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The Effect of QR Code Scavenger Hunt Media on Children's Ability to Recognize Number Symbols

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Abstract: Early childhood mathematics is an important foundation for later learning, yet initial observation at TK Kasih Ibu showed that many Group B children had difficulty recognizing and representing number symbols. Previous studies have shown the potential of QR-code media for early childhood learning, but limited research has combined QR-code exploration, a scavenger hunt activity, and animated demonstrations of number formation. This study aimed to examine the effect of QR Code Scavenger Hunt media on children's number-symbol recognition. A pre-experimental one-group pretest-posttest design was conducted with 28 Group B children. Data were collected through pretest and posttest assessments and analyzed using descriptive statistics and the Wilcoxon signed-rank test. The mean score increased from 69.63 to 87.79, with an average gain of 18.16 points. The proportion of children achieving the highest score category increased from 35.7% to 92.9%. The test showed a significant difference between pretest and posttest scores ($p < 0.001$). The novelty lies in integrating physical exploration, QR-code access, animated visualization of number formation, and follow-up learning activities. The findings indicate a significant improvement in children's number symbols recognition following the implementation of QR Code Scavenger Hunt media among Group B children.

Keywords: Early Childhood Education, Number-Symbol Recognition, QR Code Scavenger Hunt.

INTRODUCTION

Early childhood education in the Society 5.0 era is increasingly expected to use digital technology to enrich learning while maintaining developmentally appropriate experiences. Recent research indicate that digital technology can enrich early childhood learning when it is integrated with play-based, collaborative, and developmentally appropriate pedagogy rather than used as replacement for children's active experiences (Hu et al., 2024; Li et al., 2026). similarly research on digital technologies in early childhood emphasizes the importance of children's agency and meaningful participation rather than treating technology as end in itself (Wilson, Murcia, Cross , & Lowe , 2023). Technology and interactive media can support young children's learning when they are used intentionally, appropriately, and in connection with clear educational goals. Therefore, digital technology in early childhood education should

function as a learning support that expands children's opportunities to explore and construct understanding rather than becoming the learning objective itself.

Early mathematics is one of the important developmental foundations for children because mathematical understanding developed in the early years is related to subsequent mathematical learning. Research on early childhood mathematics emphasize the importance of meaningful experience, interaction, exploration, and developmentally appropriate learning activities (Björklund, Panhuizen, & Kullberg , 2020). Numeracy development begins before formal schooling and involves children's developing understanding of quantities, number relations, and symbolic representations, which are important foundations for later mathematical learning (Chen et al, 2024; Libertus et al., 2024). One fundamental component of early mathematics is number-symbol recognition. This ability involves more than reciting number names; children need to identify symbols, distinguish them from one another, connect symbols with numerical meaning, and represent numbers using appropriate symbols. The importance of early numeracy is also evident in the Indonesian context. Novita et al found that numeracy skills among Indonesian preschool children were related aspects of children's learning environments and preschool activities (Novita, et al., 2023). These finding suggest that children's mathematical development is influenced not only by individual cognitive development but also bye the quality and characteristics of learning experiences provide to them. Early mathematical experiences therefore need to be provided through learning activities that are appropriate to children's developmental characteristics and that enable them to observe, explore, practice, and receive meaningful feedback.

However, the expected condition has not been fully achieved in the observed learning context. An initial observation conducted with Group B children at TK Kasih Ibu found that only 13 of 28 children (46.4%) were able to recognize number symbols correctly, whereas 15 children (53.6%) still experienced difficulties. The observed difficulties included inaccurate number forms and incorrect writing direction. These findings indicate that children's visual recognition of number symbols and understanding of numerical representations still require stronger stimulation. The findings also indicate a gap between the expected development of early mathematical abilities and the children's actual performance. Learning activities therefore need to provide clear visual models, opportunities for exploration and repetition, and direct practice.

Learning media can provide children with opportunities to engage with mathematical concepts through concrete, visual and meaningful experience. Resent research has shown that interactive and technology supported approaches can be used to strengthen early mathematical learning. Emen-Parlatan et al reported positive effect of a technology supported mathematics program using educational robots on preschool children's early mathematics skills (Emen-Parlatan, Ördek-İnceoğlu, Gürgah-Oğul, & Aslan , 2023). Similarly, Alseed and Aladil highlighted the importance of integrating digital and physical interactive learning environments in early childhood mathematics (Alsaeed & Aladil, 2024). More recent research has also demonstrated the potential of digital game based learning to improve children's early mathematical skills when digital activities are embedded within meaningful learning contexts (Maghfirah, Kartika, Hasnur, Azzahra, & Pertiwi, 2025).

One relatively simple technology that can connect physical learning materials with digital content is the Quick Response Code (QR code). QR codes can provide children with access to supplementary digital content while retaining a physical learning environment. Previous studies have demonstrated the potential of QR-code-based media in early childhood education. Developed children's worksheets using QR codes for early childhood science learning and reported that the product was valid and effective (Utami et al., 2021). Developed Dadu QR Code as an alternative medium for introducing reading, writing, and numeracy to children aged 5–6 years and found the product feasible for use (Turnip & Wijayaningsih, 2022). These studies indicate that QR-code technology can be integrated into early childhood learning. However,

the existing products differ from the present study because they do not specifically combine a physical search activity with animated demonstrations of number formation and subsequent number-symbol learning activities. QR-code-based media has also been applied to mathematics learning at the elementary school level. Developed a QR-code-based pop-up book to support reading and arithmetic skills and reported that the product was valid, feasible, attractive, and helpful in improving students' learning outcomes (Fitroh et al., 2024).

Although this finding supports the potential of QR codes to connect physical media with digital content, the study involved elementary school students and focused on reading and arithmetic rather than early childhood number-symbol recognition. Thus, evidence remains limited regarding the use of QR-code technology for developmentally appropriate early mathematics activities among kindergarten children. Recent reviews further indicate that digital technologies can contribute to young children's STEM and mathematical learning, but their educational value depends strongly on how technology is embedded within pedagogical activities and children's active engagement (Hu et al., 2024; Alsaeed & Aladil, 2024; Li et al., 2026). Based on these previous studies, a research gap can be identified. QR-code media has been developed for early childhood learning, but its use has rarely been directed specifically toward number-symbol recognition through an exploratory search activity. Likewise, previous QR-code studies have not integrated the sequence of searching for a code, scanning the code, observing an animated demonstration of number formation, and continuing with a learning activity in one structured experience. This study addresses that gap by using QR Code Scavenger Hunt media, in which children search for QR codes, access animated visual content, and engage in follow-up learning activities related to number symbols.

The novelty of this study therefore lies not simply in the use of QR-code technology, because QR-code learning media has been developed previously (Utami et al., 2021; Turnip & Wijayaningsih, 2022; Fitroh et al., 2024). Bay and Hartman showed that digital technology in preschool classrooms is used in diverse ways and needs to be adapted to children's interests, needs, and developmental characteristics (Bay & Hartman, 2025). The novelty lies in the pedagogical integration of physical exploration, QR code scanning, animated visualization of number formation, and follow up number symbol activities within a single play oriented learning sequence. The study consequently aimed to examine whether QR Code Scavenger Hunt media was associated with improved number-symbol recognition among Group B children at TK Kasih Ibu. Based on this description, the problem can be formulated as follows, does the use of QR-Code Scavenger Hunt media significantly improve children's ability to recognize number symbols ?

METHODS

Research Design

This study employed a pre-experimental quantitative approach using a one-group pretest-posttest design. The design consisted of an initial measurement (O1), an intervention using QR Code Scavenger Hunt media (X), and a final measurement (O2). The design was selected to compare children's number-symbol recognition performance before and after the learning intervention. The participants were 28 Group B children at TK Kasih Ibu, Tanah Bumbu, South Kalimantan. Total sampling was used because all children in the Group B population participated in the study.

Data Collection

Data were collected through a structured assessment of children's number-symbol recognition before and after the intervention. The same assessment framework was administered at both measurement points to identify changes in children's performance.

Data Analysis

Descriptive statistics were used to summarize the distribution of scores, including frequency, percentage, mean, median, range, and standard deviation. Because the pretest and posttest measurement were paired observations and no-parametric procedure was used, the Wilcoxon signed-rank test was used to examine the difference between pretest and posttest. The decision rule was set at 0.05; a two-tailed significance value below 0.05 indicated rejection of the null hypothesis. The use of the Wilcoxon signed-rank test is consistent with its application for assessing differences between paired measurements when a non-parametric procedure is appropriate (Rizki et al., 2023).

Research Procedure

The research procedure consisted of three stages: pretest, intervention, and posttest. First, the pretest was administered to measure children's initial number-symbol recognition ability. Second, children participated in the QR Code Scavenger Hunt activity. Children searched for QR codes placed in designated learning areas, scanned the codes, accessed the linked animated learning content, observed the visual demonstration of number formation, and subsequently completed number-symbol learning activities. Third, the posttest was administered using the same assessment framework to identify changes in children's performance.

The hypotheses are formulated as follows:

1. H0 = There is no significant difference in children’s number symbols recognition scores before and after the implementation of QR Code Scavenger Hunt media
2. Ha = There is a significant difference in children’s number symbols recognition scores before and after the implementation of QR Code Scavenger Hunt media

RESULTS AND DISCUSSION

The findings showed a statistically significant improvement in children’s ability to recognize number symbols following the implementation of QR-Code Scavenger Hunt media ($p < 0.001$) among Group B children at TK Kasih Ibu. The statistical analysis included 28 children with complete paired pretest and posttest scores. The results are presented through frequency distributions, descriptive statistics, and the Wilcoxon signed-rank test.

Frequency Distribution of Pretest and Posttest Scores

Table 1. Frequency Distribution of Pretest and Posttest Scores

Category	Interval	Pretest f	Pretest (%)	Posttest f	Posttest (%)
Score 4	76–100	10	35.7	26	92.9
Score 3	51–75	13	46.4	2	7.1
Score 2	26–50	5	17.9	0	0.0
Score 1	0–25	0	0.0	0	0.0
Total		28	100.0	28	100.0

The pretest distribution shows that 13 children (46.4%) were in Score 3, 10 children (35.7%) were in Score 4, and 5 children (17.9%) were in Score 2. No child was classified in Score 1. After the intervention, 26 children (92.9%) were in Score 4 and only 2 children (7.1%) remained in Score 3, while no children were found in Scores 1 or 2. This shift indicates a substantial movement toward the highest score category after the use of QR Code Scavenger Hunt media.

Final Descriptive Statistics of Pretest and Posttest Scores

Table 2. Descriptive Statistics of Pretest and Posttest Scores

Statistic	Pretest	Posttest
Mean	69.63	87.79
Median	70.85	83.30
Range	41.70	25.00
Std. Deviation	14.56	7.00
Variance	212.12	49.01
Minimum	50.00	75.00
Maximum	91.70	100.00

The mean score increased from 69.63 in the pretest to 87.79 in the posttest, representing an average gain of 18.16 points. The median increased from 70.85 to 83.30. At the same time, the standard deviation decreased from 14.56 to 7.00, and the score range decreased from 41.70 to 25.00. These results indicate not only higher posttest achievement but also a more concentrated distribution of scores after the intervention.

Wilcoxon Signed-Rank Test

Table 3. Wilcoxon Signed-Rank Results for Posttest and Pretest Scores

Rank Direction	N	Mean Rank	Sum of Ranks
Negative ranks (Posttest < Pretest)	1	2.50	2.50
Positive ranks (Posttest > Pretest)	26	14.44	375.50
Ties (Posttest = Pretest)	1	–	–
Total	28	–	–

Table 4. Wilcoxon Signed-Rank Test Statistics

Test Statistic	Value
Wilcoxon statistic (W)	2.50
Z	-4.504
Asymp. Sig. (2-tailed)	< 0.001
Decision	H0 rejected; Ha accepted

The Wilcoxon signed-rank analysis identified 26 positive ranks, 1 negative rank, and 1 tie. The test yielded $W = 2.50$, $Z = -4.504$, and $p < 0.001$ (two-tailed). Because the significance value is below 0.05, H0 is rejected and Ha is accepted. Therefore, there is a statistically significant difference between the pretest and posttest scores, with the posttest scores being predominantly higher. These findings indicate a statistically significant improvement in children's number-symbol recognition scores following the implementation of QR Code Scavenger Hunt media in the studied group.

Discussion

The results demonstrated a clear improvement in children's number-symbol recognition following the implementation of QR Code Scavenger Hunt media. The mean score increased from 69.63 in the pretest to 87.79 in the posttest, representing an average increase of 18.16 points. The proportion of children achieving the highest score category also increased substantially, from 35.7% to 92.9%. In addition, the standard deviation decreased from 14.56 to 7.00, indicating that posttest scores were not only higher but also more concentrated. The Wilcoxon signed-rank test showed a statistically significant difference between the paired measurements ($W = 2.50$, $Z = -4.504$, $p < .001$). Thus, the research question is supported by evidence of significantly higher number-symbol recognition scores after the intervention.

The improvement in consistent with research showing that early mathematical learning benefits from meaningful, interactive, and developmentally appropriate experience. emphasize

that young children develop mathematical understanding through interaction, exploration, and guided learning activities (Björklund, Panhuizen, & Kullberg , 2020). Recent evidence also indicates that technology-supported learning can contribute to the development of young children's mathematical abilities when the technology is implemented within an appropriate pedagogical context (Emen-Parlatan et al., 2023; Alsaeed & Aladil, 2024).

The finding also extends previous QR code research in early childhood education. Demonstrated the feasibility of QR code based learning worksheets for early childhood science learning (Utami, Rantina, & Edi, 2021), developed a QR code based medium for introducing early literacy and numeracy (Turnip & Wijayaningsih, 2022). However, these studies did not combine QR code access with a physical search activity and animated visualization of number formation. The present study therefore extends previous work by integrating QR code technology into an exploratory, play oriented learning sequence.

The improvement may also be related to the combination of visual animation and active exploration. Resent research has reported positive outcomes from animated video media in early mathematics learning, including studies involving kindergarten children. For example reported that animated video media was effective in supporting early mathematical abilities (Nurmaliza, 2023), while Nur et al found significant effect of animated video based learning media on kindergarten children's mathematical abilities (Nur, Nurhafizah, Yaswinda, & Utoyo, 2026). Similarly investigated two-dimensional animated video for children's number recognition and highlighted the relevance of attractive visual media for supporting early number learning (Auliza, Rakimahwati, Utoyo, & Syafnita, 2026). Unlike video only approaches, the QR code Scavenger Hunt requires children to move, search, locate, scan, observe, and respond. This combination may provide a more active learning experience than passive viewing alone.

This interpretation is also consistent with recent research on digital pedagogy in early childhood education. A scoping review by Li et al found that play based, project based, problem based, and collaborative pedagogies are important characteristics of effective early childhood digital pedagogy (Li, He, Luo, & Li, 2024). Hu et al emphasized that the educational value of digital technology for young children depends on how technology is integrated into meaningful learning activities (Hu, Fang, & Liang, 2024). Research on digital technology in preschool classrooms indicates that children's interests, developmental needs, and classroom planning influence how technology contributes to learning (Bay & Hartman, 2025). Recent research has demonstrated that contextual digital game-based learning can improve children's early mathematical skills, while digital games designed around number concepts can promote engagement and provide opportunities for children to interact with numerical representations (Maghfirah et al., 2025; Perini et al., 2025). The QR Code Scavenger Hunt similarly introduces an element of exploration and play into number-symbol learning. The activity therefore has the potential to transform an otherwise abstract learning target into a sequence of observable and engaging actions.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The findings indicate that the implementation QR Code Scavenger Hunt media was associated with a significant improvement in number-symbol recognition among the 28 Group B children studied at TK Kasih Ibu. The proportion of children achieving the highest score category increased from 35.7% in the pretest to 92.9% in the posttest, while the mean score increased from 69.63 to 87.79. The Wilcoxon signed-rank test demonstrated a statistically significant difference between the paired pretest and posttest scores ($W = 2.50$, $Z = -4.504$, $p < .001$). These findings answer the research question by showing that children demonstrated significantly higher number symbol recognition scores after participating in the QR Code

Scavenger Hunt learning activity. The result is consistent with earlier evidence that QR-code-based media can be feasible for early childhood learning (Utami et al., 2021; Turnip & Wijayaningsih, 2022). The distinctive contribution of the present study lies in integrating physical exploration, QR-code access, animated visualization, and follow-up number-symbol activities within one learning sequence. However, because the study employed a one-group pretest–posttest design without a comparison group, the findings should be interpreted as evidence of significant improvement following the intervention within the studied group rather than definitive proof of a causal effect across broader populations.

Limitations

This study has several limitations. First, the participants consisted of only 28 Group B children from one kindergarten, so the findings should not be generalized automatically to children in other schools, regions, or developmental contexts. Second, the one-group pretest-posttest design did not include a control or comparison group; therefore, other factors occurring during the study period may have contributed to the observed improvement. Third, the study measured short-term changes between the pretest and posttest and did not examine whether the improvement in number-symbol recognition was maintained over time. Fourth, the study focused specially on number-symbol recognition and therefore does not establish whether the media would produce similar outcomes for other components of early mathematics.

Recommendations

Future research should involve larger and more diverse samples and, where feasible, use employ quasi-experimental or randomized comparative designs to strengthen evidence regarding the effectiveness of the QR Code Scavenger Hunt medium. Subsequent studies should also include a follow-up post-test (conducted after a time lapse) to observe whether improvements in number symbol recognition are sustained over time. Furthermore, researchers could compare the QR Code Scavenger Hunt with conventional number symbol materials, video-only instruction, and other game-based digital media to identify which components contribute most significantly to children's learning. Additional studies could also examine whether this approach can be adapted for other early mathematical concepts, such as matching quantities to symbols, counting, simple arithmetic operations, patterns, measurement, and spatial concepts.

Author Contributions

All authors made significant contributions to this study. These contributions included research conceptualization, development of the theoretical framework, data collection, data analysis, interpretation of results, manuscript preparation, scholarly revision, and final approval of the manuscript for publication. All authors confirm that they have read and approved the final version of the article.

REFERENCES

Alsaeed, M. S., & Aladil, M. K. (2024). Digital and Physical Interactive Learning Environments: Early Childhood Mathematics Teachers' Beliefs about Technology through Reflective Writing. *Education Sciences*, 517. https://doi.org/10.3390/educsci14050517.

Auliza, D., Rakimahwati, Utoyo, S., & Syafnita, T. (2026). Pengaruh penggunaan video animasi dua dimensi terhadap kemampuan mengenal angka pada anak usia dini di TK Aisyiyah 14 Padang. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 198-210. https://doi.org/10.23969/jp.v11i02.47078.

Bay, D. N., & Hartman, D. K. (2025). Digital Technology in Preschool Classrooms: A Qualitative Case Study. *Early Education and Development* , 1454-1477. https://doi.org/10.1080/10409289.2025.2484824.

Björklund, C., Panhuizen, M., & Kullberg , A. (2020). Research on early childhood mathematics teaching and learning. *ZDM–Mathematics Education*, 607-619. https://doi.org/10.1007/s11858-020-01177-3.

Chen, C.-C., Berteletti, I., & Hyde, D. C. (2024). Neural evidence of core foundations and conceptual change in preschool numeracy. *Developmental Science*, 1-14. https://doi.org/10.1111/desc.13556.

Emen-Parlatan, M., Ördek-İnceoğlu, S., Gürgah-Oğul, İ., & Aslan , D. (2023). Technology and early mathematics skills: Effectiveness of I Love Math with Robots. *The Journal of Educational Research*, 90-99. https://doi.org/10.1007/s11858-020-01177-3.

Fitroh, S. K., Alfi, C., & Fatih, M. (2024). Development of Pop Up Book Media Based on Qr Code to Improve Reading and Arithmetic Skills of Grade 2 Elementary School Student. *Journal of Educational Sciences*, 772-790. https://doi.org/10.31258/jes.8.4.p.772-790.

Hu, X., Fang, Y., & Liang, Y. (2024). Roles and Effect of Digital Technology on Young Children's STEM Education: A Scoping Review of Empirical Studies. *Education Sciences*, 357. https://doi.org/10.3390/educsci14040357.

Li, H., He, H., Luo, W., & Li, H. (2024). Early Childhood Digital Pedagogy: A Scoping Review of Its Practices, Profiles, and Predictors. *Education Sciences*, 263–284. https://doi.org/10.1007/s10643-024-01804-8.

Libertus, M., Miller, P., Zippert, E. L., Bachman, H. J., & Darzl, E. V. (2024). Predicting individual differences in preschoolers' numeracy and geometry knowledge: The role of understanding abstract relations between objects and quantities. *Journal of Experimental Child Psychology*, 1-45. https://doi.org/10.1016/j.jecp.2024.106035.

Maghfirah, F., Kartika, W. I., Hasnur, R. A., Azzahra, V., & Pertiwi, A. (2025). Enhancing Early Childhood Mathematical Skills through Contextual Digital Game-Based Learning: Evidence from the BEKANTAN Intervention in Indonesia. *Golden Age: Jurnal Ilmiah Tumbuh Kembang Anak Usia Dini*, 295-311. https://doi.org/10.14421/jga.2025.102-07.

Novita, S., Anindhita, V., Wijayanti, P. A., Santoso, L. A., Batavee, H. L., Tampubolon, F. A., & Syafitri , A. N. (2023). Relationship Between Numeracy and Vocabulary Skills in Indonesian Preschool Children and the Impacts of Learning Environments. *International Journal of Early Childhood*, 297–314. https://doi.org/10.1007/s13158-023-00356-z.

Nurmaliza, A. (2023). Efektivitas Penggunaan Video Animasi Terhadap Kemampuan Matematika Awal Anak Di Taman Kanak-Kanak Mawar Kabupaten Padang Pariaman. *JCE (Journal of Childhood Education)*, 10-18. https://doi.org/10.30736/jce.v7i1.1405.

Nur, N. A., Nurhafizah, N., Yaswinda, Y., & Utoyo, S. (2026). The Effect of Animated Video Traditional Games Learning Media on Kindergarten Children's Mathematical Abilities: An Experimental Study. *KIDDO: Jurnal Pendidikan Islam Anak Usia Dini*, 1-13. https://doi.org/10.19105/kiddo.v7i1.23860.

Perini, N., Porru, A., Moeller, K., Jay, T., Lucangeli, D., & Sella , F. (2025). Number Express: A Digital Game to Improve Early Numeracy. *Electronic Journal of e-Learning*, 37-51. https://doi.org/10.34190/ejel.22.10.3522.

Rizki, N. A., Watulingas, J. R., & Asnawati. (2023). Analisis perbedaan nilai setiap siklus dalam penelitian tindakan kelas menggunakan uji Wilcoxon. Buana Matematika: Jurnal Ilmiah Matematika dan Pendidikan Matematika, 13(2), 169–180. https://doi.org/10.36456/buanamatematika.v13i2.7258.

Sa'idah, S. H. (2026). *Pengembangan Buku Interaktif Berbasis QR Code Untuk Kemampuan Mengenal Angka Pada Anak 4-5 Tahun.* Malang: Fakultas Tarbiyah Universitas Islam Negeri Malang.

Turnip, H. A., & Wijayaningsih, L. (2022). Pengembangan Dadu QR Code untuk Alternatif Pengenalan Calistung Anak Usia 5- 6 Tahun. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 4392–4404. https://doi.org/10.31004/obsesi.v6i5.2595.

Utami, F., Rantina, M., & Edi, R. (2021). Pengembangan Lembar Kerja Anak Menggunakan QR Code Pada Materi Sains Anak Usia Dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 1976–1990. https://doi.org/10.31004/obsesi.v6i3.1882.

Wilson, S., Murcia, K., Cross , E., & Lowe , G. (2023). Digital technologies and the early childhood sector: are we fostering digital capabilities and agency in young children? *The Australian Educational Researcher*, 1425–1443. https://doi.org/10.1007/s13384-023-00647-3.