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The Role of Number Animation Videos in Improving the Arithmetic Ability of Children with Dyscalculia: A Literature Review

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Abstract

This study aims to analyze the role of animated number videos in improving the numeracy skills of children with dyscalculia through a literature review. The method used is a Systematic Literature Review (SLR) by reviewing 20 relevant scientific articles from various databases, namely Google Scholar, DOAJ, ERIC, and Scopus-indexed journals, in the publication period 2015–2025. Article selection was carried out through the identification stage, title and abstract screening, and full-text review based on predetermined inclusion and exclusion criteria. The results of the study indicate that visual and audiovisual media, including animated videos, generally have a positive influence on mathematics learning, especially in improving conceptual understanding, learning motivation, and student learning outcomes. In children with dyscalculia, various studies also show that digital-based interventions, such as multimedia, educational games, and mobile learning, are effective in improving numeracy and arithmetic operations. However, research specifically discussing animated number videos in children with dyscalculia is still limited. Therefore, animated number videos have the potential to be developed as a learning medium that is more adaptive, concrete, and appropriate to the learning needs of children with dyscalculia.

Keywords: animated number videos, arithmetic skills, dyscalculia, learning media, literature review.

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INTRODUCTION

Numeracy is a fundamental skill essential for elementary school mathematics learning. This ability is not only related to addition, subtraction, multiplication, or division, but also serves as the foundation for students' understanding of mathematical concepts at higher levels. In daily learning activities, numeracy skills also play a role in developing students' logical and systematic thinking. Therefore, numeracy skills need to be developed from an early age through learning tailored to the individual's characteristics. However, in reality, many students still experience difficulties understanding number concepts and simple arithmetic operations. These difficulties can be caused by various factors, both internal and inappropriate learning processes. This condition aligns with findings that elementary school students' numeracy skills in Indonesia are still relatively low and require special attention in the learning process (OECD, 2019; Apriadi, 2021).

Numeracy difficulties are further complicated by children with specific learning disabilities, one of which is dyscalculia. Children with dyscalculia generally have difficulty recognizing numbers, understanding number concepts, and performing simple arithmetic operations accurately. This barrier causes students to take longer to understand mathematics than other students. In classroom learning, mathematics material is often presented abstractly, making it even more difficult for children with dyscalculia to grasp the concepts being taught. Therefore, a more concrete learning approach is needed that is tailored to the students' learning needs. Research shows that children with dyscalculia require visual and gradual learning support to more easily grasp numerical concepts (Morsanyi et al., 2018; Butterworth et al., 2016). Therefore, conventional learning that relies solely on verbal explanations and written exercises is not yet effective enough for children with this disability.

One way to help children with dyscalculia is to utilize visual learning media. Visual media is considered capable of presenting information more clearly and easily understood because it directly engages the sense of sight. In mathematics learning, the use of visual media can help students understand abstract concepts more concretely. One form of media that can be used is animated number videos. Animated videos combine images, sound, and movement, making the presentation more engaging and less monotonous. The use of animation-based media in mathematics learning has been shown to increase students' attention and understanding of the material being taught (Mayer, 2017; Zhang et al., 2020). Furthermore, research in Indonesia also shows that visual and audiovisual-based learning media can significantly improve students' mathematics learning outcomes (Akbar & Komarudin, 2020).

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The use of animated number videos in arithmetic learning has great potential to help children with dyscalculia understand number concepts. Through this medium, students can directly see the relationship between numbers and their visual representations. Presenting material accompanied by animation and sound can help students focus more on the lesson. Furthermore, animated videos can be played repeatedly, giving students the opportunity to understand the material at their own pace. This is particularly important for children with dyscalculia, who generally require longer learning times. The use of audiovisual media is also known to increase student motivation and reduce boredom during the learning process (Hidayat et al., 2019; Zhang et al., 2020). Therefore, animated number videos can be an effective alternative medium to support arithmetic learning.

However, research specifically addressing the use of animated number videos for children with dyscalculia is still relatively limited. Most studies focus on regular students, resulting in limited research examining the effectiveness of this medium for children with specific learning disabilities. However, the learning characteristics of children with dyscalculia differ from those of students in general, necessitating a more adaptive approach. These research limitations indicate gaps that require further study. Therefore, this study was conducted to analyze the use of animated number videos in improving the arithmetic skills of children with dyscalculia. The results are expected to contribute to the development of learning media that are more tailored to the needs of children with special needs, particularly in mathematics. In addition, this research can also be a reference for teachers in choosing more effective and interesting learning strategies.

LITERATURE SYNTHESIS RESULTS

Based on the literature search and selection process, 20 relevant studies were identified that focused on the use of video-based media, animation, multimedia, and digital games in mathematics education, particularly in relation to arithmetic skills, numeracy development, and mathematical learning difficulties among children with dyscalculia. The review indicates that only a limited number of studies have specifically investigated the use of number animation videos as an intervention for children with developmental dyscalculia. Most existing research can be categorized into two major themes. The first group examines the effectiveness of animated videos, multimedia, and audiovisual learning media in enhancing mathematics learning among general elementary school students. The second group focuses on digital interventions, including computer-assisted learning programs, gamification, and educational games designed for students experiencing mathematical learning difficulties or developmental dyscalculia. This pattern confirms the research gap identified in the present study, namely that empirical investigations specifically examining number animation videos for children with dyscalculia remain scarce.

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Therefore, the current study contributes to the literature by exploring a more targeted instructional approach that integrates animated numerical visualization with the unique cognitive characteristics of learners with dyscalculia. The synthesis of the reviewed literature is presented in Table 1.

No.	Author(s)	Article/Journal Title	Main Findings
1	Mayer (2017)	*Using Multimedia for E-learning*	Multimedia instruction is most effective when relevant verbal and visual information are integrated. This principle provides a theoretical foundation for using animation to facilitate understanding of abstract mathematical concepts.
2	Morsanyi et al. (2018)	*The Prevalence of Specific Learning Disorder in Mathematics and Comorbidity with Other Developmental Disorders in Primary School-Age Children*	Demonstrates that mathematical learning disorders are prevalent among primary school children, emphasizing the need for adaptive instructional support.
3	Anjarsari, Farisdianto, & Asadullah (2020)	*Development of Powtoon Audiovisual Media for Mathematics Learning in Elementary Schools*	Powtoon audiovisual media was found to be appropriate and effective in making elementary mathematics learning more engaging.
4	Benavides-Varela et al. (2020)	*Effectiveness of Digital-Based Interventions for Children with Mathematical Learning Difficulties: A Meta-analysis*	A meta-analysis involving 15 studies and 1,073 participants concluded that digital interventions significantly improve mathematics learning outcomes for children with mathematical learning difficulties.
5	Günbaş (2020)	*Students Solve Mathematics Word Problems in Animated Cartoons*	Students taught through animated cartoon stories demonstrated significantly greater improvement in

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			mathematical problem-solving than those taught using conventional text-based instruction.
6	Kohn et al. (2020)	*Efficacy of a Computer-Based Learning Program in Children with Developmental Dyscalculia: What Influences Individual Responsiveness?*	The adaptive digital program **Calcularis 2.0** effectively strengthened number representation, mental number line understanding, and arithmetic operations in children with developmental dyscalculia.
7	Cheng et al. (2020)	*Short-Term Numerosity Training Promotes Symbolic Arithmetic in Children with Developmental Dyscalculia: The Mediating Role of Visual Form Perception*	Short-term numerosity training significantly enhanced symbolic arithmetic performance among children with developmental dyscalculia.
8	Akmalia et al. (2021)	*Development of Powtoon Animation Learning Media in Improving Understanding of Mathematical Concepts*	Powtoon-based animation was validated as highly feasible and effective in improving students' understanding of mathematical concepts.
9	Devisri & Tharani (2021)	*An Effect of Mathematical Intervention Strategies for Dyscalculia Students*	Mathematical intervention strategies produced significant positive effects on students with dyscalculia.
10	Yaftian & Barghamadi (2022)	*The Effect of Teaching Using Multimedia on Mathematical Anxiety and Motivation*	Multimedia instruction significantly increased students' motivation while reducing mathematics anxiety.
11	Bulkani, Fatchurahman, Adella, & Setiawan (2022)	*Development of Animation Learning Media Based on Local Wisdom to Improve Student Learning Outcomes in Elementary Schools*	Animation-based instructional media significantly improved student achievement, with post-test scores exceeding pre-test results.
12	Ojo (2022)	*Effects of Animated Instructional Packages on Achievement and*	Animated instructional materials significantly enhanced students' achievement and

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		Interest of Junior Secondary School Students in Algebra	interest in algebra, while gender showed no significant effect.
13	Amelia & Supena (2022)	*Mathematics Learning Strategy for Dyscalculia Students in Elementary School*	Effective instruction for children with dyscalculia should be direct, structured, individualized, and involve collaboration between teachers and parents through both face-to-face and online approaches.
14	Fatwana et al. (2023)	*The Use of Learning Aids for Dyscalculia: A Systematic Literature Review*	A review of 13 studies concluded that children with dyscalculia require appropriate, adaptive, and concrete learning aids to support mathematical understanding.
15	Firdaus, Suripah, & Angraini (2023)	*Development of Animated Video-Based Mathematics Learning Media Using Adobe After Effects on Three-Dimensional Materials to Improve Mathematical Literacy*	The developed animated video was validated as practical, effective, and capable of improving mathematical literacy.
16	Ramadhan et al. (2023)	*Development of Gamified Mathematics Learning Material for Treating Children with Dyscalculia at Age 4–6 Years Old*	Gamified mathematics learning materials were specifically designed to help young children with dyscalculia master foundational numeracy skills.
17	Mohammed & Bello (2024)	*Performance of Mathematics Students Using Video Learning in Flipped and Flipped Collaborative Learning Settings*	Video-based instruction within flipped and collaborative flipped classrooms significantly improved students' mathematics achievement and knowledge retention.
18	Aliifah, Prakosha, & Gunarhadi (2024)	*Effect of the Fun Mathematics Educational Game on the Arithmetic Operation Skills of Children with Dyscalculia*	Students' mean scores increased from **47.43 to 72.57**, indicating that educational games significantly improved arithmetic operation skills among children with dyscalculia.

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19	Twiningsih, Gunarhadi, & Musadad (2024)	*Empowering Gamification-Based Mobile Learning Media to Improve Mathematics Learning Outcomes for Dyscalculia Students*	Gamification-based mobile learning produced a large positive effect on mathematics achievement among students with dyscalculia (effect size = **1.83**).
20	Dowker (2024); Hornos-Arias et al. (2025); Wang & Jamaludin (2025)	*Developmental Dyscalculia in Relation to Individual Differences in Mathematical Development*; *Early Detection and Intervention of Developmental Dyscalculia Using Serious Game-Based Digital Tools*; *Neural Investigations of a Digital Game-Based Intervention for Young Learners with Mathematical Developmental Variability*	Collectively, these studies emphasize that dyscalculia is a distinct numeracy disorder requiring specialized intervention. Serious game-based digital tools show strong potential for early identification, remediation, and improvement of mathematical performance, while also influencing neural mechanisms underlying mathematical learning.

DISCUSSION

The findings of the literature synthesis demonstrate that digital learning media, particularly animation, multimedia, educational videos, and game-based applications, have become increasingly important in improving mathematics learning outcomes, especially for children experiencing mathematical learning difficulties such as developmental dyscalculia. Across the twenty studies reviewed, a consistent pattern emerges indicating that technology-enhanced learning environments contribute positively to students' conceptual understanding, arithmetic performance, learning motivation, and engagement. However, despite this growing body of evidence, relatively few studies have specifically examined the effectiveness of number animation videos for children with dyscalculia. This gap highlights the importance of the present study, which seeks to investigate a more specialized instructional medium tailored to the cognitive characteristics of learners with numerical processing deficits.

From the perspective of Mayer's Cognitive Theory of Multimedia Learning (2017), the positive outcomes reported across the reviewed studies can be explained by the assumption that meaningful learning occurs when learners actively process information through two separate but interconnected cognitive channels: the visual-pictorial channel and the auditory-verbal channel. Mayer argues that students learn more effectively when words and images are presented

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simultaneously in ways that complement rather than duplicate one another. Mathematical concepts, particularly numbers and arithmetic operations, are inherently abstract, making them difficult for young learners—and especially children with dyscalculia—to understand through verbal explanations alone. Animation videos transform these abstract numerical symbols into concrete visual representations accompanied by narration and movement, thereby reducing cognitive overload while facilitating deeper conceptual understanding. This theoretical explanation is strongly supported by the findings of Anjarsari et al. (2020), Akmalia et al. (2021), Firdaus et al. (2023), and Mohammed and Bello (2024), who consistently found that multimedia and animated video significantly improved students' mathematical understanding and academic achievement.

The literature also demonstrates that visual animation provides important cognitive support for children with developmental dyscalculia. According to the Information Processing Theory, children with dyscalculia often experience deficits in working memory, number representation, and processing speed, which interfere with their ability to understand numerical relationships and perform arithmetic calculations. Traditional teacher-centered instruction frequently places excessive demands on verbal memory and symbolic processing, making learning even more challenging for these students. Digital animation, however, presents information gradually through synchronized images, sounds, and movement, allowing learners to process mathematical concepts more efficiently. This explanation aligns with the findings of Kohn et al. (2020), whose adaptive digital learning program, Calcularis 2.0, successfully strengthened children's mental number line, number representation, and arithmetic performance. Likewise, Cheng et al. (2020) reported that short-term numerosity training significantly improved symbolic arithmetic abilities among children with developmental dyscalculia. These findings suggest that digital learning environments support not only observable academic achievement but also the underlying cognitive mechanisms responsible for numerical processing.

The effectiveness of multimedia interventions is further reinforced by the results of Benavides-Varela et al. (2020), whose meta-analysis involving more than one thousand participants confirmed that digital interventions produce significant improvements in mathematical performance among children with learning difficulties. Meta-analytic evidence provides stronger empirical support because it synthesizes findings from multiple independent studies, reducing the influence of individual research bias. The consistency of these findings suggests that the effectiveness of digital mathematics instruction is not limited to a single intervention type but extends across various technological approaches, including multimedia

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learning, computer-assisted instruction, educational games, and mobile learning. Consequently, the proposed use of number animation videos is theoretically consistent with broader evidence supporting technology-based mathematics interventions.

The reviewed literature also emphasizes the importance of Dual Coding Theory proposed by Allan Paivio. According to this theory, information presented simultaneously through verbal and visual systems creates two independent memory traces, increasing the likelihood of long-term retention and recall. Number animation videos naturally implement this principle by integrating spoken explanations with animated numerical objects, colorful illustrations, and dynamic movement. Such multimodal presentation allows children with dyscalculia to associate abstract numerical symbols with meaningful visual experiences. This mechanism explains why animated instructional media consistently improve mathematical understanding across different educational contexts. Günbaş (2020), for example, demonstrated that animated storytelling significantly enhanced students' mathematical problem-solving performance compared with traditional text-based instruction. Rather than memorizing formulas mechanically, students constructed conceptual understanding through engaging visual narratives that supported meaningful learning.

Another important theoretical explanation derives from Constructivist Learning Theory, particularly the ideas of Piaget and Vygotsky, which emphasize that learners actively construct knowledge through meaningful interactions with learning materials. Animation-based mathematics instruction encourages students to observe numerical relationships, recognize patterns, and connect new information with prior knowledge instead of passively receiving explanations. Children with dyscalculia often require concrete learning experiences before they can understand symbolic representations. Animated videos provide this concrete bridge by transforming numbers into visual objects that can be observed repeatedly and interpreted gradually. Moreover, the possibility of replaying instructional videos enables students to learn according to their own pace, which is especially beneficial for learners who require additional processing time. Therefore, animation supports individualized learning while accommodating differences in cognitive development.

The literature further indicates that the effectiveness of digital media depends not only on technological sophistication but also on instructional design quality. Mayer's multimedia principles—including coherence, signaling, redundancy, spatial contiguity, temporal contiguity, and segmenting—suggest that poorly designed multimedia may increase extraneous cognitive load rather than facilitate learning. Therefore, effective number animation videos should present

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only relevant information, organize visual and verbal elements coherently, and divide complex mathematical concepts into manageable instructional segments. This interpretation explains why studies such as Yaftian and Barghamadi (2022) and Mohammed and Bello (2024) found that multimedia becomes significantly more effective when integrated with appropriate instructional strategies rather than being used merely as supplementary classroom material. High-quality instructional design enhances students' motivation, reduces mathematics anxiety, and promotes sustained attention throughout the learning process.

Research focusing specifically on children with dyscalculia also highlights the importance of interactive and motivating learning environments. According to Self-Determination Theory (Deci & Ryan), intrinsic motivation increases when learners experience autonomy, competence, and enjoyment during learning activities. Educational games and gamified learning environments satisfy these psychological needs by providing immediate feedback, progressive challenges, and rewarding experiences. Aliifah et al. (2024) demonstrated substantial improvement in arithmetic skills following the implementation of the Fun Mathematics Educational Game, while Twiningsih et al. (2024) reported a very large effect size (1.83) for gamification-based mobile learning among students with dyscalculia. Although animation videos are generally less interactive than educational games, they can incorporate motivational elements such as storytelling, colorful characters, engaging narration, and sequential challenges that maintain learners' attention and encourage repeated practice. Consequently, number animation videos possess considerable potential to combine conceptual visualization with motivational engagement.

An additional theoretical perspective comes from Universal Design for Learning (UDL), which advocates providing multiple means of representation, engagement, and expression to accommodate diverse learning needs. Children with dyscalculia represent a heterogeneous population whose mathematical difficulties vary in severity and cognitive profile. Number animation videos align well with UDL principles because they offer multiple sensory pathways for learning, allowing students to access mathematical content through visual, auditory, and contextual representations simultaneously. Such flexibility makes animation particularly suitable for inclusive educational settings where students demonstrate diverse cognitive abilities and learning preferences.

Overall, the literature synthesis provides strong theoretical and empirical evidence that digital multimedia, animation, educational videos, and game-based learning positively influence mathematics achievement, conceptual understanding, numeracy development, motivation, and learning engagement. Nevertheless, the review also reveals an important research gap: very few

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studies have directly investigated the effectiveness of number animation videos specifically designed for children with developmental dyscalculia. Most existing studies examine either animation in general mathematics education or broader digital interventions for mathematical learning difficulties without focusing on numerical animation as the primary instructional medium. This limitation strengthens the significance of the present research. By developing and evaluating number animation videos specifically tailored to the cognitive characteristics of children with dyscalculia, this study contributes both theoretically and practically to the growing field of technology-assisted special education. The findings are expected to extend multimedia learning theory into the context of developmental dyscalculia while providing evidence-based instructional innovations capable of improving numeracy skills, reducing learning barriers, and supporting inclusive mathematics education.

CONCLUSION

Based on a literature review of 20 articles, it can be concluded that the use of visual and audiovisual-based learning media, particularly animated videos, has generally been shown to have a positive impact on mathematics learning. These media can help students understand abstract concepts more concretely, increase learning motivation, and support improved learning outcomes. In children with dyscalculia, various studies have shown that digital-based interventions, such as multimedia, educational games, and mobile learning, are effective in improving numeracy and arithmetic skills. This suggests that children with dyscalculia require a visual, interactive, and gradual learning approach to better understand number concepts.

However, research specifically examining the use of animated number videos for children with dyscalculia is still limited. Most of the existing findings are indirect, derived from studies on general students or other digital interventions. Therefore, animated number videos have great potential to be developed as a more adaptive alternative learning medium for children with dyscalculia, particularly in assisting with understanding basic arithmetic concepts. Thus, this study contributes to identifying the potential use of animated number videos as a learning medium, while also showing the need for more specific and empirical further research to test its effectiveness in children with dyscalculia...

FUTURE DIRECTIONS

Future research should move beyond evaluating the general effectiveness of digital learning media by investigating the specific impact of number animation videos on different

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cognitive components of dyscalculia, including number sense, symbolic number processing, arithmetic fluency, and working memory. Longitudinal and experimental studies involving larger and more diverse participant samples are needed to determine the long-term effectiveness and generalizability of animation-based interventions across different educational settings. In addition, future studies should explore the integration of animation with adaptive learning technologies, gamification, artificial intelligence, and personalized feedback systems to provide individualized instruction that accommodates the diverse learning profiles of children with developmental dyscalculia. Researchers are also encouraged to examine the role of teachers and parents in implementing animation-based learning at school and at home, as well as to compare the effectiveness of number animation videos with other digital interventions, such as serious games, mobile learning applications, and virtual reality environments. Such investigations will contribute to the development of evidence-based, inclusive, and technology-enhanced mathematics instruction that effectively supports numeracy development among children with dyscalculia.

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