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Treasure Hunt Educational Game to Improve Grade 1 Early Mathematics Skills

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Abstract: This study aimed to examine whether the educational game stimulus "Mencari Harta Karun" (Treasure Hunt) could improve early mathematics competence among Grade 1 primary pupils. The study was conducted at SDN Puncak (Dusun 1, Desa Genteng) using a quantitative one-group pretest–posttest design. Twenty Grade 1 pupils participated and completed both assessments. The intervention was implemented across six sessions, including preparation of the board-game media and question cards (addition and subtraction within 1–20), a baseline pretest, three guided gameplay sessions facilitated by the class teacher, and a posttest. Primary data were pupils' pretest and posttest scores, analysed using descriptive statistics and a paired-samples significance test, with effect size reported to estimate practical impact. Results showed an increase in mean scores from 7.85 (SD = 1.56) to 8.95 (SD = 1.28) out of a maximum possible score of 10, suggesting a noticeable improvement in students' early numeracy achievement and also indicating an average gain of 1.10 points, with a statistically significant difference ($p = 0.004$). The intervention effect was moderate-to-large (Cohen's $d \approx 0.74$), suggesting educationally meaningful improvement rather than a marginal change. Posttest dispersion was also lower, indicating more consistent attainment across pupils after the intervention. This study contributes evidence that a low-resource, non-digital "Treasure Hunt" game, aligned with indicator-based numeracy assessment, can function as a practical instructional approach for strengthening early mathematics competence in Grade 1. The findings support integrating structured game-based activities into routine early-grade numeracy learning, particularly in contexts with limited access to technology-based learning media.

1. Introduction

Early mathematical abilities in lower primary school students are an important foundation for mathematics learning at subsequent levels (Onoshakpokaiye, 2023; Wongupparaj & Kadosh, 2021). Mathematics is hierarchical in nature, whereby mastery of basic concepts such as number recognition, the relationship between numbers and quantities, and addition and subtraction operations are prerequisites for understanding more complex concepts later on (Jordan et al., 2022; Safari & Faradila, 2024). When students have not adequately mastered these early skills, they will encounter recurring difficulties that are not caused by incompetence, but rather by a weak conceptual foundation (Hanifa & Usodo, 2025).

In early classroom learning practices, weaknesses in numeracy skills often manifest in simple forms, such as misreading number symbols or mismatching numbers with concrete objects (Jarmita, 2015; Ningrum et al., 2025). Although these errors appear basic, they have significant consequences because fundamental arithmetic operations serve as essential tools across various mathematical tasks and classroom activities (Safari & Nurhida, 2024). When these foundational skills are not well established, students tend to experience difficulties in understanding contextual problems, comparing quantities, and carrying out simple procedures (Amalia et al., 2024; Ayunani & Indriati, 2020; Sa'diyah et al., 2024), which over time may reduce motivation, lower self-confidence, and weaken engagement in mathematics learning. These challenges are not solely attributable to individual cognitive factors but are also influenced by the broader social and instructional environment, including limited learning support at home, low parental involvement, and insufficient variation in teaching strategies (Hidayati et al., 2022). Furthermore, approaches that merely increase the amount of practice exercises are often inadequate to address foundational gaps (Hartwig & Rohrer, 2025; Vaughn et al., 2012), highlighting the need for learning strategies that provide richer, more active, enjoyable, and meaningful experiences to effectively strengthen early numeracy skills ((Clements & Sarama, 2020; Van Oers, 2020).

Within the framework of cognitive development theory, primary school students are generally at the concrete operational stage (ages 7–12) according to Piaget (A. Agustyaningrum & Pradanti, 2022). At this stage, children begin to be able to think logically, but still rely on real objects and direct experiences to understand abstract concepts (N. Agustyaningrum & Pradanti, 2022). Therefore, effective mathematics learning for children of this age needs to involve concrete, exploratory activities and provide space for physical manipulation and social interaction. Vygotsky added the importance of scaffolding and social cooperation in shaping mathematical understanding through gradual assistance from more expert individuals, including teachers or peers (N. Agustyaningrum & Pradanti, 2022; Perry, 2019).

Unfortunately, the learning models used in the field still tend to be conventional: lectures, repetitive exercises, and media with minimal variation. Meanwhile, some early grade students actually need a flexible, visual, and game-based approach to optimise their understanding (N. Agustyaningrum & Pradanti, 2022; Hayat et al., 2024). Technology-based learning media such as Android applications and Augmented Reality have been proven to increase student engagement and understanding of mathematical material (Hristova & Topalska, 2025; Seabra et al., 2025), but their implementation has not been widespread due to limitations in infrastructure and teacher competence (Zulminiati et al., 2023).

In these circumstances, non-digital educational games are a relevant alternative. These media have the advantages of low cost, flexibility of use, and ease of adaptation in various classroom conditions (Bay-Aken, 2025). Research also shows that traditional educational games can improve numeracy skills, stimulate learning motivation, and enrich students' cognitive experiences (Ashadi, 2022; Irwanti & Azizah, 2025). Educational games combine elements of play and learning, so that children not only understand mathematical.

However, although the literature has extensively discussed the benefits of educational games, there are still limited studies that specifically examine their impact on the early mathematical abilities of first-grade primary school students in a real classroom context. Therefore, this study focuses on the development and implementation of a simple educational game entitled 'Searching for Treasure'. This game is designed to provide a combination of basic numeracy exercises, exploratory activities, and social interactions that are in line with the characteristics and needs of early grade students. Thus, this study is expected to provide empirical contributions to the development of more active, enjoyable, and effective mathematics learning strategies in lower grades of primary school.

This study aims to test the effectiveness of the educational game stimulus 'Treasure Hunt' in improving the early mathematics abilities of first-grade elementary school students. The activity was carried out at SDN Puncak, Dusun 1, Genteng Village, with six learning sessions that actively involved teachers and students. This location was chosen based on preliminary observations which showed that most first-grade students at the school still had difficulties in basic numeracy, such as recognising number symbols, connecting numbers with concrete objects, and performing simple addition and subtraction operations fluently. In addition, mathematics learning practices in the classroom tended to be conventional, dominated by lectures and written exercises, without much use of concrete media or activities that support active learning. This condition was a strong reason to implement a simple, cost-effective, easily replicable, non-digital educational game-based intervention that was appropriate for the cognitive development stage of early grade students. The measurement focus is directed at four main indicators of early numeracy, namely: (1) recognition of number symbols, (2) the ability to connect numbers and quantities, (3) basic arithmetic skills, and (4) understanding of quantity comparisons. In the instrument development, the fourth indicator was operationalized into two measurable aspects: (4.a) number ordering (seriation) and (4.b) direct quantity comparison, based on prior studies suggesting that quantity comparison can be assessed through both sequencing and explicit comparative judgments. Consequently, although conceptually framed into four domains, the instrument consists of five observable indicators to allow a more detailed measurement of students' comparison skills. In addition to testing the effectiveness of these learning media, this study also aims to provide an empirical basis for lower grade teachers in designing more active, contextual, and enjoyable mathematics learning, in accordance with the characteristics of children in the concrete operational stage (Piaget), and in line with the principles of social interaction and scaffolding in learning according to Vygotsky (N. Agustyaningrum & Pradanti, 2022; Clements & Sarama, 2020; Van Oers, 2020).

Based on the background and objectives of the study, the hypothesis proposed in this study is that the use of the educational game 'Treasure Hunt' will have a positive impact on the early mathematical abilities of first-grade students at SDN Puncak, Dusun 1, Genteng Village. This hypothesis is formulated based on the assumption that game-based learning can create a more concrete, enjoyable, and participatory learning atmosphere, which is in line with the cognitive development characteristics of primary school children. By actively involving students in exploratory activities, this game is expected to strengthen their understanding of basic numeracy concepts, while also increasing their motivation to learn.

This hypothesis is reinforced by Piaget's developmental theory, which emphasises the importance of concrete experiences in learning mathematics at the concrete operational stage, as well as Vygotsky's sociocultural approach, which underlines the role of social interaction and scaffolding in supporting concept formation (N. Agustyaningrum & Pradanti, 2022; Clements &

Sarama, 2020). Empirically, previous studies have also shown that educational games can improve students' numeracy understanding and learning engagement in early grades (Bay-Aken, 2025; Irwanti & Azizah, 2025; Seabra et al., 2025)

2. Methodology

This study investigated a classroom-based educational game stimulus, “Mencari Harta Karun” (Treasure Hunt), implemented to strengthen early mathematics competence among Grade 1 primary pupils. The selected case was the structured use of the game as a learning activity and the measurable change in pupils’ numeracy performance before and after the intervention. The study was conducted at SDN Puncak, Dusun 1, Desa Genteng, chosen because the Grade 1 cohort was engaged in foundational numeracy learning and the class setting enabled the intervention to be implemented in a consistent manner with teacher facilitation. The event examined was a six-session implementation cycle in which the game was introduced, delivered in repeated learning sessions, and evaluated through pretest and posttest measures.

The study employed a quantitative approach using a one-group pretest–posttest design to capture changes in pupils’ performance following the intervention. Primary data consisted of individual pupils’ pretest and posttest scores collected immediately before and after the intervention cycle. Secondary data comprised structured documentation of the implementation process, including preparation activities and classroom delivery notes, as well as the indicator framework used to construct assessment items. The indicators and item construction were aligned with prior work on early numeracy competence and cognitive constructs relevant to learning with concrete representations (Hayat et al., 2024; Lestari et al., 2023; Moritz & Wilbert, 2018). These secondary materials were used to support procedural transparency and to demonstrate coherence between what pupils practised during the game and what was assessed in the tests.

The participants were 20 Grade 1 pupils at SDN Puncak who completed both the pretest and posttest during the study period. The class consisted of children aged approximately 6–7 years, who were in the early stages of developing basic numeracy skills, particularly addition and subtraction within the range of 1–20. The Grade 1 teacher collaborated as the implementing partner, assisting in classroom management and ensuring the intervention was conducted consistently.

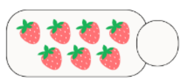
The study was conducted over six sessions. The first session involved preparation of the board-game-based learning media and a brief teacher orientation. The second session administered the pretest to establish baseline competence. Sessions three to five implemented the intervention through guided small-group gameplay using question cards focused on basic arithmetic. The sixth session administered the posttest to measure pupils’ competence after the intervention.

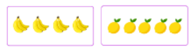
Data collection relied primarily on the pretest and posttest instruments aligned to five indicators of early mathematics competence: recognising and producing number symbols (0–20), matching number symbols to concrete quantities, performing simple addition and subtraction supported by concrete representations, ordering numbers up to 20, and comparing quantities (more than, less than, equal) (Hayat et al., 2024; Lestari et al., 2023; Moritz & Wilbert, 2018). The test items used concrete visual prompts and simple tasks (for example counting objects, drawing a specified number of marks, and selecting the larger or smaller set) to reflect the competence targets practised during the game. Classroom documentation was collected as supporting evidence to record the flow of implementation and to confirm that the planned procedures were carried out consistently across the intervention sessions.

All pretest and posttest scores were compiled per pupil and checked for completeness prior to analysis. The dataset was first processed using descriptive statistics to summarise minimum and maximum scores, means, and standard deviations for both measurement points, enabling the study to describe overall change and score dispersion. Pretest and posttest means were then compared using a paired-samples significance test at the 0.05 level to determine whether the observed difference was statistically significant. To support practical interpretation, effect size was calculated to estimate the magnitude of the intervention's impact, and a correlation analysis was conducted to describe the association between baseline and post-intervention performance. Together, these analyses were used to present both the statistical and practical implications of the game-based intervention for early numeracy competence. An illustration of the Treasure Hunt Game used in the intervention and the research instrument employed to assess pupils' numeracy competence are presented in Figure 1 and Table 1, respectively.

Figure 1 Treasure Hunt Game

Table 1. Research Instrument

Indicator	Theoretical Basis / Previous Research	Pre-Test Items	Post-Test Items
Recognizing and naming number symbols (0–20) orally and in writing	Understanding symbols as the foundation of concrete thinking (Börnert-Ringleb & Wilbert, 2018)	What number is this? (15) Please write the number "eleven."	What number is this? (18) Please write the number "twenty."
Matching number symbols with the quantity of concrete objects	Conservation and classification skills; recognizing that quantity remains unchanged despite changes in arrangement (Hayat et al., 2024)	Count the number of strawberries shown below.  Draw 8 circles.	Count the number of mangoes shown below.  Draw 11 lines.
Performing simple addition and subtraction using concrete objects	Beginning to perform arithmetic operations at the concrete operational stage (Lestari et al., 2023)	Count the total number of kiwis shown below.  Some toys have been taken away. Count how many toys remain. 	Count the total number of apples shown below.  Some toys have been taken away. Count how many toys remain. 

Arranging numbers in ascending and descending order (up to 20)	Seriation as an indicator of concrete operational thinking (Hayat et al., 2024)	Arrange these numbers from the smallest to the largest: 5, 7, 3. Arrange these numbers from the largest to the smallest: 15, 18, 12.	Arrange these numbers from the smallest to the largest: 16, 18, 14. Arrange these numbers from the largest to the smallest: 3, 9, 6.
Demonstrating the concepts of "more," "less," and "equal" through comparisons of concrete objects	Understanding conservation and quantity comparison (Börnert-Ringleb & Wilbert, 2018)	Circle the group that has more objects.  Circle the group that has fewer objects. 	Circle the group that has more objects.  Look at the picture below. The number of lemons is _____ than the number of bananas. 

3. Results

The results indicate an overall improvement in pupils' early mathematics competence following participation in the "Mencari Harta Karun" (Treasure Hunt) intervention. Across the 20 Grade 1 pupils, the average posttest score was higher than the average pretest score, suggesting that the game-based learning activities contributed positively to numeracy development. In addition, score variability decreased after the intervention, indicating more consistent performance among pupils. Detailed descriptive statistics are presented in Table 2.

Table 2 Descriptive Statistics of Pretest and Posttest Scores

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	20	6,00	10,00	7,8500	1,56525
Posttest	20	6,00	10,00	8,9500	1,27630
Valid N (listwise)	20				

Table 2 presents the descriptive statistics for pupils' early mathematics competence before and after the "Mencari Harta Karun" (Treasure Hunt) intervention. Prior to gameplay-based learning, the Grade 1 pupils (N = 20) achieved a mean pretest score of 7.85 (SD = 1.57), with scores ranging from 6 to 10. Following the intervention, the mean posttest score increased to 8.95 (SD = 1.28), with the same observed range (6 to 10). The increase in the mean score indicates an overall improvement in early mathematics competence after pupils engaged in the structured game activities.

To provide a visual comparison of pupils' performance before and after the intervention, Figure 2 illustrates the mean scores and associated variability across the two measurement points.

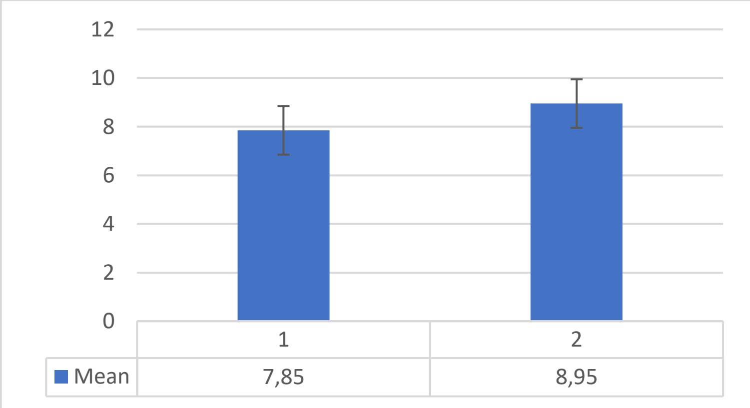


Figure 2 Mean Pretest and Posttest Scores

In addition to the mean increase, the reduction in standard deviation from 1.57 (pretest) to 1.28 (posttest) suggests that pupils' performance became more consistent after the intervention. This pattern is aligned with what is shown in the mean comparison visualisation (Figure 2), where the posttest error bar is smaller than the pretest error bar. In practical classroom terms, this indicates that the intervention did not only benefit a small subset of higher-performing pupils, but also contributed to a more even distribution of competence across the class. Such a shift is important in early-grade numeracy contexts where baseline competence often varies considerably at the start of schooling.

Table 3 Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	7,8500	20	1,56525	,35000
	Posttest	8,9500	20	1,27630	,28539

Table 3 summarizes paired data: pretest mean 7.85 (SD 1.57), posttest 8.95 (SD 1.28), and mean difference 1.10. This confirms the average gain after three game sessions with teacher guidance. Scores improved across the class, reflecting real learning from structured play and feedback.

The paired-sample summary (Table 3) confirms the same pattern using matched observations for the same pupils at two time points. The mean pretest score was 7.85 (SD = 1.56), while the mean posttest score was 8.95 (SD = 1.28), producing an average gain of 1.10 points. This gain reflects improvement after three gameplay sessions delivered between the two tests, supported by teacher facilitation and repeated practice. The observed change represents the combined effect of structured exposure to core numeracy tasks and immediate feedback in a game setting.

Table 4 Paired Samples Correlations

			Significance	
	N	Correlation	One-Sided p	Two-Sided p
air 1Pretest & Posttest	20	,470	,018	,036

Table 4 reports moderate positive correlation between pretest and posttest ($r = 0.47$, $p = 0.036$). Students with higher starting scores stayed relatively ahead but all benefited. The correlation isn't too strong, so the game added new gains beyond baseline ability.

Table 4 reports a moderate positive association between baseline and post-intervention performance ($r = 0.47$, $p < 0.05$). This suggests that pupils who entered with stronger early mathematics competence generally remained relatively stronger after the intervention, while still benefiting from the learning cycle. At the same time, the correlation is not so high that it implies the posttest results were merely a continuation of baseline ranking, meaning the intervention likely contributed meaningful learning gains beyond initial differences. This is consistent with classroom realities where pupils respond differently to the same learning activity due to attention, confidence, and prior exposure to numeracy at home or in early childhood settings (Hidayati et al., 2022).

Table 5 Paired Samples Test

Paired Samples Test										
		Paired Differences							Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
Pair 1	Pretest - Posttest	-1,10000	1,48324	,33166	-1,79418	-,40582	-3,317	19	,002	,004

Table 5 shows the paired t-test: pretest-posttest difference is statistically significant (p = 0.004). This proves the “Mencari Harta Karun” intervention truly boosted early math skills, not by chance. For Grade 1 classrooms, this matters as baseline skills often vary widely.

The paired comparison test (Table 5) indicates that the difference between pretest and posttest scores was statistically significant (p = 0.004). This result supports the conclusion that pupils’ early mathematics competence improved after participation in the “Mencari Harta Karun” learning sessions. To complement statistical significance with practical interpretation, Table 6 reports an effect size estimate; Cohen’s d was reported as 0.74, which falls in the moderate-to-large range. Taken together, these findings indicate that the intervention delivered not only a statistically detectable change but also a meaningful improvement that is educationally relevant for Grade 1 numeracy development.

Table 6 Paired Samples Effect Sizes

					95% Confidence Interval	
			Standardizer[a]	Point Estimate	Lower	Upper
air 1	Pretest - Posttest	Cohen's d	1,48324	-,742	-1,231	-,237
		Hedges' correction	1,54519	-,712	-1,182	-,228

Table 6 gives Cohen's d = 0.74 (Hedges' g = 0.71), a medium-to-large effect. Posttest average was 0.74 SD above pretest not just statistically significant, but educationally meaningful. Even with small sample adjustment, the gain holds up.

Effect size estimates in Table 6 indicate that the improvement from pretest to posttest was educationally meaningful, not merely statistically significant. The reported Cohen’s d of approximately 0.74 suggests a moderate-to-large gain, meaning the average posttest performance was about three-quarters of a standard deviation higher than the pretest performance. In practical classroom terms, this magnitude implies that the “Mencari Harta Karun” intervention produced a substantial shift in early mathematics competence rather than a marginal increase.

Table 6 also reports Hedges’ correction, which adjusts the estimate for a relatively small sample size. The adjusted value remains close to Cohen’s d, indicating that the conclusion about the strength of the intervention effect is robust and not an artefact of sample size. Although the confidence interval in the table appears with negative values, this is a consequence of the direction used in computation (pretest minus posttest). Interpreted in the intended direction (posttest higher than pretest), the interval supports the same substantive conclusion: the intervention’s effect is of moderate-to-large magnitude and aligns with the significant paired comparison reported earlier (p = 0.004). ini menyajikan temuan penelitian secara sistematis berdasarkan tujuan penelitian. Hasil harus disajikan secara objektif, diikuti dengan pembahasan yang menginterpretasikan temuan tersebut dalam konteks teori dan literatur sebelumnya.

4. Discussion

This study provides evidence that the “Mencari Harta Karun” (Treasure Hunt) educational game supports measurable gains in the early mathematics competence of Grade 1 pupils. Pupils’ mean score increased from 7.85 (SD = 1.56) at pretest to 8.95 (SD = 1.28) at posttest (on a 10-point scale), and the difference was statistically significant (p = 0.004), with a moderate-to-large effect size (Cohen’s d ≈ 0.74). These findings indicate that the improvement was not only statistically detectable but also educationally meaningful in classroom practice. The reduced score dispersion further suggests that pupils’ learning outcomes became more evenly distributed after the intervention, particularly across foundational numeracy indicators such as number-symbol recognition, mapping symbols to quantities, simple operations, ordering, and comparison (Moritz & Wilbert, 2018).

The findings can be interpreted through Piaget’s theory of cognitive development, particularly the transition toward concrete operational thinking. Piaget argued that young children develop mathematical understanding most effectively when abstract concepts are linked to tangible experiences and observable objects. The Treasure Hunt Game provided opportunities for pupils to manipulate numerical information through concrete tasks such as counting objects, matching quantities with symbols, comparing sets, and performing simple arithmetic operations. These activities correspond closely to the development of classification, seriation, and conservation abilities that characterize the concrete operational stage. Consequently, the observed improvement in numeracy competence suggests that the intervention successfully transformed abstract mathematical concepts into meaningful experiences that were cognitively accessible to Grade 1 learners.

The findings are also consistent with constructivist learning theory, which views knowledge as actively constructed through interaction with learning tasks rather than passively received from teachers. During the intervention, pupils were required to solve problems, make decisions, and respond to numerical challenges while progressing through the game. Such experiences encouraged active engagement with mathematical concepts and allowed learners to construct understanding through repeated practice and immediate feedback. The research by Hieftje et al. (2017) explains this pattern, in evaluating a first-grade mathematics video game, found that structured gameplay can enhance engagement, provide repeated practice in a low-anxiety setting, and offer immediate feedback—mechanisms that are especially beneficial for pupils with initially weaker skills. This suggests that the gains observed in the present study may not only reflect increased practice but also the supportive learning environment created through game-based interaction, which can foster both cognitive consolidation and greater participation among early-grade learners.

These findings may also be understood through Vygotsky’s concept of the Zone of Proximal Development (ZPD), which emphasizes the importance of social interaction and instructional support in learning. The intervention was implemented with teacher facilitation and peer interaction, enabling pupils to receive guidance when encountering difficulties and gradually perform tasks independently. The combination of structured challenges and scaffolding may therefore have contributed to pupils’ ability to achieve higher levels of mathematical performance than would have been possible through individual practice alone.

Another interpretive layer concerns affective experience. While the statistical results demonstrate cognitive gains, the structure of the intervention, challenge cards, movement, and collaborative turn-taking, may also have shaped pupils' emotional responses to mathematics tasks. Chikha et al. (2024) reported that treasure-based game formats in early grades were associated with improvements in post-learning mood, suggesting that positive affect can coexist with, and potentially reinforce, conceptual learning. In this study, the game structure appeared to sustain attention without reducing task rigour, indicating that enjoyment and academic focus were not mutually exclusive but functioned together within the learning process.

From a curriculum implementation perspective, the findings suggest that the pedagogical value lies not in the novelty of the game, but in its systematic design. Because each task was directly mapped onto measurable indicators, the activity operated as structured practice rather than entertainment. This distinction is important: the results imply that when playful formats are intentionally aligned with assessment criteria, they can function as targeted instructional tools rather than supplementary motivation strategies.

Finally, the intervention's feasibility within a non-digital classroom context strengthens its practical relevance. Although many studies examine technology-based game learning, the present findings suggest that the underlying pedagogical principles, structured challenge, indicator alignment, and routine integration, can be operationalised without advanced infrastructure. Future research should therefore compare this format with conventional worksheet-based practice and include delayed posttests to determine whether the observed gains are sustained over time.

5. Conclusion

The most salient finding of this study is that a low-resource, classroom-implemented "Treasure Hunt" educational game ("Mencari Harta Karun") produced a statistically significant and educationally meaningful improvement in Grade 1 pupils' early mathematics competence. Pupils' mean performance increased from 7.85 to 8.95, supported by a moderate-to-large effect size (Cohen's $d \approx 0.74$) and a significant paired comparison ($p = 0.004$). Beyond mean improvement, a notable and distinctive pattern was the reduced dispersion of posttest scores relative to pretest scores, suggesting that the intervention not only raised average attainment but also contributed to more consistent competence across pupils. This is particularly important in early-grade contexts where baseline numeracy readiness often varies and can widen over time if not addressed through targeted practice.

This study contributes methodologically by providing an indicator-aligned, pretest–posttest evaluation of a non-digital educational game that is feasible for routine classroom use. Unlike approaches that position games primarily as engagement tools, this intervention was directly linked to measurable early numeracy indicators, including number-symbol recognition, symbol–quantity mapping, simple operations, ordering, and quantity comparison. Conceptually, the study supports the argument that game-based learning can function as purposeful numeracy instruction when designed around concrete tasks and repeated practice, rather than being treated as an auxiliary activity. The inclusion of teacher involvement in media preparation also strengthens the contribution by emphasising implementability and potential sustainability in contexts where technology-based media may be difficult to adopt consistently.

6. Suggestion

This study has several limitations. First, the use of a one-group pretest–posttest design without a control group limits the ability to attribute learning gains solely to the intervention. Second, the small sample size and single-school setting restrict the generalizability of the findings. Third, the study measured only short-term outcomes and did not examine the sustainability of pupils' learning gains over time. Future research should employ experimental or quasi-experimental designs with larger and more diverse samples to strengthen the validity of the findings. In addition, delayed posttests are recommended to evaluate the long-term effectiveness of game-based learning interventions in supporting early mathematics competence.

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