International Journal of Education and Practice
2024 Vol. 12, No. 2, pp. 312-323
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v12i2.3680

The effects of interactive electronic picture books on young children's oral expression skills

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Article History
Received: 4 August 2023
Revised: 30 October 2023
Accepted: 28 February 2024
Published: 15 March 2024

Keywords
Arduino
Cognitive abilities
Early childhood education
Interactive electronic picture books
Oral expression skills
Sensor
Young children.

ABSTRACT

The application of interactive electronic picture books can strengthen young children's reading comprehension skills. Interactive electronic picture books that involve interaction with sensors, with the interaction integrated into the story, should be developed to enhance children's reading experience and improve their oral expression skills. Interactive electronic picture books that involved children manipulating stuffed animals containing sensors that provided feedback were developed for this study. Visual, auditory, and tactile stimuli can be used to create an interactive feedback system. Data was collected through semi-structured interviews with teachers, who gave their opinions regarding the curriculum of their preschool. The results indicate that the intuitiveness of the system helped improve the children's reading experience, strengthened their motivation to read, and improved their cognitive abilities. In addition, interactive electronic picture books were found to improve the children's oral expression skills.

Contribution/Originality: The results indicate that technology plays a central role in modern in-person or remote educational environments, including early childhood education classrooms.

1. INTRODUCTION

1.1. The Importance of Improving Young Children's Oral Expression Skills

Young children have strong learning abilities because of their high neural plasticity and ability to imitate, and they are driven by curiosity. Preschool teachers providing developmentally appropriate learning environments, equipment, and activities for young children can positively affect their language development. Young children's language development before the age of six years is vital, and improving their oral expression skills is essential as their organs develop and they encounter different experiences. During this crucial period of language development, reading can improve children's linguistic expression and familiarize them with the structure and tone of written language, which is critical to developing adult-level reading comprehension. Preschool teachers should collaborate sincerely and diligently for the benefit of young children, and in the course of every effort they can improve pedagogy (Al-Harbi, 2020; Chou & Chen, 1998; Lin, 2005; Montessori, 2004; Parker, 1902; Shih, 2020a; Shih, Wu, & Chung, 2022).

1.2. Integrating Technology into Education to Increase its Effectiveness for Young Children

Technology plays a central role in modern in-person or remote educational environments, including early childhood education classrooms (Arkansas State University, 2022).

Su (2004) used augmented reality to help children learn phonetic symbols and various stimuli as a means of increasing their learning effectiveness and enriching the learning process. Compared with traditional methods, this method improved the children's academic performance, strengthened their motivation to learn, and encouraged interaction. These findings indicate that interactive technology can strengthen children's motivation to learn and thereby improve their learning outcomes.

Chang, Chang, and Wei (2011) used an Xbox 360 Kinect to conduct a somatosensory brain exercise and explore its effects on learning motivation among schoolchildren; the results indicated that using the Kinect increased students' willingness to learn, which can improve the likelihood of retention of information and learning effectiveness.

Shih (2017) explored the effects of interactive electronic whiteboards on English learning in children and sought teachers' and parents' opinions regarding the whiteboards. The results revealed that when native English speakers used the whiteboards to teach English, the teaching was extremely effective.

In conclusion, these studies indicate that the integration of technology into teaching can increase the effectiveness of learning. For this reason, this study created electronic interactive picture books to improve children's oral expression skills and increase learning effectiveness. Few somatosensory, electronic interactive picture books have been developed to strengthen children's oral expression skills in Taiwan. This study added interactive elements to electronic interactive picture books to make the books more interesting to young children. For example, this study used electronic sensing devices to ensure the books would stimulate the system and thus enhance young children's oral expression skills. The study objectives are as follows:

(1) Explore theories of learning in young children.

(2) Explore the relationship between interactive electronic picture books and language development.

(3) Discuss the effects of the interactive electronic picture books developed in the current study.

(4) Present conclusions regarding this study's findings that may serve as a reference and offer suggestions for preschool educators.

2. LITERATURE REVIEW

2.1. Theories of Learning in Young Children

Theories of learning in young children are based on nativist theory, learning theory, cognitive theory, and sensory theory. Nativist theory was proposed by Chomsky and frames language development and other physiological functions as inherent. Skinner's learning theory indicates that language is acquired through imitation and enhancement; children have no internal mechanisms or abilities to independently acquire language. Cognitive scholar Piaget indicated that children's language abilities are related to cognitive development. Sensory theory describes two processes of language acquisition—language reception and language production—both of which are involved in language use and development. According to these theories, the key factors that affect children's language abilities include reactions to language-related environmental stimuli, innate language-learning mechanisms, cognitive abilities, social interactions with peers and teachers, and active participation in language learning and use (Christiansen & Chater, 2008; Flavell, 1963; Messerly, 1992; Piaget, 1966; Yang, 2014). Combining these factors within a picture book would facilitate children's language development and improve their oral expression skills.

2.2 The Relationship Between Interactive Electronic Picture Books and Children's Oral Expression Skills

Exposing children to language in the early developmental stages can have positive long-term effects. Children can be exposed to language through reading materials such as picture books (Yang, 2010) which can strengthen their language abilities and improve their oral expression skills (Fu, 2014). Parent–child reading is also an effective means of improving language development because parents can explain the connotations of the text, which can help children understand the meanings of words, social rules and norms, and social values, thereby improving their oral expression skills (Chen, 2013). Lin (2010) conducted experiments to explore the effects of electronic picture books and discovered that they improved children's oral expression skills.

3. RESEARCH METHOD

3.1. Research Tools

Visual, auditory, and tactile stimuli can be used to create an interactive feedback system. The current study used Arduino electronic sensors, the Scratch animation program (custom building block animation), and computer games to create interactive picture books.

3.1.1. Electronic Sensors

Physical phenomena, including temperature, humidity, brightness, kinetic energy, potential energy, and pressure, can be digitized through infrared sensing or radio frequency identification (RFID). The most commonly used type of sensor for such digitization is motion sensors; for example, motion sensors are often used to automatically turn lights on when objects or people pass by and are typically used for automatic doors.

3.1.2. Arduino Control Board

The Arduino hardware and software were launched in 2005. Arduino can be used by individuals with no programming experience to creatively manipulate simple sensors. It is an open-source software and hardware platform mainly used by artists and designers. Arduino sensors receive input from the environment, and the microcontroller program can be used to develop various sensing devices. Flash, Processing, Max/MSP, and other software can be used with Arduino.

Max/MSP is a set of graphical programming languages (visual programming language) and a tool for applying Creative Coding to music composition. It can be used to control sound parameters, real-time interaction, sound synthesis, design prototypes, and other fields.

The Arduino controller is less expensive than other controllers and provides a universal serial bus interface and accepts a 9V direct current power input, which makes it convenient. The designs of interactive products are often limited by designers with insufficient software writing skills and by the complexity of hardware. The Arduino circuit control board enables users to connect electronic devices, such as light-emitting diodes (LEDs), speakers, motors, switches, temperature and humidity sensors, infrared transmitters and receivers, liquid crystal display (LCD) devices, and communication modules, such as Ethernet, Wi-Fi, XBee, Bluetooth, RFID devices, and global positioning systems (GPS). Arduino can also be used for automatic control. For example, temperature sensors can be used to control fans, resistors can be used to control lights and the speed of motors, infrared sensors can be used to control home appliances, and servos can be used to control mechanical arms or robots and create self-propelled cars and aircraft.

3.1.3. Hardware Architecture

Figure 1 presents a reference diagram for the hardware architecture of the picture books in this study (with RFID tags included as examples).

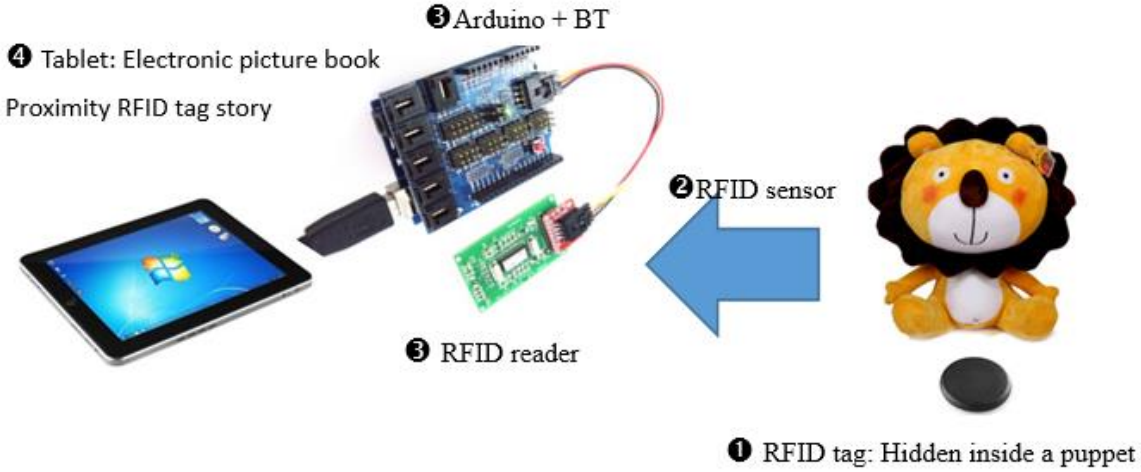
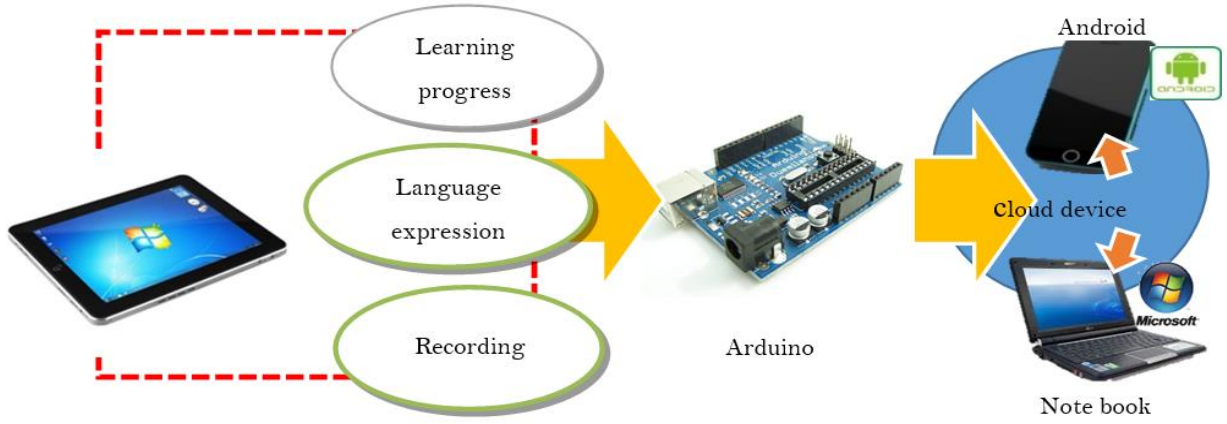


Figure 1. Hardware of interactive picture books.

We placed RFID tags in a stuffed lion, elephant, sun, moon, and other objects. Through RFID inductive coupling, a tablet computer can distinguish between each object and present the scenes from the story that correspond to the objects. Temperature, humidity, infrared, and light sensors are also used to sense the environment and adjust the story to the environment. For example, the photoresistor can sense the brightness of the environment and integrate it into the story; the background of the books during the day is a blue sky with clouds and at night is a night sky with the moon and stars.

3.1.4. Preschool Curriculum and Teaching Evaluation

According to the Level 4 standards of the Quality Evaluation Form of Preschool Curriculum and Teaching, preschool teachers must be able to document preschool children's exploration of their learning environment and create records of their learning progress that can serve as references for other teachers. Figure 2 presents the system architecture of the picture books.



Child end	Microcontroller and communication interface	Teacher end
Preschool teachers record reading progress, linguistic expression, and children narrating stories	Arduino + Bluetooth	Reading progress information provided to teachers for inquiry

Figure 2. System architecture of picture books.

At the child end, preschool teachers record reading progress, linguistic expression, and children narrating stories, and at the teacher end, information on reading progress is provided to teachers for inquiry.

3.2. Qualitative Case Study

Qualitative case studies enable researchers to investigate complex phenomena by identifying relevant factors and observing how they interact. Case studies involve various means of data collection, including observation, interviews, surveys, document analysis, and detailed descriptions provided by participants (Shih, 2022a). This study collected data through semi-structured interviews with teachers, who gave their opinions regarding the curriculum in their preschool.

3.2.1. Subject

The subject of the case study was a nonprofit preschool in Hsinchu County, Taiwan, that was established in August 2019. This preschool was established as part of the public early-childhood education policy implemented to address the declining birth rate in Taiwan. Through the policy, the government provides free land, buildings, and equipment for preschools; assigns public welfare personnel to operate the preschools; and ensures parity for local parents and that childcare needs are met. Currently, 60 children are enrolled at the preschool, and all are in mixed-age classes. The educational philosophy of the preschool is based on love, health, life, and learning. Preschool creates a home-like and warm learning environment, emphasizes the importance of learning through games, and helps children develop skills through exploration. A total of 21 children enrolled at this preschool participated in the present study.

3.2.2. Data Collection

3.2.2.1. Observation and Recording

The researchers observed the children in their classroom and used video and audio equipment to document classroom activities.

3.2.2.2. Documentation Analysis

The preschool teachers evaluated the recordings of the children's linguistic expression and narration of the stories.

3.2.2.3. Semi-structured Interviews

During the interviews, the preschool teachers gave their opinions of the class. Each interview lasted for two hours. Table 1 presents the demographic information of the interviewees; Table 2 presents the method used to code their responses.

Table 1. Teachers' demographics.

Job title	Gender	Age	Education level	Work experience
Preschool teacher A	Female	38 years	Bachelor's in early-childhood education	Early-childhood education: 14 years
Preschool teacher B	Female	28 years	Bachelor's in early-childhood education	Early-childhood education: 4 years
Preschool teacher C	Female	32 years	Bachelor's in early-childhood education	Early-childhood education: 8 years

Table 2. Coding method.

Interviewee	Code
Preschool teacher A	Practitioner interview, A20210316
Preschool teacher B	Practitioner interview, B20210316
Preschool teacher C	Practitioner interview, C20210316

Understand preschool teachers' opinions and thoughts on oral expression in the indicators of children's academic ability in the field of language after the implementation of teaching.

4. PROCESS

The core value of education lies in loosening educational regulations for preschools and emphasizing the autonomy of children, in turn providing children with alternative education and appropriate development opportunities (Shih, 2020b, 2022b; Wu, 2022).

The first page of each picture book was used to excite and motivate the young children for appropriate development. The young children were asked to guess the title of the book based on the cover and were guided through this process with open-ended questions. Subsequently, the children, especially the shyer children, were encouraged to tell stories for everyone. They received verbal praise for their stories, and the preschool teachers asked them questions and prompted the other children to ask them questions.

The researchers presented the young children with interactive picture books on a tablet computer and allowed them to ask questions about the books. They interacted with the books via the sensors, which provided feedback. The researchers then asked the young children what titles they would give the books if they were the authors. After, the children played games and created stories based on the picture books. The preschool teachers shared the children's stories to a cloud network for other young children to view and discuss.

5. RESULT

5.1. Picture Books

Four picture books were developed for this study based on the level 4 standards of the preschool curriculum and teaching quality evaluation of "1.3.2 Diversified Textbook Types." The picture books promote gender equality and multiculturalism.

5.1.1. Let's All Be Friends

Discussions and games were used to teach the children to accept people of different genders. RFID sensors were also used.

5.1.2. Where Are the Mice?

This book helped the children learn how to count from 1 to 10, identify even and odd numbers, learn sorting order, and make comparisons based on size. RFID and limit switches were used.

5.1.3. Happy Festival

In this book, the moon is the protagonist, and Vietnamese festivals are introduced. Photoresistors and light-shielding sensors were used.

5.1.4. Scientific Cooking King

An example of making biscuits was used to teach the children about the science of cooking. RFID and limit switches were used.

Figure 3 presents *Scientific Cooking King* and the materials used to create the book.

Figure 3. Scientific cooking king and related materials.

5.2. Effects on Oral Expression Skills

To determine the effects of the picture books and their related activities, this study observed the students and evaluated recordings of the learning process to identify changes in the students' speech after the class. Table 3 presents the results.

Table 3. Effects of the picture books.

Indicators of 5-year-old children's language abilities (Chinese; Lu (2003))			**Number of children at or above the threshold based on teachers' observations**
Target axis	**Indicator**	**Operational definition of the indicator**	
Speech	1. Explaining phenomena	1-1 Ability to use the correct terms to describe objects	90.5%
		1-2 Ability to speak and ask questions clearly and concisely	95.2%
		1-3 Ability to use simple sentences to describe relationships among objects	90.5%
	2. Narrating a story	2-1 Ability to express feelings in words	90.5%
		2-2 Willingness to attempt to describe experiences in words	90.5%
		2-3 Willingness to attempt to describe events	90.5%
	3. Repeating a sentence	3-1 Ability to repeat what others have said	95.2%
		3-2 Ability to retell short stories	90.5%
	4. Using appropriate tone and volume	4-1 Ability to speak at an appropriate volume	85.7%
		4-2 Ability to speak in the proper tone of voice	81.0%
		4-3 Likelihood of eventually developing the ability to use greetings and polite speech	90.5%

The young children's abilities to explain phenomena, describe their experiences and the story plots, repeat sentences, and use an appropriate tone all improved, with more than 80% of children exhibiting an improvement in each indicator. Therefore, the picture books improved the young children's oral expression skills.

5.3. Effects on Cognitive Abilities

Picture books mainly comprise pictures that are used to create a coherent story. The Mandarin word for picture book was derived from a Japanese term. Children's ability to think creatively can be strengthened through the creation of stories (Yang, 2010). In addition to helping young children read text, picture books can also convey information regarding social values and ethics (Jalongo, Dragich, Conrad, & Zhang, 2002).

Picture books tell stories through images and text, and the stories of such books tend to be positive and open-ended, which strengthens young children's cognitive abilities, values, imagination, creativity, and reading comprehension. Picture books can also help young children develop the ability to make predictions, establish an order of events, make inferences, and increase their visual sensitivity (Ye, 2017). The results of this study indicate that picture books can strengthen children's cognitive abilities.

Preschool teacher A stated:

"Interactive electronic picture books can enhance young children's cognitive abilities" (Practitioner interview, A20210316).

Preschool teacher B stated:

"Young children prefer interactive electronic picture books that are interactive. Interactive electronic picture books can enhance young children's cognitive abilities" (Practitioner interview, B20210316).

5.4. Effects on Motivation to Learn

Adding media to textual books can make them easier for young children to read. Electronic picture books can be presented to entire classes or on personal electronic devices. Interactive interfaces can also provide feedback on young children's learning that can be recorded. Electronic devices can hold multiple picture books at the same time, which makes them more convenient than paper books. Electronic picture books can also be updated, whereas traditional paper books cannot. In addition, electronic picture books can contain moving images, sound, and other interactive elements, which make them more dynamic than paper picture books, and such elements can increase learning motivation. Teaching using electronic interactive picture books can increase young children's interest in learning and their motivation. Electronic picture books are easy to distribute, and their interactive designs can increase young children's interest in such books. Picture books can also include links to supplementary materials, games, and entertainment. The picture books developed for this study are portable and can be read anywhere. Developments in multimedia network technologies may lead to a new mode of early-childhood language learning through electronic interactive picture books (Chen, 2012).

In the current study, the teachers indicated that most picture books are paper books and that some two-dimensional electronic picture books have been developed. They had never used picture books with three-dimensional physical objects or interactive picture books, and they reported that the children found the books developed for this study to be interesting.

Preschool teacher A stated:

"They're very interesting teaching aids. When young children start using them, they keep trying to read them" (Practitioner interview, A20210316).

Preschool teacher B stated:

"Young children prefer things that move. Regular e-books are a bit boring and not appealing to children, but adding interactive elements can lead them to become interested in learning" (Practitioner interview, B20210316).

Preschool teacher C noted:

"The young children in our class added to the stories themselves, which made the experience more interesting" (Practitioner interview, C20210316).

6. DISSUSION

Intelligent teaching aids can provide timely feedback and flexibility and enable big data analysis. They can help teachers increase the effectiveness of their instruction, and the applications of such aids have received an increasing amount of attention. An example of a mature, intelligent teaching aid is educational robots. Such robots can strengthen children's motivation to learn, create a sense of participation among children and teachers, and encourage children to explore (Chen, Park, & Breazeal, 2020).

The most common intelligent teaching aid used to prepare children for constructive learning in preschool education is robots that tell stories. Before formal teaching begins, the robots introduce themselves to the children, sing, and play games to familiarize the children with the topic of instruction, and teachers often design activities in which the children can ask the robot questions, which increases the interactivity of learning (Chen, 2018). These robots can then guide the children through reading a story book and ask questions that prompt the children to reflect on the book's meaning (Fridin, 2014). Alves-Oliveira, Sequeira, and Paiva (2016) conducted similar experiments on storybook-based teaching but with a focus on the role of intelligent robots in education. After interacting with robots, the children considered them to be friends or peers, which demonstrates the feasibility of using intelligent robots to enhance education.

In the near future, intelligent robot-assisted teaching will develop further and be applied to teach topics such as computational thinking (Bers, González-González, & Armas–Torres, 2019) and personal hygiene, which can help children develop. However, several problems must be addressed before this can occur. For example, the software used for robots cannot be customized to each preschool, and story books are usually copyright protected. In addition, robots are also exclusive, unlike laptops or tablets, which can be applied to various aspects of education. For these reasons, the current study used interactive electronic picture books and did not use robots to achieve its teaching goals.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Education cultivates an individual child into a "person" and lets students understand their living situations, inspire their social responsibility, and develop civic awareness of service participation (Shih, 2020c, Ye & Shih, 2021). In particular, it promotes students' diverse development.

This study added interactive sensors to picture books to improve young children's oral expression skills. Arduino was used to control the sensors in picture books that were developed based on the preschool curriculum and teaching quality evaluation standards, and the children used the books for six weeks.

Various sensors, such as RFID sensors, photoresistors, and limit switches, were used to create four interactive picture books entitled Let's All Be Friends, Where are the Mice?, Happy Festival, and Scientific Cooking King. These picture books differ from normal picture books in that they include sensors that respond to young children's movements in the form of corresponding animations, which enhances the children's learning experience. The results of this study are in line with Laird's sensory theory of learning.

To understand the effects of interactive electronic picture books, this study observed indicators of children's oral expression skills. The teachers interviewed in this study observed the children's reactions to the picture books and identified changes in their speech after they read the picture books. More than 90% of the children exhibited an improved ability to explain phenomena, narrate, and retell the story.

During the interviews, the preschool teachers exhibited positive attitudes toward the picture books. They indicated that the books held the children's attention for a short period of time and that the recordings obtained during the process helped them understand each child's progress. The teachers also offered suggestions regarding how the process and system could be improved, including changing the fonts and using small games to increase interactivity, which would help integrate the practical elements of teaching into the books. Preschool teachers

should also provide guidance to children and inspire them to strengthen their motivation to learn and develop their cognitive abilities.

7.2. Recommendations

The implementation of education affects a country's development and success, and early childhood education is desirable for the development of a country (Shi, 2022a; Wang & Shih, 2022, 2023).

Most young children have little experience with electronic interactive picture books, especially those with sensors. However, such books can be effective teaching aids, and the method used in this study can be used to create new interactive picture books; this study offers several suggestions to facilitate this process.

In addition to Arduino and sensors, auxiliary teaching aids can be used to hold young children's attention. For example, in Scientific Cooking King, the process of making biscuits is presented as an example. The animations of the book prompt children to add ingredients, such as eggs and milk, which were represented by physical building blocks. Using materials that resembled the ingredients improved the young children's experience of reading the book.

The interviews with the preschool teachers revealed that some young children did not follow the steps provided in the picture books in the correct sequence. Therefore, picture books should be modified to enable the addition of other storylines, or an artificial intelligence-based semantic analysis should be incorporated into the system to create an open plot. Games can also be incorporated to add entertainment value. The indicators of the young children's expression skills that were considered in this study were only related to speech; indicators related to listening, reading, and writing can also be used. Indicators of listening can be used to measure children's ability to determine the meaning of spoken language and stories and to identify attitudes conveyed through speech. Indicators of reading can be used to measure children's ability to recognize symbols, enjoyment of reading, and recognition of words. Indicators of writing can be used to measure children's ability to use writing instruments and write symbols. In subsequent research for industry practitioners and academics, the hardware of the interactive picture books should be modified, and operational definitions of the aforementioned indicators should be used to evaluate the effects of new media on young children's learning. Future studies should also explore whether interactive picture books can improve listening, reading, and writing abilities.

Funding: This research is supported by the National Science and Technology Council (Grant number: MOST 109-2637-H-159-002).
Institutional Review Board Statement: The Ethical Committee of the National Yang Ming Chiao Tung University, Taiwan, R.O.C has granted approval for this study (Ref. No. NYCU-REC-111-068F).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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