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Technical Supports and Emotional Design in Digital Picture Books for Children: A Review

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Abstract

In recent years, the digital picture book has been an increasingly important reading and writing medium for children. Research on the effects of digital picture books on learning has produced mixed results. As a potential tool, some researchers found that such books could foster and scaffold for developing emergent literacy in the early childhood education. However, some still have the skeptical attitude toward integrating the technology in picture books. This survey reviews techniques and emotional design that have been applied in picture books. We also compared and discussed different types of picture books.

Keywords: Digital Picture Book; Emotion Design; Augmented Reality

1. Introduction

Digital picture books for children have become a new reading mode with the rapid development of information technology. Recently, many researchers have tried to apply information technology to children's picture books to improve their reading experience and the quality of parent-child interaction. However, most picture books' interfaces and interactive patterns are designed for entertainment rather than supporting children in understanding. Besides, the design of such books concentrates on digital interaction while ignoring the emotional interaction of children. Research on the effects of digital picture books on learning has produced mixed results. Some researchers found that such books could foster and scaffold for developing emergent literacy in early childhood education as a potential tool. However, some still have a skeptical attitude toward integrating technology in picture books. This paper discusses the impact of information technology on children's picture books during their reading experience and literacy improvement from the perspective of technical support and emotional design level.

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2. The Screen Controversy of Technological Terminal for Children

Research highlights the negative effects of excessive screen exposures on young children's use of digital devices and encourages parents to limit their children's screen time. With the development of information technology, digital picture books are becoming more popular. One of the concerns is that screen time may replace the opportunity to establish an active interpersonal relationship, even ignoring the interaction among their family members. There is a focus of debate about whether digital picture books can replace parents accompanied by parent-child interactive reading. In contrast, the studies have found a positive influence of digital terminals in the family and school environment. Such as, McClure [17] has shown that it may also help to strengthen social relationships under the enthusiasm and intentional condition of technology between young children and adults. The study believes that even infants can benefit from remote communication with adults through FaceTime or Skype. So it concludes that technology does not isolate children, conversely strengthens the connection between children and their peers or adults. Meanwhile, technology still plays a role in improving the classroom environment and curriculum resources to support children at home and school. However, the impact of technology on children's reading development is still unclear.

2.1. The Positive Impact of Digital Picture Books

With the children's picture books transforming from traditional paper to digital, research turned to digital picture books. Digital picture books refer to stories that are digitized, including images, texts, recorded videos, audio, and music [27]. Yokota et al. [43] divided digital picture books into four categories according to the evolution of the book features: (1) Scanned printed picture books; (2) Add a visual and auditory design to turn picture books into movies; (3) Add some digital features to the picture book, such as font setting, voice, music background, and some hot spots; (4) Add interactive functions and turn picture books into games. This study divides digital picture books into four categories into the two dimensions of dynamic versus static and interactive versus non-interactive, including scanning static picture books, dynamic video picture books, interactive game picture books, and augmented reality (AR) picture books. These digital picture books involve the presentation of verbal and non-verbal information. According to multimedia cognitive learning theory[15], deeper learning occurs when information is presented in both verbal and non-verbal ways. The dual coding theory [20] also shows that the processing of verbal and non-verbal information is in two channels that do not affect each other. Therefore, digital picture books can enhance children's understanding of stories better than traditional picture books [36].

Relevant research results in that digital picture books can promote children's learning. For example, Ihmeideh [7] compared the differences in children's reading and writing ability between traditional and scanning digital books with multimedia design. The results showed that children in the experimental group improved printing awareness and vocabulary better than those in the control group. In addition, Korat et al. [12]also assure that digital picture books can support children's reading and writing ability. Other studies have found that online picture books with interactive functions can promote primary school students' English reading literacy [45]. It is worth mentioning that Tackacs et al. [35] applied meta-analysis through the data from 2,147 children in 43 studies and found that digital picture books with technological enhancements improved the children's story understanding and vocabulary. Still, most of the technological improvements in the study were animation, interaction, music without games or AR technologies.

With the development of AR technology, researchers have begun to apply it to picture books. Not only Indonesian scholars have conducted a demand analysis on the development of AR picture books [34], but also scholars from various countries have embark on AR picture books [42] [37] [10] [3] [2] [41], and developed tools to facilitate the production of AR picture books [6] [9]). However, none of the above studies designed experiments to explore the impact of AR picture books on students' reading ability, interest, and motivation. Lin [13] make up the gap of experimental research. By comparing traditional picture books and AR picture books, they found that AR picture books promote students' knowledge and understanding of insect growth and deformation processes. Such books stimulate kids' imagination and improve their motivation to learn. The work in [4] compared children's reading ability under the two conditions of traditional picture books and AR picture books through quasi-experimental design. The authors found that AR picture books with multimedia content can improve students' comprehension ability.

In conclusion, the current research finds that digital picture books are beneficial to enhancing children's reading comprehension ability, interest, and motivation.

2.2. Comparison Between Digital and Traditional Picture Books

Most of the above studies related to digital picture books discuss the differences between digital and traditional picture books. According to Mayer [16], these works belong to the category of media research that summarizes the comparative studies on picture books, as shown in Table 1. There are relatively lots of studies on media comparison. Some studies reveal that digital picture books can improve learning, while others suggest no difference between digital and traditional picture books. Simultaneously, a considerable number of studies have indicated that the design of multimedia elements in picture books may increase readers' cognitive load and distract their attention, which is not conducive to learning [36]. Therefore, to further explore the design problems in digital picture books, it is necessary to analyze the impact differences of digital picture books, namely, value-added research, as shown in Table 2. The value-added study of digital picture books compares students' learning status with the same picture books in different designs, involving multimedia design, interface design, and teaching characteristics related to learning design [26]. It can be found that different picture book designs have different influences on students' reading ability and motivation in the following table. For example, the higher interactive design can improve students' learning motivation and reading comprehension ability, while some multimedia design, including sound and animation, harms learning. Due to increased cognitive load, the background of sounds wastes the limited working memory capacity in the auditory channel, thus reducing the effectiveness of children in deriving the meanings of unknown words from context [11]. In addition, emotional design can enhance children's comprehensive ability and create a positive emotional resonance for children.

Table 1. Summary of media comparison research on digital picture books (2011-2021).

Citation	Design	Participants	Results
Danaei et al. (2020) [4]	Augmented reality picture book VS Traditional paper-based picture book, Between-subjects	34 , 7-9 years old	Augmented reality picture book can improve students' reading comprehension
Lin et al. (2018) [13]	Augmented reality picture book VS Traditional paper-based picture book, Between-subjects	34, 10 years old	Augmented reality picture book can promote students' motivation,imagination, and knowledge understanding
Richter & Courage. (2017) [25]	Game interactive picture book VS Traditional paper-based picture book, Within- subjects	79, 3-5 years old	The e-book group learned better
Ihmeideh. (2014) [7]	Game interactive picture book VS Traditional paper-based picture book, Between-subjects	92, 4-5 years old	The game interactive group performed significantly better than the control group
Reich et al. (2019) [24]	Game interactive picture book VS Traditional paper-based picture book, Between-subjects	200, 3-5 years old	Children are more likely to read e-books
Shamir et al. (2011) [31]	Game interactive picture book VS Traditional paper-based picture book, Between-subjects	136, 5-7 years old	Game interactive picture book can promote vocabulary acquisition of children with at risk for learning disabilities
Takacs & Bus. (2016) [35]	Video dynamic picture book VS Scan static picture book, Within- subjects	39, 4-6 years old	Video dynamic picture books are more attractive to children
Sapsaglam et al. (2020) [29]	Scan static picture book VS Traditional paper-based picture book, Between-subjects	20, 3-6 years old	The traditional group has a high level of recall
Raynaudo & Peralta. (2019) [23]	Scan static picture book VS Traditional paper-based picture book, Between-subjects	40, 4 years old	The traditional group performs better
Smeets & Bus. (2015) [32]	Scan static picture book VS Video dynamic picture book VS Game Interactive picture book, Between-subjects	136, 4-6.5 years old	Animated e-book groups increase more vocabulary

3. Emotional Design for Children's Multimedia Learning

Emotional design can be defined as the use of different design elements to influence learners' emotions to improve their learning ability [22].There has been a great deal of research on the emotional feedback of users when interacting with designed multimedia. Relevant literature displays that multimedia learning with positive emotions is beneficial

Table 2. Summary of value-added research on digital picture books (2011-2021).

Citation	Design	Participants	Results
Kao et al. (2016) [8]	High interaction VS Low interaction, Between-subjects	40, 10 years old	High interactive group perceives higher reading motivation and story understanding than low interaction group
Bu et al. (2019) [1]	Emotional design VS No emotional design, Between-subjects	20, 4-6 years old	The emotional design of electronic picture book can strongly influence children's sensory experience
Sarı et al. (2019) [30]	Music sound VS No music sound, Between-subjects Animation VS No animation, Between-subjects	99, 4-6 years old	Sounds have a negative impact on children's acceptable vocabulary Animations enable children to better understand the storyline
Xiang & Zhang. (2014) [40]	Small interaction VS Medium interaction VS Large Interaction, Between-subjects	30, 4-6 years old	Adding animation elements increases the appeal to children's attention
Zhou et al. (2021) [45]	Within- subjects	12, 7-11 years old	Game interactive picture book can promote the improvement of English reading literacy
McGlynn-Stewart et al. (2019) [18]	Within- subjects	21, 2.5-4.5 years old	Game Interactive picture book supports Early Literacy Learning

to improving students' learning performance. Park et al. [21] found that the influence of learners' emotions on multimedia learning through eye movement experiment, and the subjects would have better learning effects in positive emotional states. Feuer et al. [5] conducted an experiment to verify the effects of emotional design on problem-solving skills, attention, and motivation in mathematics for primary school students. The results indicated better performance of problem-solving ability, attention, and motivation via multimedia materials of emotional design. Munchow and Bannert [19] have experimentally demonstrated that it is harmless to improving learning effect at best in the aspect of the emotional design. Um et al. [39] found that it can induce positive emotions by applying the principles of emotional design to learning materials. At the same time, the cognitive process was promoted by learning with positive emotions based on multimedia learning. However, there is no definitive conclusion on how emotional design influences children's learning effect in digital picture books.

3.1. The Intrinsic Motivation of Digital Picture Books

According to the existing literature, few studies on the influence of emotional design in digital picture books on children's emotions and reading experience. From a particular perspective, there was a good effect on children's understanding of story content with the emotional design in digital picture books. Tsai [38] investigated the influence of children's picture books on the affective understanding and regulation of 5-6 years old Taiwanese students. They found that children's emotional comprehension ability improved by picture books with emotional elements. However, it may negatively affect emotional design in picture books. Excessive and inappropriate emotional factors may distract them from reading. Visual effects may distract children, lead them to think of the story as a game for entertainment purposes, and interfere with their understanding of the story as a motive [33]. There are also too many exaggerated and fancy animation elements that distract children's attention. Children can not better understand the story's content, not to improve children's reading literacy. As a result, children seem to prefer animations to stories, and this emotional motivation prevents them from understanding the story sincerely.

3.2. External Rational Layout of Emotional Design

The research suggested that the layout of picture books should be reasonable for the picture book design. The difficulty of picture books and pages should be adapted to age level for the children's reading habits. Parents share picture books with children, customed to let the child read pictures at first. Then they explain the meaning of words and provide the imagination to combine images and words to form their understanding. For digital picture books, the total time of pictures reading, stories telling, and listening to audio should not exceed the maximum duration of children's ability to read and the most acceptable difficulty to avoid the negative impact of cognitive load. If the

cognitive load exceeds the normal level, children are likely bored. Since children can hardly read independently, parents should scaffold children to read and explain to them. In other words, the words in picture books are not for children to read but for children to listen [44]. When children read it with their parents, they hear the story and put themselves in the characters' position, which further reflects the theory of mind. Children are immersed in reading activities through the multi-dimensional experience of vision, hearing, entertainment, and thinking [14]. This can also promote communication and interaction between parents and children to a certain extent; avoiding that technology may decrease young children's social interaction. Also, children will have a new experience by repeatedly listening to the audio story.

3.3. Emotional Design Model in Digital Picture Books

PCE (Perception & Comprehension & Expression) model has been proposed [1]. The research carries on the emotion design to the picture book from several aspects. First, on the perception level, it provides excellent multi-sensory interaction, promotes children's multi-dimensional experience when reading picture books, makes them fully participate in reading activities, and meets children's emotional needs. Second, it establishes an immersive cognitive interaction at the cognitive level to assist themselves with the characters in the picture books and enhance their sense of identity. Finally, based on emotion recognition and feedback, it will produce a certain emotional interaction at the emotional level. Studies have shown that the emotional design of digital picture books for children can stimulate readers to have a positive reading experience and affect cognitive results (i.e., comprehension ability) and emotional results (i.e., happiness). This model puts forward evaluation indicators for the further design of digital picture books, which can further standardize and evaluate the quality of digital picture books for children. Parents will no longer choose picture books blindly and be in the grip of digital anxiety and panic.

4. Conclusion

The ultimate purpose of the technical support and emotional design in children's digital picture books is to improve children's reading ability and positive experience. Researchers should consider how to meet children's emotional needs when designing digital picture books. Further study should focus on how expressive ways like vocabulary, oral language, and comprehension impact reading. Also, there is a need to investigate how experiential indicators of the reading process, including orthographic awareness, phonological awareness, and eye movement characteristics, impact reading. Previous studies have found that digital picture books have positive or negative effects on improving children's reading comprehension and vocabulary learning, referring to software quality, interactive function, repeated reading, and adult interactive support. Children can create an overall reading experience independently, or with adult support by synergistic effects [28]. Studies have found that children may enjoy listening to both human beings and digital devices [24]. However, there are still questions about whether self-reading e-books are as good, better, or worse than real people reading paper books.

We reviewed current studies and pointed out their achievements and current knowledge gaps. The limitation of the review lies in the lack of cross-cultural research comparison. From the perspective of technology, future research can focus on emotional design by integrating digital picture books with sufficient interaction and parental agents to eliminate screen anxiety.

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