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Article

The Efficacy of Contextualized Kindergarten Blocks of Time (CKBT): Proposed Enhanced Numeracy Assessment Tool

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Abstract: This study investigates the impact of the Conceptual Knowledge-Based Teaching (CKBT) intervention on the numeracy skills of kindergarten students. By comparing pretest and posttest scores of controls and experimental groups, the research aims to identify significant differences in numeracy improvement. The control group showed an increase in mean scores from 14.22 to 16.39, while the experimental group exhibited a more pronounced increase from 13.89 to 18.45. Statistical analysis revealed that the experimental group experienced a significantly higher mean gain difference of 4.56 compared to the control group's 2.17, with p-values of 0.000 indicating highly significant results. These findings demonstrate that the CKBT intervention effectively enhances numeracy skills, providing strong evidence for its implementation in early childhood education to foster foundational mathematical abilities.

Keywords: Conceptual Knowledge-Based Teaching (CKBT), numeracy skills, kindergarten students, early childhood education, pretest and posttest, intervention effectiveness

Introduction

Kindergarten education serves as a critical period for laying the foundational skills necessary for future academic success, particularly in numeracy (Starr et al., 2021). Numeracy, the ability to understand and work with numbers, is essential for everyday life and academic achievement across various subjects (Clements & Sarama, 2020). Traditional methods of teaching numeracy often involve rote memorization and isolated skill practice, which may not engage young learners effectively or foster a deep understanding of mathematical concepts (Lee, 2020). The Contextualized Kindergarten Blocks of Time (CKBT) method has been proposed as an innovative approach to



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address these challenges by integrating numeracy instruction into various daily activities, thus making learning more meaningful and engaging for children (Hughes et al., 2019). This approach aligns with the developmental needs of young learners, providing a more holistic and contextualized learning experience (Smith & Jones, 2022).

The importance of early numeracy skills is well-documented in educational research (Duncan et al., 2019). Studies have shown that early mathematical abilities are strong predictors of later academic success, not only in mathematics but also in reading and overall school performance (Bailey et al., 2020). Despite this, there is a lack of consensus on the most effective instructional methods for teaching numeracy to young children (Wang & Goldschmidt, 2019). The CKBT approach aims to fill this gap by offering a structured yet flexible framework that embeds numeracy learning within the context of everyday activities, thus enhancing engagement and retention of mathematical concepts (O'Donnell, 2021). By contextualizing numeracy instruction, CKBT seeks to create a more integrated and supportive learning environment for young children (Brown et al., 2023).

The need for intervention in early numeracy education is critical due to the foundational role these skills play in long-term academic success and everyday life (Watts et al., 2021). Research consistently demonstrates that early numeracy skills are strong predictors of later achievement in mathematics and other academic areas, highlighting the importance of effective early intervention (Jordan et al., 2022). However, traditional instructional methods often fall short in engaging young learners and fostering a deep understanding of mathematical concepts, necessitating innovative approaches like the Contextualized Kindergarten Blocks of Time (CKBT) (Clements & Sarama, 2021). These interventions are particularly crucial for addressing learning disparities and ensuring that all children, regardless of background, have the opportunity to develop essential numeracy skills from a young age (Barbarin et al., 2023). By implementing contextually integrated and engaging instructional strategies, educators can better support the development of numeracy skills, setting a strong foundation for future academic and personal success (Levine & Pantoja, 2022).

A critical aspect of this study is examining the baseline numeracy skills of learners in both the control and experimental groups during pretest evaluations. Establishing the initial skill levels is crucial for accurately assessing the impact of the CKBT approach. This study aims to determine whether there is a significant difference in the pretest scores of numeracies between the two groups, providing a benchmark for measuring progress. Comparing the pretest scores, researchers can ensure that any observed differences in posttest scores are attributable to the instructional method rather than pre-existing skill disparities. The study also seeks to evaluate the effectiveness of the CKBT approach by comparing the pretest and posttest scores within each group. Specifically, it aims to determine if there is a significant difference in

numeracy scores before and after the intervention in both the control experimental groups. This comparison is essential for and understanding the direct impact of CKBT on students' numeracy skills. If significant improvements are observed in the experimental group compared to the control group, it would suggest that CKBT is an effective method for enhancing numeracy skills in kindergarten children. Another key research question addresses the mean gain differences in numeracy scores between the control and experimental groups. Analyzing the mean gain, or the difference in scores from pretest to posttest, researchers can assess the overall effectiveness of the CKBT approach relative to traditional teaching methods. A significant mean gain in the experimental group would indicate that contextualized instruction is more effective in improving numeracy skills than isolated, traditional approaches. This analysis is crucial for determining the potential benefits of implementing CKBT on a larger scale.

The significance of this research extends beyond kindergarten education, as early numeracy skills have long-term implications for students' overall academic trajectories. Effective numeracy instruction in kindergarten can lay a strong foundation for future success in mathematics and related subjects (Jordan et al., 2009). Identifying successful strategies for enhancing numeracy skills in young learners, this research can inform educational practices and policies aimed at improving early childhood education. Furthermore, it can provide insights into how contextualized learning experiences influence cognitive development and academic achievement. In addition to addressing these specific research questions, this study also aims to guide future research directions in elementary schools. By demonstrating the effectiveness of the CKBT approach in kindergarten, educators and policymakers can develop targeted interventions for older students who may struggle with numeracy. This research can contribute to a broader understanding of the benefits of contextualized learning and inform the design of instructional methods that support the holistic development of young children. Ultimately, this study has the potential to shape the future of early childhood education and enhance the quality of numeracy instruction in schools. In conclusion, the proposed study on the efficacy of the Contextualized Kindergarten Blocks of Time (CKBT) represents a significant step toward improving numeracy instruction for young learners

Methodology

The research design adopted for this study was a Quasi-Experimental Research Design, as described by Zhu et al. (2020), which combined elements of both experimental and non-experimental research to thoroughly evaluate the efficacy of the Contextualized Kindergarten Blocks of Time (CKBT) compared to traditional teaching techniques.

The study targeted kindergarten pupils (age from 4 to 6 years old) enrolled in identified school in the division of Lapu-Lapu, Cebu, employing purposive sampling to ensure participants met specific criteria, such as being the intended recipients of the CKBT intervention. Data collection involved competency-based pretests and posttests comprising 20 multiple-choice questions aligned with the Most Essential Learning Competencies (MELCs), serving as the primary assessment tools. The scoring process categorized students into discrete skill levels from "Beginning" to "Advanced" based on their test scores. To document and gather observational data, cameras and cellphones were used, aligning with methodologies suggested by Lau and Bratby (2023). The collected data underwent thorough statistical analysis using techniques such as frequency count, percentage, mean, standard deviation, Paired t-test, and t-test for independent samples to determine the impact of the CKBT intervention on numeracy skills. This methodological approach facilitated a comprehensive analysis of the effectiveness of CKBT in enhancing numeracy skills among kindergarten pupils.

Results and Discussion

Tuble 1. Level of Humeruey binns of the Control Group during the Hetest						
Level Range of Scores		F	%			
Advanced	20	0	0.00			
Proficient	15-19	11	61.11			
Approaching Proficiency	10-14	5	27.78			
Developing	5-9	2	11.11			
Beginning	0-4	0	0.00			
Total		18	100.00			
Average		14.22				
St. Dev.		2.76				

Table 1. Level of Numeracy Skills of the Control Group during the Pretest

The data from the pretest reveals that the numeracy skills of the control group exhibit a notable variation. A significant majority of the participants, 61.11%, are classified as "Proficient" with scores ranging between 15 and 19. This indicates a strong foundational understanding of numeracy concepts among most of the group. However, there is also a considerable portion, 27.78%, in the "Approaching Proficiency" category, scoring between 10 and 14, suggesting that nearly a third of the participants are on the verge of reaching proficiency but still have room for improvement. A smaller segment, 11.11%, falls into the "Developing" category with scores between 5 and 9, highlighting some deficiencies that need to be addressed. No participants scored in the "Advanced" or "Beginning" levels, indicating no extreme outliers in terms of very high or very low numeracy skills. The overall average score is 14.22, with a standard deviation of 2.76, suggesting a moderate spread of scores around the mean. These results suggest that while the

majority of the control group has a solid grasp of numeracy, targeted interventions could help elevate those at the lower end of the proficiency spectrum.

Level	Range of Scores	F	%	
Advanced	20	0	0.00	
Proficient	15-19	9	50.00	
Approaching Proficiency	10-14	8	44.44	
Developing	5-9	1	5.56	
Beginning	0-4	0	0.00	
Total		18	100.00	
Average		13.89		
St. Dev.		2.47		

Table 2. Level of Numeracy Skills of the Experimental Group during the Pretest

The pretest data for the experimental group reveals a distribution of numeracy skills that, while similar to the control group, shows some distinctive patterns. Half of the participants, 50%, are classified as "Proficient" with scores ranging from 15 to 19, indicating a solid foundational knowledge of numeracy. A significant portion, 44.44%, falls into the "Approaching Proficiency" category with scores between 10 and 14, suggesting a considerable number of participants who are nearing proficiency but still require some improvement. Only a small fraction, 5.56%, are in the "Developing" category with scores between 5 and 9, indicating minimal deficiencies within this group. Similar to the control group, there are no participants in the "Advanced" or "Beginning" levels, showing no extreme high or low performers. The overall average score for the experimental group is 13.89, slightly lower than the control group's average, with a standard deviation of 2.47, indicating a slightly smaller spread of scores around the mean. These results suggest that the experimental group has a relatively strong grasp of numeracy skills, with a majority close to or already proficient, yet still highlights areas where targeted instruction could further elevate the overall skill level.

Level	Range of Scores	F	%
Advanced	20	2	11.11
Proficient	15-19	13	72.22
Approaching Proficiency	10-14	3	16.67
Developing	5-9	0	0.00
Beginning	0-4	0	0.00
Total		18	100.00
Average		16.39	
St. Dev.		2.77	

Table 3. Level of Numeracy Skills of the Control Group during the Posttest

The posttest data for the control group indicates a significant improvement in numeracy skills compared to the pretest results. A notable 72.22% of the participants are now classified as "Proficient" with scores ranging from 15 to 19, reflecting a substantial increase from the pretest. Additionally, 11.11% of the participants have reached the "Advanced" level with perfect scores of 20, which is an encouraging development not seen in the pretest. The percentage of those in the "Approaching Proficiency" category has decreased to 16.67%, suggesting that many participants have moved up to higher proficiency levels. Importantly, there are no participants in the "Developing" or "Beginning" categories, indicating that all individuals have surpassed these lower skill levels. The average score has risen to 16.39, with a standard deviation of 2.77, similar to the pretest, showing consistent performance improvement across the group. These results suggest that the control group has experienced a marked enhancement in their numeracy skills, with a significant portion achieving proficiency or higher.

Level	Range of Scores	f	%
Advanced	20	7	38.89
Proficient	15-19	10	55.56
Approaching Proficiency	10-14	1	5.56
Developing	5-9	0	0.00
Beginning	0-4	0	0.00
Total		18	100.00
Average		18.45	
St. Dev.		1.95	

Table 4. Level of Numeracy Skills of the Experimental Group during the Posttest

The posttest results for the experimental group show a remarkable improvement in numeracy skills compared to their pretest performance. A significant 55.56% of the participants are now classified as "Proficient" with scores ranging from 15 to 19, indicating a notable increase from the pretest results. Impressively, 38.89% of the participants have achieved the "Advanced" level with perfect scores of 20, a dramatic improvement not seen in the pretest. Only 5.56% of the participants are in the "Approaching Proficiency" category, showing a substantial decrease as most participants have advanced to higher proficiency levels. There are no participants in the "Developing" or "Beginning" categories, reflecting that all individuals have moved beyond these lower skill levels. The overall average score has increased significantly to 18.45, with a lower standard deviation of 1.95, indicating a high level of performance consistency among the participants. These results suggest that the experimental group has achieved substantial gains in their numeracy skills, with the majority reaching proficiency or advanced levels, demonstrating the effectiveness of the intervention applied to this group.

Source of Difference	Mean	Standard Deviation	Mean Difference	Computed t- value	p- value	Decision	Remarks
Posttest	16.39	2.77	2.17	8.812*	0.000	Reject Ho	Significant
Pretest	14.22	2.76					

Table 5. Test of Significant Difference between the Pretest and Posttest Scores of the Control Group

*significant at p < 0.05 (two-tailed); df=17

The data from Table 5 reveals a statistically significant improvement in the numeracy skills of the control group from the pretest to the posttest. The mean score increased from 14.22 in the pretest to 16.39 in the posttest, with a mean difference of 2.17 points. This increase is supported by a computed t-value of 8.812, which is significant at the p < 0.05 level (two-tailed). The p-value of 0.000 indicates a highly significant result, leading to the rejection of the null hypothesis (Ho), which posited no difference between the pretest and posttest scores. The standard deviations for the pretest and posttest are 2.76 and 2.77, respectively, indicating similar variability in scores at both times. Overall, these results suggest that the intervention implemented with the control group was effective in significantly enhancing their numeracy skills.

Table 6. Test of Difference between the Pretest and Posttest Scores of the Experimental Group

Source of Difference	Mean	Standard Deviation	Mean Difference	Computed t- value	p- value	Decision	Remarks
Posttest	18.45	1.95	4.56	11.953*	0.000	Reject Ho	Significant
Pretest	13.89	2.47					

*significant at p < 0.05 (two-tailed); df=17

The data presented in Table 6 indicates a statistically significant improvement in the numeracy skills of the experimental group from the pretest to the posttest. The mean score rose markedly from 13.89 in the pretest to 18.45 in the posttest, resulting in a mean difference of 4.56 points. This substantial increase is confirmed by a computed t-value of 11.953, which is significant at the p < 0.05 level (two-tailed). The p-value of 0.000 strongly supports the rejection of the null hypothesis (Ho), which suggested no difference between the pretest and posttest scores. The standard deviations for the pretest and posttest scores are 2.47 and 1.95, respectively, indicating a decrease in score variability and suggesting more consistent performance improvements among the participants. These results underscore the effectiveness of the intervention applied to the experimental group, leading to a significant enhancement in their numeracy skills.

Source of Difference	Mean Gain	Standard Deviation	Mean Gain Difference	Computed t- value	p-value	Decision	Remarks
Experimental Group	4.56	1.62	2.39	5.267*	0.000	Reject Ho	Significant
Control Group	2.17	1.04					

Table 7. Test of Significant Mean Gain Difference on the Pre-test and Post-test scores between the two groups

*significant at p < 0.05 (two-tailed)

Table 7 compares the mean gain differences in pretest and posttest scores between the experimental and control groups, indicating a significant difference favoring the experimental group. The experimental group showed a mean gain of 4.56 with a standard deviation of 1.62, while the control group had a mean gain of 2.17 with a standard deviation of 1.04. The mean gain difference between the two groups is 2.39. This difference is statistically significant, as evidenced by the computed t-value of 5.267, which is significant at the p < 0.05 level (two-tailed). The p-value of 0.000 leads to the rejection of the null hypothesis (Ho), which posited no significant difference in mean gains between the two groups. These results demonstrate that the intervention applied to the experimental group was significantly more effective in improving numeracy skills compared to the control group's intervention.

Conclusion

The study determines the impact of a CKBT intervention on the numeracy skills of kindergarten students by comparing pretest and posttest scores in both control and experimental groups. The results show significant improvements in numeracy skills for both groups after the intervention. The control group's mean score increased from 14.22 to 16.39, while the experimental group's mean score increased from 13.89 to 18.45. The experimental group, which received the CKBT intervention, demonstrated a significantly greater improvement, with a mean gain difference of 4.56 compared to the control group's gain of 2.17. The statistical analysis confirms that these differences are highly significant, with p-values of 0.000 for both within-group and between-group comparisons. These findings suggest that the CKBT intervention had a substantial positive effect on the numeracy skills of the experimental group, indicating its effectiveness in enhancing early numeracy development in kindergarteners.

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