly influences future school success, problem-solving abilities, and overall educational outcomes (Claessens & Engel, 2013; Chang, 2023). As a result, improving numeracy development during the early years has become a global educational priority aligned with Sustainable Development Goal 4, which advocates inclusive and equitable quality education for all learners. Despite its recognized importance, concerns regarding early numeracy performance continue to emerge across different educational contexts. Studies have reported that many young learners struggle to demonstrate expected numeracy competencies during the transition to formal schooling (Dewi et al., 2025; Ovianti et al., 2024). Similar challenges have been documented among children from diverse populations, including those in developing and underserved communities where school readiness in literacy and numeracy remains a persistent concern (Sahu & Behera, 2024). Furthermore, vocabulary development and language proficiency have been shown to contribute significantly to numeracy acquisition, suggesting that early mathematical learning is influenced by multiple developmental factors (Bleses et al., 2023). In the Philippines, evidence indicates that many kindergarten learners continue to experience difficulties in counting, number recognition, and mathematical reasoning despite existing educational interventions (Lavador et al., 2024).

Among the factors associated with early numeracy development, parental involvement has received substantial scholarly attention. Parents play a critical role in creating learning opportunities, reinforcing mathematical concepts, and fostering positive attitudes toward learning at home (Ghazali et al., 2021). Empirical studies have reported positive relationships between parental engagement and children's literacy and numeracy outcomes (Alonso et al., 2025; Ponce et al., 2025; Siason et al., 2025). Similarly, parental support has been identified as a key contributor to children's academic achievement and educational experiences across various contexts (Cariaga et al., 2025). Nevertheless, findings remain inconsistent, as some studies suggest that the effectiveness of parental involvement depends on the quality and nature of engagement rather than its frequency alone (Sarmiento et al., 2025; Zambak et al., 2025). Another important determinant of children's learning outcomes is social interaction. Sociocultural Theory posits that cognitive development occurs through meaningful interactions with others, particularly through collaborative activities and guided participation (Vygotsky, 1978). Through peer engagement, communication, and cooperative problem-solving, children are able to internalize concepts and develop higher-order thinking skills. Recent studies have emphasized the importance of social play, communication, and interaction in promoting learning readiness and academic development among preschool learners (Lee et al., 2022). Furthermore, sociocultural perspectives suggest that children's mathematical thinking develops through social experiences that facilitate the construction of knowledge within meaningful contexts (Hiltrimartin, 2024). These findings indicate that social interaction may serve as a significant mechanism through which numeracy competencies are strengthened during early childhood.

Although parental involvement and social interaction have independently been linked to children's academic performance, limited research has examined their simultaneous influence on early numeracy performance within a single predictive model, particularly in rural Philippine settings. Existing studies often focus on either home-based parental engagement or classroom-based social experiences without determining their relative predictive contributions. Moreover, the literature remains scarce regarding how these factors interact within communities characterized by limited educational resources and varying levels of parental support. This gap highlights the need for empirical evidence that identifies which factors most strongly predict numeracy performance among kindergarten learners.

Therefore, this study examined the extent to which parental involvement and children's social interaction predict early childhood numeracy performance among kindergarten learners in a rural elementary school in Banaybanay District, Davao Oriental, Philippines. Anchored in Sociocultural Theory, the study sought to determine the unique and combined contributions of these variables to numeracy outcomes. The findings are expected to contribute to the growing body of knowledge on early childhood education and provide evidence-based recommendations for teachers, school leaders, parents, and policymakers seeking to strengthen numeracy development among young learners.

METHODOLOGY

Design

This study employed a predictive quantitative research design grounded in a postpositivist paradigm (Creswell, 2014). This design is appropriate as the study aims to predict early childhood numeracy performance using parental involvement and children's social interaction as predictors, aligning with the sociocultural theoretical framework (Shmueli et al., 2023).

Sampling

Total enumeration sampling was used. All 78 kindergarten parents and learners from one elementary school in Banaybanay District, Davao Oriental, Philippines (2025–2026) participated. The manageable population size made total enumeration feasible, minimizing sampling bias (Malagamba & Cajandig, 2025). Inclusion criteria: parent of a kindergarten learner enrolled during the study period. No exclusion criteria were applied. The school was purposively selected for having the district's lowest numeracy proficiency.

Collection

Data were gathered via three adapted questionnaires. First, parental involvement (32 items, 10-point Likert scale) adapted from Ghazali et al. (2021). Second, children's social interaction (6 items, 10-point rubric) was adapted from Lee et al. (2022). Third, numeracy performance (20 competencies, 3-point scale) adapted from DepEd Order No. 8, s. 2015. Questionnaires were administered in Cebuano with English translations. Parents completed the first survey; teachers rated social interaction and numeracy performance.

Data Analysis

Data were analyzed using SPSS. Descriptive statistics (mean, SD) described variable levels. Pearson correlation ($\alpha = 0.05$) determined relationships between predictors and the criterion. Multiple linear regression (standardized/unstandardized beta coefficients) assessed unique and combined predictive contributions using F-test, R^2, and p-values.

Ethical Considerations

Ethical approval was obtained from the Society for Moral Integrity and Legal Ethics Board and DepEd. Written informed consent was secured. Anonymized data were stored securely with limited access. Participants could withdraw without penalty.

Limitations and Rigor

Limitations include: a single school (N = 78) limiting generalizability; self-report bias in parental involvement; teacher-researcher positionality; and low explained variance ($R^2 = 22.6\%$). rigor was maintained via validated instruments, total enumeration sampling, systematic statistical procedures, and transparent reporting of all findings.

Ethical Considerations

Prior to data collection, ethical clearance was obtained from the Society for Moral Integrity and Legal Ethics Board, and permission to conduct the study was secured from the Department of Education and the school administration. Participation in the study was voluntary, and informed consent was obtained from all parents or legal guardians of the kindergarten learners involved in the research. Participants were informed of the study's objectives, procedures, potential benefits, and their right to withdraw at any stage without penalty. To ensure confidentiality and privacy, no personally identifiable information was collected or disclosed in any research report or publication. All responses were anonymized through coding procedures, and data were stored in password-protected files accessible only to the researchers. The study adhered to the principles of respect for persons, beneficence, and justice throughout the research process. Special consideration was given to the involvement of young children by ensuring that all data collection procedures posed minimal risk and did not interfere with regular educational activities. The study was conducted in accordance with established ethical standards for educational research and the provisions of the Data Privacy Act of 2012 (Republic Act No. 10173) of the Philippines.

RESULTS AND DISCUSSION

Parental involvement scored very high (M = 7.65), indicating active parent engagement in numeracy activities, consistent with Ghazali et al. (2021). The standard deviation (SD = 1.50) reveals low response consistency, suggesting variability across parents due to differences in education, work schedules, or home learning resources. Children's social interaction scored moderately high (M = 5.86). Communication scored highest (6.01) and conflict resolution lowest (5.68), indicating learners communicate well but struggle with peer conflict—a common developmental challenge (Lee et al., 2022). The high SD (1.79) reflects diverse social skill development. Numeracy performance scored developing (M = 2.04), meaning learners demonstrate expected competencies with minimal supervision but lack consistent mastery.

The findings indicate that parents demonstrated a high level of involvement in supporting their children's numeracy learning. This suggests that families recognize the importance of early mathematics and actively engage in activities that promote mathematical development at home. Previous studies have consistently identified parental involvement as an important contributor to children's academic readiness, particularly in literacy and numeracy domains, because it provides opportunities for reinforcement, encouragement, and learning support beyond the classroom (Ghazali et al., 2021; Alonso et al., 2025; Ponce et al., 2025). However, the presence of high parental involvement alongside only developing numeracy performance suggests that the quantity of involvement may not necessarily translate into effective learning outcomes. This observation supports emerging perspectives that emphasize the quality, intentionality, and pedagogical value of parental engagement rather than participation alone (Cariaga et al., 2025; Zambak et al., 2025). Children's social interaction was found to be moderately high, indicating that learners generally possessed adequate communication and peer-engagement skills. Social interaction has long been recognized as a critical component of cognitive development because it provides opportunities for children to construct knowledge through dialogue, observation, and collaborative problem-solving. The relatively stronger performance in communication compared with conflict resolution suggests that learners are capable of engaging with peers but may still require structured opportunities to develop higher-order social competencies. Similar developmental patterns have been reported among preschool learners, where communication skills typically emerge earlier than complex social problem-solving abilities (Lee et al., 2022).

Despite favorable levels of parental involvement and social interaction, numeracy performance remained at the developing level. This finding suggests that early numeracy achievement is influenced by a broader constellation of factors beyond family support and peer engagement. Previous research has demonstrated that language development, mathematical vocabulary, instructional quality, cognitive readiness, and access to learning resources all contribute significantly to numeracy acquisition (Bleses et al., 2023; Chang, 2023; Dewi et al., 2025). The present result therefore highlights the multifaceted nature of numeracy development and reinforces the need for comprehensive interventions that address both home- and school-based influences.

Table 1
Descriptive Statistics of Parental Involvement, Children's Social Interaction, and Early Childhood Numeracy Performance (N = 78)

Variable	N	M	SD	Descriptive Level
Parental Involvement in Early Numeracy Skills	78	7.65	1.50	Very High
Ability to Teach	78	7.61	1.85	Very High
Involvement in Mathematical Activities at Home	78	7.73	1.83	Very High

Variable	N	M	SD	Descriptive Level
Perception on the Importance of Numeracy	78	7.67	1.67	Very High
Attitude Towards Teaching Numeracy	78	7.59	1.58	Very High
Children's Social Interaction	78	5.86	1.79	Moderately High
Joining and Initiating Interaction	78	5.87	1.76	Moderately High
Cooperation/Sharing/Turn-Taking	78	5.92	1.76	Moderately High
Communication	78	6.01	1.79	Moderately High
Empathy/Prosocial Behavior	78	5.76	1.94	Moderately High
Conflict Resolution/Social Problem Solving	78	5.68	1.86	Moderately High
Sustained Interaction/Engagement	78	5.92	1.83	Moderately High
Early Childhood Numeracy Performance	78	2.04	0.68	Developing

Note. M = Mean; SD = Standard Deviation.

Both parental involvement (r = .258, p = .023) and children's social interaction (r = .452, p = .000) correlated positively with numeracy performance, indicating that higher levels of each predict better numeracy outcomes. The parental involvement correlation supports Siason et al. (2025) but partially contradicts Sarmiento et al. (2025), who found no significant relationship. This discrepancy may reflect contextual differences: the present rural Philippine study may show stronger effects due to limited formal learning resources, unlike urban populations with greater educational support. Children's social interaction showed a stronger correlation (r = .452) than parental involvement (r = .258), suggesting peer interaction may influence numeracy more than home-based engagement. The significant positive relationships observed between parental involvement, children's social interaction, and numeracy performance suggest that both home and social learning environments contribute to children's mathematical development. Learners who receive greater support from parents and who engage more actively with peers tend to demonstrate stronger numeracy outcomes. These findings are consistent with previous studies reporting that parental engagement facilitates academic achievement by creating supportive learning conditions and encouraging positive learning behaviors (Cariaga & Gerodias, 2025; Siason et al., 2025; Ponce et al., 2025).

However, the stronger association between social interaction and numeracy performance suggests that learning processes occurring within social contexts may exert a more direct influence on early mathematical development. From a sociocultural perspective, learning is fundamentally a social process in which knowledge is constructed through interaction with more knowledgeable others and through participation in collaborative activities (Vygotsky, 1978). Through discussion, peer modeling, and shared problem-solving experiences, learners gain access to cognitive strategies that support mathematical understanding. This interpretation is supported by recent evidence indicating that social competence and collaborative engagement facilitate children's readiness for academic learning and mathematical reasoning (Lee et al., 2022; Hiltrimartin, 2024).

Table 2
Correlation Between Parental Involvement, Children's Social Interaction, and Early Childhood Numeracy Performance (N = 78)

Variable	r	p	Decision on H_0	Interpretation
Parental Involvement	.258	.023	Reject H_0	Low positive significant correlation
Children's Social Interaction	.452	< .001	Reject H_0	Moderate positive significant correlation

Note. Correlations are significant at $\alpha = .05$.

The regression model significantly predicts numeracy performance, $F(2,75) = 10.942$, $p = .000$, explaining 22.6% of the variance. However, only children's social interaction ($\beta = .413$, $p = .000$) contributes uniquely; parental involvement ($\beta = .152$, $p = .154$) does not. This suggests that social interaction is the only significant, unique predictor. The significant bivariate correlation between parental involvement and numeracy performance is likely explained by shared variance with social interaction—highly involved parents may also have children with better social skills, and it is social interaction, not parental involvement, that uniquely predicts numeracy.

Although both predictors demonstrated significant bivariate relationships with numeracy performance, only children's social interaction emerged as a significant unique predictor in the regression model. This finding suggests that social interaction represents the more proximal developmental mechanism through which numeracy skills are acquired during early childhood. Opportunities for peer engagement may directly support the development of mathematical reasoning by exposing learners to diverse perspectives, verbal exchanges, and collaborative problem-solving experiences. The result extends existing evidence regarding the role of social learning in mathematics education. Previous studies have emphasized that mathematical competence develops not only through individual practice but also through meaningful participation in social and instructional environments (Chang, 2023; Hiltrimartin, 2024). In developing countries, effective parental involvement is characterized by meaningful collaboration between families and schools, fostering supportive learning environments that enhance children's academic and socio-emotional development (Cariaga et al., 2025).The present findings provide empirical support for this perspective by demonstrating that children's social interaction contributes uniquely to numeracy performance even after accounting for parental involvement. This reinforces the central proposition of Sociocultural Theory that cognitive development is mediated through social experiences and interactions within learners' immediate environments (Vygotsky, 1978).

Conversely, parental involvement did not demonstrate a significant unique contribution when considered alongside children's social interaction. This finding should not be interpreted as diminishing the importance of parental engagement. Rather, it suggests that the effects of parental involvement may operate indirectly through pathways that support children's social, motivational, or cognitive development. Parental support has been identified as a key contributor to children's academic achievement and educational experiences across various contexts. Recent scholarship further emphasizes that parental involvement should be inclusive, culturally responsive, and adapted to the realities of developing-country educational systems to maximize its impact on learner outcomes (Cariaga et al., 2025). The finding aligns with research indicating that parental involvement is most effective when it promotes meaningful learning experiences rather than simply increasing the frequency of parental participation (Sarmiento et al., 2025; Ghazali et al., 2021). Consequently, parental involvement may serve as a foundational condition that facilitates children's broader developmental experiences rather than functioning as a direct determinant of numeracy performance. The substantial unexplained variance in the model further indicates that additional factors contribute to numeracy achievement. Prior studies have identified instructional quality, language proficiency, school support systems, learner motivation, and socioeconomic conditions as influential determinants of mathematical development (Claessens & Engel, 2013; Bleses et al., 2023; Gesuelli et al., 2025). Future investigations should therefore adopt more comprehensive predictive frameworks that integrate cognitive, instructional, and contextual variables to provide a fuller understanding of early numeracy development.

Taken together, the findings provide empirical evidence that social interaction constitutes a critical pathway through which young learners acquire foundational mathematical competencies. By demonstrating the relative predictive strength of social interaction within a rural Philippine context, the study contributes to the growing international literature emphasizing the social foundations of early mathematics learning and offers support for educational approaches that prioritize collaborative and interactive learning environments.

Table 3
Multiple Linear Regression Analysis Predicting Early Childhood Numeracy Performance (N = 78)

Predictor	B	SE B	β	t	p	Decision on H_0
Constant	0.582	0.388	—	1.498	.138	—
Parental Involvement	0.069	0.048	.152	1.441	.154	Accept H_0
Children's Social Interaction	0.159	0.040	.413	3.929	< .001	Reject H_0

Model Summary

Statistic	Value
R	.475
R^2	.226
F(2, 75)	10.942
p	< .001

Note. Dependent variable: Early Childhood Numeracy Performance. The regression model significantly predicted numeracy performance, $F(2, 75) = 10.942$, $p < .001$, explaining 22.6% of the variance in numeracy performance.

Theoretical and Practical Implications

These findings partially affirm Sociocultural Theory (Vygotsky, 1978). The theory posits that cultural tools (parental involvement) and social interactions (peer interaction) benefit cognitive development. While social interaction demonstrated strong predictive validity, parental involvement as a cultural tool did not uniquely predict numeracy performance. This partial affirmation suggests that in the context of early numeracy, peer social interaction may be a more powerful mechanism than home-based parental teaching. Practically, the results imply that educational leaders should prioritize classroom strategies that foster structured peer interaction.

Limitations

Several limitations affect interpretation. First, the single-school, modest sample size (N = 78) restricts generalizability. Second, the low explained variance (22.6%) indicates that key predictors remain unmeasured. Third, self-report bias may affect parental involvement data. Fourth, the teacher-researcher's dual role may introduce positionality bias. Despite these limitations, the study offers original empirical evidence from an underrepresented rural Philippine population and integrates two predictors within a single analytic model.

Conclusion and Recommendations

This study examined the predictive roles of parental involvement and children's social interaction in early childhood numeracy performance among kindergarten learners in a rural Philippine context. The findings indicate that children's social interaction emerged as the strongest predictor of numeracy performance, whereas parental involvement did not demonstrate a significant unique contribution when both variables were considered simultaneously. These results suggest that opportunities for peer engagement, communication, and collaborative learning may play a more influential role in early numeracy development than home-based involvement alone. The findings contribute to the growing body of literature on early childhood mathematics education by extending the application of Sociocultural Theory to rural educational settings. Specifically, the study highlights the importance of social learning processes in supporting the development of foundational numeracy skills among young learners. By integrating parental involvement and social interaction within a single predictive framework, the study provides a clearer understanding of their relative contributions to early numeracy outcomes.

From a practical perspective, educators and school leaders should strengthen classroom environments that encourage meaningful peer interaction through cooperative learning, guided play, and collaborative problem-solving activities. Parent engagement initiatives should likewise focus on enhancing the quality of home-based numeracy support through targeted training and resource provision. Future research should examine additional cognitive, instructional, and socioeconomic factors that may further explain variations in numeracy performance across diverse educational contexts.

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