

An Analysis of Motion Design Principles in Animated Storybooks to Enhance Children's Reading Skills

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ABSTRACT

Digital reading increasingly shapes early literacy through animated storybooks that integrate text, narration, and motion. While animation has the potential to support comprehension, poorly designed or excessive motion can distract young readers and increase cognitive load. In the Malaysian context, animated storybooks are widely adopted in line with national ICT-in-education initiatives; however, visual appeal often takes precedence over pedagogical effectiveness. This study examines motion design principles in animated storybooks that enhance children's reading skills. Eight purposively selected animated storybooks were analysed using qualitative content analysis guided by eleven motion design principles adapted from Krasner (2013), including timing, spacing, rhythm, staging, and hierarchy. The findings indicate that well-designed motion effectively guides visual attention and improves narrative clarity. Temporal elements such as timing and rhythm regulate information flow, while staging and hierarchy highlight key text and story elements. These findings highlight the pedagogical potential of strategic motion design in supporting early literacy development beyond purely decorative animation.

Keywords: Motion Design Principles, Animated Storybooks, Children's Reading Skills, Motion Graphic, Literacy



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1 INTRODUCTION

Digital reading environments increasingly influenced how children engaged with early literacy materials. Animated storybooks offered multimodal experiences by combining text, illustrations, narration, and motion, which significantly differed from traditional printed books. Research in reading psychology demonstrated that children's comprehension was shaped by their processing of visual and verbal information, strongly influenced by eye movements, attentional patterns, and working memory capacity (Rayner & Pollatsek, 2006; Fernández-López et al., 2018; Gathercole et al., 2014). Animated elements within digital storybooks had the potential to highlight key story events, clarify complex sequences, and maintain children's engagement, positively contributing to vocabulary development and narrative comprehension (Smeets & Bus, 2014; Takács & Bus, 2016).

Despite these benefits, animation did not automatically improve children's literacy outcomes. Studies demonstrated that unnecessary or distracting motion could increase cognitive load, interrupt meaning-making processes, and weaken comprehension (Takács, Swart, & Bus, 2015; Liu et al., 2024). Eye-tracking research showed that children were particularly vulnerable to attentional drift when exposed to overly stimulating visual features, resulting in inefficient reading patterns and reduced understanding (Smallwood et al., 2017; Hutton et al., 2021). These findings indicated that the

effectiveness of animated storybooks depended on how motion supported, rather than competed with, the reading task.

In the Malaysian context, animated storybooks began to appear in educational settings, yet their development often lacked grounding in evidence-based design principles. Many local digital reading materials prioritized visual attractiveness over educational quality. Gidor and Abu Bakar (2024) observed limited research on how the design of animated materials influenced Malaysian children's reading development. Therefore, there was a need for a deeper understanding of how animation had been utilized and how it contributed to early literacy.

This study addressed this gap by analysing motion elements in animated storybooks and evaluating how these elements related to children's reading comprehension, vocabulary growth, and reading engagement. The study aligned with broader literacy findings that emphasized the importance of supportive visual environments for early learners, as noted in influential reports and empirical studies (National Early Literacy Panel, 2008; Carver, 2015; Sirois et al., 2020). Through this investigation, the study contributed to a clearer understanding of how animated storybooks could support early literacy development in Malaysia.

1.1 Research Objective

This study aimed to identify the motion design principles used to analysed animated storybooks intended to support children's reading skills. It examined how these motion design principles contributed to children's reading comprehension, vocabulary development, and engagement with the story.

1.2 Problem Statement

The integration of animated storybooks into early literacy instruction in Malaysia presented an insightful opportunity, aligned with the national policy drive for Information and Communication Technology (ICT) in education. However, this potential was consistently undermined by a critical design paradox. Research guided by Cognitive Load Theory (Mayer, 2009; Clark & Mayer, 2016) emphasized that the instructional quality of digital media was paramount. Resources that prioritized aesthetic appeal over clear pedagogical function imposed extraneous cognitive load on young learners, which interfered with the primary task of decoding text and building comprehension, leading to detrimental learning outcomes (Ross et al., 2016). Evidence advocated for a strategic design approach where motion guided the child's attention to text-critical details (Takács & Bus, 2016).

This challenge was intensified by the paucity of scholarly research in the Malaysian educational context. While digital storytelling (DST) was increasingly adopted, its deployment often lacked empirical validation. A systematic review confirmed this local deficit, highlighting the absence of rigorous studies that examined DST as an effective pedagogical strategy in Malaysian classrooms (Gidor et al., 2024). This lack of localized, evidence-based guidelines left educators ill-equipped to select or develop content that effectively improved student outcomes. Therefore, there was an urgent need for the current study to systematically analysed and measure the direct impact of specific visual design elements, particularly the application of motion principles, on young learners' reading and comprehension skills.

2 LITERATURE REVIEW

This literature review focused on the relationship between motion design principles and children's reading skills in animated storybooks. It highlighted how effective application of fundamental motion design principles could support attention, comprehension, and engagement in digital reading environments. Furthermore, it examined empirical studies on animated storybooks and their effects on vocabulary development and narrative understanding in young children.

2.1 Motion Design

Motion design referred to the structured use of movement in visual media to communicate meaning, direct attention, and evoke emotion (Krasner, 2013). In animated storybooks, motion design played a crucial role in highlighting story events, guiding viewers' focus, and enhancing the readability of narrative sequences. Motion was not merely decorative; it had the potential to support cognitive processing, narrative comprehension, and vocabulary acquisition when applied with pedagogical intent (Crook & Beare, 2016; Shaw, 2017).

2.2 Motion Design Principles

Previous studies have identified motion design principles as key strategies for structuring movement to convey meaning and guide attention (Krasner, 2013). Research has highlighted that timing, spacing, and rhythm influence the pace and flow of motion, contributing to visual clarity and continuity (Shaw, 2017; Sun, Loh & Roberts, 2019). Anticipation, follow-through, and easing have been noted to produce natural and smooth movements, enhancing perceptual coherence (Crook & Beare, 2016). Additionally, arcs, staging, and hierarchy facilitate the organization of visual elements and focus attention, while transitions support the seamless connection of sequences. Emotion has been recognized for its role in conveying expressive qualities and engaging viewers (Shaw, 2017; Sun, Loh & Roberts, 2019). Collectively, these principles provide a framework frequently applied in animated media to guide visual perception and attention, though empirical validation of their effects in educational contexts remains limited.

2.2.1 Timing

Timing controls the duration of actions, fundamentally shaping narrative emphasis and pacing to potentially optimize the processing rate of visual and textual information for young children (Krasner, 2013; Sun, Loh & Roberts, 2019). While the importance of precise timing for narrative clarity is well-accepted across design literature (Crook & Beare, 2016), a crucial area for refinement exists in empirically defining the quantifiable temporal thresholds that distinguish optimal animation speeds from those that may induce attentional disruption (Takács & Bus, 2016). This study seeks to move beyond qualitative concepts of "appropriate pacing" toward specific, measurable design metrics to support cognitive pacing.

2.2.2 Spacing

Spacing regulates the distribution of object positions over time, directly enhancing the perceived speed and smoothness of motion, thereby maintaining visual flow and continuity necessary for sustained attention (Shaw, 2017; Crook & Beare, 2016). The theoretical link between optimized spacing and reduced visual fatigue is clear, but research tends to treat spacing implicitly as a function of timing. This suggests a compelling opportunity to experimentally isolate spacing as an independent variable to confirm its unique contribution to attentional stability and flow, validating its prescriptive use in educational design.

2.2.3 Rhythm

Rhythm involves the patterned repetition of movement, providing a temporal structure that supports narrative stability and is believed to aid memory retention by offering stable visual patterns (Krasner, 2013; Smeets & Bus, 2014). This principle is highly effective for establishing mood and engagement; however, its academic utility is limited by the challenge of disentangling its cognitive effects from those of general pacing variables. Future studies, including this one, must confirm whether a structured rhythmic pattern provides a measurable cognitive advantage in stabilizing attention and retention that surpasses the benefits achieved by maintaining optimal, non-rhythmic timing.

2.2.4 Anticipation

Anticipation uses preparatory movements to signal impending actions (Crook & Beare, 2016), a vital cue theorized to reduce cognitive load by preparing the visual system for incoming events and mitigating abruptness (Sun, Loh & Roberts, 2019). The theoretical rationale for anticipation supporting young learners with limited processing capacity is robust; however, its measurable impact has not been definitively quantified. Research must therefore transition from theoretical assertion to direct, objective validation by quantifying the precise magnitude of cognitive load reduction attributable solely to anticipatory motion via physiological metrics.

2.2.5 Follow-through

Follow-through ensures that motion continues naturally after a primary action, significantly enhancing visual realism and narrative believability, which supports children's comprehension of cause-effect relationships (Crook & Beare, 2016; Takács & Bus, 2016). While powerful for improving high-level narrative integration, the existing literature does not clearly differentiate its influence on foundational reading skills, such as visual attention or word recognition. This points to a need for targeted investigation to establish if its primary value lies in refining comprehension quality or if it offers earlier support for decoding tasks.

2.2.6 Easing

Easing entails gradual acceleration and deceleration of movement, making motion appear organic and visually comfortable, thereby minimizing distraction and facilitating enhanced attention (Shaw, 2017; Crook & Beare, 2016). Given its direct link to visual comfort and continuity, Easing is a critically important variable for managing attention. While its theoretical benefit in reducing visual jarring is strong, empirical validation directly linking optimized easing curves to a measurable decrease in fixation duration (Rayner & Pollatsek, 2006) is required to establish prescriptive design standards.

2.2.7 Arcs

Arcs define the curved pathways of movement, successfully adhering to principles of natural motion to support continuity and fluid visual storytelling (Crook & Beare, 2016). This principle excels at enhancing visual realism, which supports narrative immersion. However, its direct cognitive utility in supporting reading skills appears secondary when compared to the critical functions of temporal principles like Timing and Easing. Thus, while essential for production quality, its immediate priority in cognitive load studies is lower.

2.2.8 Staging

Staging is the strategic arrangement of visual elements to clarify focus and intention (Shaw, 2017), fundamentally necessary for reducing cognitive ambiguity and guiding attention toward narrative-critical information (Takács & Bus, 2016). Staging is highly valuable, but its effectiveness is often contingent upon other principles (e.g., Timing highlighting a staged element). Therefore, staging functions effectively as a crucial moderator whose optimal application determines the successful implementation and perception of the temporal motion principles under investigation.

2.2.9 Hierarchy

Hierarchy organizes visual elements based on importance, directing an audience's attention and enabling the audience to distinguish primary content from secondary detail (Krasner, 2013; Smeets & Bus, 2014). This established principle reliably supports comprehension and reduces cognitive redundancy through static organization. The logical next step involves validating dynamic motion-

based hierarchy. Future research must quantify how dynamic movement is used to establish and shift visual importance over time, thereby confirming its efficacy in managing sustained attention across static text and time-based visual support.

2.2.10 Transition

Transition facilitates the visual connection between scenes, successfully maintaining narrative coherence and reducing cognitive load by guiding attention (Krasner, 2013; Takács & Bus, 2016). While the importance of a smooth transition is clear, the current gap lies in classifying which specific transition types (e.g., hard cuts versus gradual fades) are empirically optimal for educational contexts, and precisely how their speed affects the cognitive recovery period required by young learners between successive informational units.

2.2.11 Emotion

Emotion captures the expressive qualities conveyed through movement and visual cues, acting as a powerful and essential driver of affective engagement, comprehension, and intrinsic motivation (Shaw, 2017; Sun, Loh & Roberts, 2019). The challenge lies not in its value, but in its measurement; research must shift to identifying the technical underpinnings (e.g., timing and rhythm) that reliably produce the desired emotional effects, thereby providing designers with measurable parameters to optimize attention.

2.3 Animated Storybooks

Animated storybooks have been robustly validated as effective multimodal resources for improving engagement, vocabulary acquisition, and narrative comprehension in early learners (Smeets & Bus, 2014; Son & Butcher, 2024; Savva, Higgins & Beckmann, 2022), often outperforming traditional printed formats (Wu & Amzah, 2023). However, this success is tempered by the critical finding that non-pedagogical features can severely increase cognitive load and undermine comprehension (Ross et al., 2025; Takács, Swart, & Bus, 2015). This demonstrates a clear need to refine the current understanding, which suffers from an attribution problem where benefits are generalized to "multimedia." The field requires research that specifically isolates the impact of motion quality to develop the prescriptive design criteria needed, particularly in contexts like Malaysia where aesthetic prioritization limits pedagogical effectiveness (Gidor & Abu Bakar, 2024).

2.4 Reading Skills

Reading proficiency is underpinned by fundamental cognitive mechanisms, where controlled eye movements (Rayner & Pollatsek, 2006), attentional stability (Fernández-López et al., 2018), and working memory capacity (Gathercole et al., 2014) are established predictors of early reading outcomes. The literature successfully maps these prerequisites and confirms that physiological markers reflect cognitive load during reading (Sirois et al., 2020), suggesting animated storybooks can reinforce these skills by guiding attention (Takács & Bus, 2016). The opportunity for research, however, lies in moving from measurement to prescription: experimentally detailing how dynamic visual stimuli, specifically the quality of motion, can be actively leveraged to mediate attentional control and minimize working memory taxation in young readers.

3 RESEARCH METHODOLOGY

This research analysed motion design principles in animated storybooks through a qualitative content analysis to understand how they enhance children's reading skills. This method was appropriate as it enabled systematic examination of visual and audiovisual materials, with emphasis on narrative function, design structure, and communicative intent rather than quantitative measurement. The analysis

was guided by Krippendorff's (2013) content analysis framework, which ensured a structured and replicable process for interpreting visual verbal materials.

The samples analysed consisted of purposively selected animated storybooks created for children that incorporated narration, textual elements, illustrations, and animated motion. Digital storybooks without animated features were excluded to maintain focus on motion-based storytelling. Each storybook was treated as a unit of analysis and examined through recorded playback to allow repeated viewing. The analysis examined motion segments in which animation was employed to support narrative events, visual focus, and emotional expression.

For consistency in analysis, this study used Krasner's (2013) motion design principles as the main theoretical framework to evaluate how motion was applied in the selected storybooks. Motion features were examined according to principles including timing, spacing, rhythm, anticipation, follow-through, easing, arcs, staging, hierarchy, transition, and emotion. A structured coding process was carried out to identify patterns showing whether these motion elements facilitated or hindered the reading experience. To ensure reliability, another researcher independently reviewed part of the data, and any disagreements were resolved through discussion.



Figure 1 Framework of Study

4 DATA SAMPLES

The study's data comprised eight animated storybooks, purposefully selected for their relevance to children's literacy, which served as the primary units for qualitative content analysis. Only digital storybooks that integrated motion with narration were included, ensuring that the analysis concentrated on materials actively engaging children in literacy practices. Static e-books without animation were excluded to maintain a focus on dynamic motion design. The selected storybooks were sourced from various producers and encompassed a wide range of narrative styles and animation techniques.

Table 1 Selection Sample of Animated Storybooks for Children

Animated Storybooks for Children	Video Label	Producer and Platform	Duration	Released Date
Read Aloud Kids Book: It's A Firefly Night! Vooks Narrated Storybooks	S1	Vooks (YouTube)	7:39	February 1, 2023
The Snail and the Whale - Animated Read Aloud Book	S2	Reading is (YouTube)	13:08	July 19, 2024
Goldilocks And The Three Bears A Super Simple Storybook	S3	Super Simple Storytime (YouTube)	8:20	February 16, 2021
Maisy Goes to the Library Animated story	S4	5 Minutes With Uncle Ben (YouTube)	6:03	August 30, 2025
Where's Spot? Animated books for Kids Read aloud	S5	LolliPop Animated Book (YouTube)	2:10	July 8, 2021
The Ugly Duckling A Super Simple Storybook	S6	Super Simple Storytime (YouTube)	6:51	Jun 18, 2021
Will Powers Read Aloud Kids Book Animated Storybook	S7	Coyco by Coy Bowles - Videos for Kids & Teachers (YouTube)	4:29	September 23, 2025
The Dot ANIMATED STORYBOOK Peter H. Reynolds IMMERSIVE Read Aloud BOOKTOPIA	S8	Booktopia Storytime (YouTube)	3:07	April 23, 2024

5 DATA ANALYSIS

This study employed a qualitative content analysis to evaluate the application of motion design principles within the selected animated storybooks. The analytical process was guided by eleven principles adapted from Krasner (2013), focusing on how motion either supported narrative comprehension or caused cognitive distraction. To measure these elements, a structural identification checklist scheme was utilized. Each principle was recorded as "Present (/)" if the component was clearly locatable and met the operational definition, while it was recorded as "Absent (-)" if the component was missing or unidentifiable. This systematic approach allowed for a consistent comparison across the eight samples.

Table 2 Analysis of Motion Design Principles for Selected Animated Storybooks for Children

Samples / Motion Design Principles	S1	S2	S3	S4	S5	S6	S7	S8
Timing	/	/	/	/	/	/	/	/
Spacing	/	/	/	/	/	/	/	/
Rhythm	/	/	/	/	-	/	/	/
Staging	/	/	/	/	/	/	/	/
Hierarchy	/	/	/	/	/	/	/	/
Easing	/	/	/	/	/	/	/	/
Arcs	-	/	-	/	-	-	/	/
Anticipation	/	/	/	/	/	/	/	/
Follow-through	-	/	/	/	-	-	/	/
Emotion	/	/	/	/	/	/	/	/
Transition	/	/	/	/	/	/	/	/

6 RESULTS

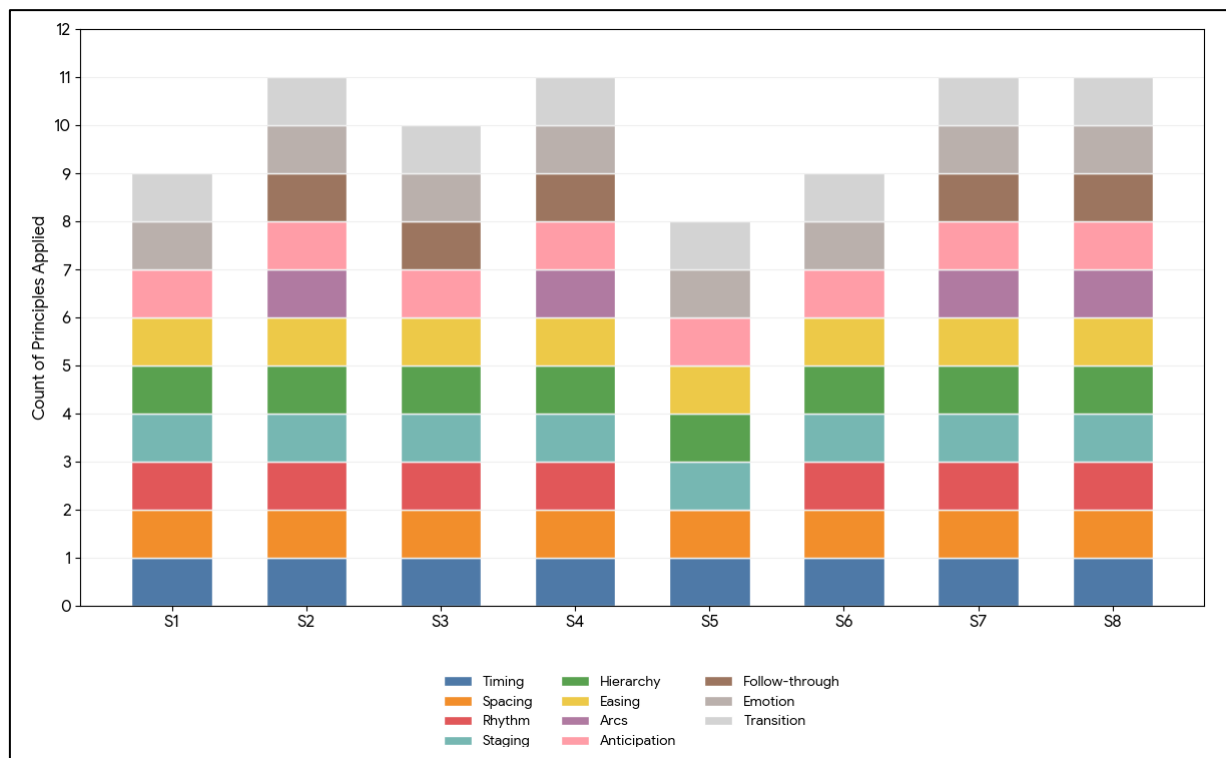


Figure 2 Results of Motion Design Principles in Animated Storybooks for Children.

7 FINDINGS

The results indicated that the strategic application of these principles managed cognitive load and directed visual attention toward narrative elements that supported literacy development. The effectiveness of these materials was found to depend heavily on how motion units supported the primary task of decoding text rather than competing for the limited working memory of the child.

The study of timing, spacing, and rhythm showed that these elements play an important role in controlling how learners process information. In *It's A Firefly Night!* (S1) and *The Dot* (S8), the researchers observed that deliberate timing synchronized effectively with the narration. This synchronization was found to mitigate attentional drift, which ensured that animated actions did not overwhelm the reader during the decoding process. Furthermore, the rhythmic patterns identified in *Goldilocks and the Three Bears* (S3) and *The Ugly Duckling* (S6) provided a stable structure that aided memory retention. These results aligned with the theories of Smeets and Bus (2012), who argued that consistent visual patterns were essential for reinforcing narrative stability and auditory-visual synchronization in early learners.

The study further identified that staging and visual hierarchy were instrumental in directing visual attention toward primary story content. In samples such as *Maisy Goes to the Library* (S4) and *Where's Spot?* (S5), motion was utilized as a signalling mechanism to highlight text-critical details. By organizing visual elements based on narrative importance, these storybooks successfully reduced cognitive redundancy. This finding validated the design approach suggested by Takács and Bus (2016), which emphasized that motion must guide the viewer toward meaningful components to prevent the distractions often associated with complex digital media. The researchers noted that samples with a clear hierarchy allowed children to focus on vocabulary-rich segments without the interference of extraneous decorative animations.

Kinetic fluidity, achieved through easing, arcs, and anticipation, significantly impacted the visual

comfort and sustained engagement of the viewers. In high-production samples such as *The Snail and the Whale* (S2) and *Will Powers* (S7), the researchers noted that organic acceleration and preparatory movements created a sense of narrative realism. According to Krasner (2013), these principles reduced the jarring visual effects that often interrupted the meaning-making process. The use of anticipation was particularly effective in preparing the child's visual system for upcoming actions, thereby reducing the cognitive effort required to track moving characters.

Finally, the universal presence of emotional appeal and narrative transitions across the samples indicated that expressive motion facilitated a supportive environment for vocabulary acquisition and story immersion. Expressive cues in *The Dot* (S8) were found to convey deep emotional meaning, which fostered intrinsic motivation in the reader. Smooth transitions between scenes were also identified as necessary for maintaining narrative flow, as they reduced the cognitive recovery period required by young learners when moving between different visual contexts. Collectively, these findings suggested that when motion design was grounded in established frameworks, it transcended its role as entertainment and became an active support system for children's reading comprehension and engagement.

CONCLUSION

This study concluded that the integration of motion design principles in animated storybooks served as a vital pedagogical tool for enhancing children's reading skills. By identifying and analysing eleven core principles across eight samples, the research confirmed that motion, when grounded in the frameworks of Krasner (2013), effectively managed cognitive load and directed visual attention toward meaningful narrative content. The findings demonstrated that these principles directly contributed to improved reading comprehension by clarifying story sequences and supporting vocabulary development through affective engagement.

RECOMMENDATION

Ultimately, the results suggested that the quality of motion was a decisive factor in the educational effectiveness of digital storybooks. Moving forward, it was recommended that developers and educators prioritize pedagogical animation, where motion is used strategically to signal importance rather than purely for entertainment. Incorporating the motion design framework established in this study enables animated storybooks to move past being merely passive media and serve as interactive platforms that promote early literacy development. Future research should consider empirical testing with child participants to further quantify the impact of these specific motion units on real-time reading performance.

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AUTHOR CONTRIBUTIONS

All authors played equal contributions towards the production of this paper.

CONFLICT OF INTEREST

The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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