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Developing the Interactive Game-based Picture Book "Food Ninja" to Enhance Creativity in Elementary School Students

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Abstract: As technology reshapes educational paradigms, traditional picture books have evolved into interactive, game-based versions that blend storytelling with dynamic, immersive elements. This study investigates the effect of an interactive game-based picture book on creativity among elementary school students, using a semi-experimental design. Two classes were selected as experimental and control groups, and the study employed self-designed digital tools and diverse assessment measures to evaluate creativity across dimensions such as fluency, flexibility, and originality. Results showed significant improvements in all creativity dimensions, with the experimental group exhibiting higher gains in originality due to the interactive, game-like features. These findings underscore the transformative potential of interactive game-based picture books in fostering creativity and call for further refinement in their design and implementation for educational use.

Keywords: Interactive game-based picture book, creative thinking, storytelling, technology-supported learning, elementary school students.

1. Introduction

Tadashi Matsui (1995) proposed that diverse experiences are crucial for developing imagination and creativity. Chou (2005) noted that picture books can enhance creative thinking. In recent years, traditional paper picture books have gradually transformed into digital picture books (Roskos, Burstein, You, Brueck, & O'Brien, 2011), extending the advantages of traditional picture books in teaching creative thinking, stimulating learning motivation, and improving learning outcomes (Lai, 2018). This study aims to explore the impact of digital picture books and their interactive behaviors on creativity, focusing on four subcategories of creative thinking: fluency, flexibility, originality, and elaboration. It aims to

develop a digital picture book and assessment tools to provide insights into future design and instruction.

1.1 Interactive Digital Picture Book

The characteristics of picture books were identified by various scholars (Lin, 2000; Su, 1998; Chou, 2004). This study summarizes as follows:

(1) Child-Centric: Picture books are designed mainly for preschool or school-age children. Illustrations, content, and viewpoints are tailored to suit children's development and interests. (2) Artistic: Text uses imagination, metaphor, and description, while illustrations focus on creativity, unique styles, and harmonious layouts. (3) Educational: Picture books help children develop knowledge, personality, morality, and life skills. (4) Communicative: Picture books combine textual and visual communication to create a cohesive narrative and a seamless flow between words and images. (5) Fun: Picture books use vibrant colors, lively designs, and humor. The fun aspect can be found in playful illustrations and rhythmic content. (6) Creative: The vivid stories and lively illustrations can foster children's imagination and offer ample scope for creativity.

Interactive digital picture books allow readers to interact with animations, providing rich visual, auditory, and tactile feedback. Digital picture books integrate questions, and interactive games can train readers' focus, cognitive skills, and creativity (Lai, 2018).

1.2 Creativity

The definition of creativity remains complex. Early scholars typically focused on one dimension in the 4P's Creativity Model to conduct their studies and discussions (Yang Y, W, 2021). This study views creativity as a measurable behavioral capability. It uses the four subcategories from the Torrance Tests of Creative Thinking, developed initially by E. Paul Torrance in 1966 and later revised by Wu J, J in 1891, to define and measure creativity. The aim is to estimate the level of creativity according to the dimensions of fluency, flexibility, originality, and elaboration of one's ideas. Table 1 outlines the meanings and test performances for each subcategory.

Table 1. *Description of the Four Subcategories of Creativity*

Subcategory	Meaning	Test Performance
Fluency	The quantity of ideas produced.	Number of responses completed within a time limit.
Flexibility	The ability to generate a variety of categorically different ideas.	Number of different response categories within a time limit.
Originality	The ability to produce unusual or unique ideas.	Degree of uniqueness in responses.

Elaboration	The ability to expand and develop ideas in a detailed manner.	Degree of detail and completeness in responses.

2. Research Objectives

This study explores the impact of interactive digital picture books on students' creativity. The study has three main objectives:

(1) To evaluate the impact of the self-designed digital picture book "Food Ninja" on the effectiveness of creativity teaching across four subcategories.
(2) To examine the effect of interactive behavior in the self-designed digital picture book "Food Ninja" on the four subcategories of creativity teaching effectiveness.
(3) To explore how students' perception of interactivity in the self-designed digital picture book "Food Ninja" influences their learning experience.

3. Research Method

This study employed a semi-experimental design to investigate the impact of interactive digital picture books on creativity. Two sixth-grade classes from a public elementary school in Taichung City were randomly selected, with one class assigned as the experimental group and the other as the control group. The experimental group engaged with interactive digital picture books featuring click functions and special effects, while the control group used non-interactive digital picture books. Data collection included behavioral observation checklists, semi-structured interviews, and pre-and post-tests for triangulation. The data were analyzed using SPSS. The behavioral observation checklists and semi-structured interviews offered qualitative insights into the impact of these picture books on student creativity. The experimental group consisted of 25 students and the control group consisted of 26 students. After removing invalid questionnaires, each group had 22 valid responses. The same art teacher instructed both classes, and both were familiar with using Google Chrome Books, ensuring consistency in the research tools.

4. Research Framework and Process

The researchers created customized research tools for data collection and analysis, drawing on personal teaching experience, creativity theories compiled by Yang (2021), and the Torrance Tests of Creative Thinking (Form A) developed by Wu (1981). The overall research framework is outlined in Figure 1. The research process for this study is depicted in Figure 2.

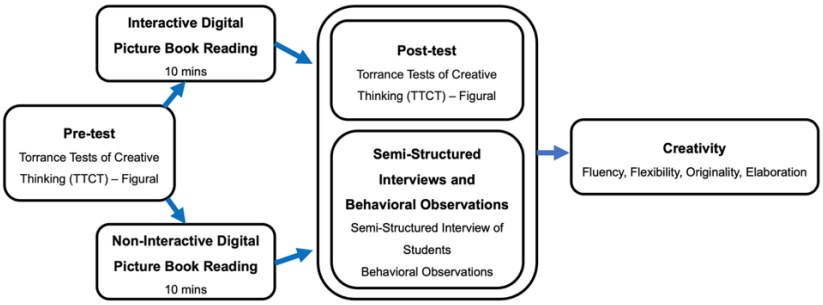

Figure 1. Research Framework

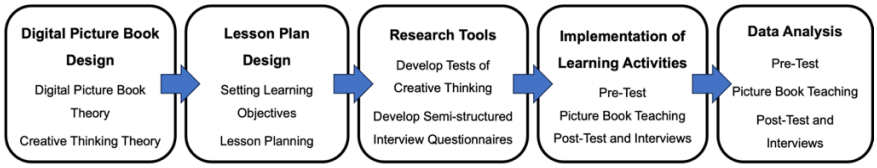

Figure 2. Research Process

5. Research Tools

5.1 Self-designed Digital Picture Book

The self-designed digital picture book "Food Ninja" aims to inspire children's creativity and visual observation skills by depicting a ninja who transforms into various food items, hiding in everyday life scenarios. In each scene, Shiba Inu faces the challenge of finding food ninjas. Students are encouraged to apply creativity in their visual analysis, fostering attention to detail. This interactive format aligns with the creative thinking framework (Torrance, 1966; Wu, 1991), helping to enhance students' fluency in generating ideas and flexibility in identifying multiple possibilities within the scenes. The book is centered around food because it is one of the most familiar and intriguing elements in children's daily lives. According to the literature on the characteristics of picture books, "Food Ninja" meets the following traits.

(1) Child-Centric: The book's theme, illustration style, and text-align with children's development and interests.
(2) Artistic: The vibrant and dynamic illustrations incorporate unique shapes and styles as the food ninja transforms, showcasing artistic creativity.
(3) Educational: Food recognition and counting are embedded within the story.
(4) Communicative: The book integrates textual and visual elements, creating a coherent and rhythmic narrative.
(5) Fun: The illustrations and the plot keep children engaged with the content.
(6) Creative: Food ninja's transformations with everyday life create a limitless space for imagination and exploration.

The story structure is shown in Table 2, and the interaction details of "Food Ninja" are illustrated in Figure 3.

Table 2. *Story Structure of "Food Ninja"*

Structure	Story Content
Trigger	A Shiba Inu finds a secret kingdom and meets the Food Ninja.
Conflict	The Food Ninja disappears and transforms into objects within the scene while retaining some distinctive features. In each scene, the Shiba Inu faces different challenges.
Resolution	With the reader's help, the Shiba Inu finds all the Food Ninjas.

Figure 3. Interaction Details of "Food Ninja

5.2 Self-designed Tests of Creative Thinking

Based on creativity theories compiled by Yang (2021) and the Torrance Tests of Creative Thinking (Form A) developed by Wu (1981), the researchers designed a test suited to the research context. The self-designed test is illustrated in Figure 4.

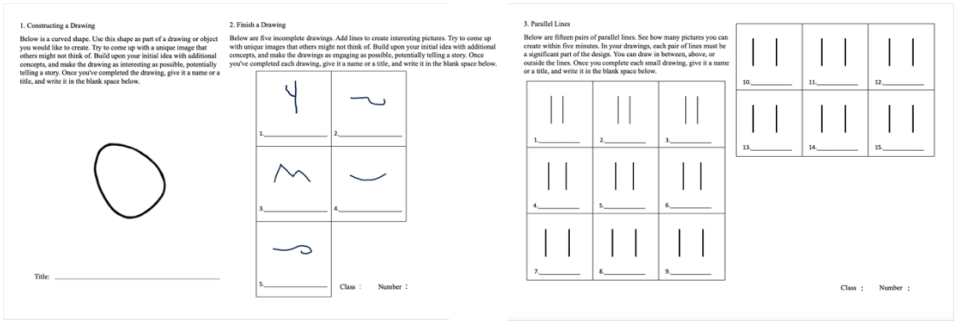

Figure 4. Self-designed Tests of Creative Thinking

5.2.1 Scoring Method

(1) Fluency: Total number of meaningful responses. Validity depends on proper titles. Scores come from Activities 2 and 3.

(2) Flexibility: Total number of unique categories. Repeated categories in the same question aren't scored. Scores are derived from Activities 2 and 3.

(3) Originality: Based on the statistical rarity of responses. If a response frequency exceeds 5%, it's not scored. Scores are derived from Activities 1, 2, and 3.
(4) Elaboration: Considers the level of detail and coherence in responses. Scores come from Activities 1, 2, and 3.

5.3 Behavioral Observation Checklist

The researchers used personal teaching experience and creativity theories compiled by Yang Y, W (2021) to conduct a behavioral observation checklist during the study activities. The behavioral observation checklist is depicted in Figure 5.

Behavior	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Able to focus on the pre-test	☐	☐	☐	☐	☐
Actively addresses questions during the pre-test	☐	☐	☐	☐	☐
Able to independently solve reading-related challenges	☐	☐	☐	☐	☐
Able to focus on reading until the entire picture book is completed	☐	☐	☐	☐	☐
Reviews previous content after finishing the book	☐	☐	☐	☐	☐
Able to focus on the post-test	☐	☐	☐	☐	☐
Actively addresses questions during the post-test	☐	☐	☐	☐	☐
Improved fluency during the post-test	☐	☐	☐	☐	☐
Shows a broader range of response categories in the post-test	☐	☐	☐	☐	☐
Increased diversity in peer response categories during the post-test	☐	☐	☐	☐	☐
More willing to spend time on detailed illustrations in the post-test	☐	☐	☐	☐	☐
Notes on Special Behavior or Individual Cases:					

Figure 5. Behavioral Observation Checklist

5.4 Semi-Structured Interview

The interview focuses on three main aspects: past experiences, activity preferences, and self-assessment. It encourages self-expression, providing deeper insights into participants' views on interactive digital picture books and their effects. Table 3 outlines the content of the interview:

Table 3. *Semi-Structured Interview*

Aspect	Question
Past Experiences	How does this digital picture book differ from others you've read?
Activity Preferences	What was your favorite part of the activity?
Self-Assessment	After reading the book, did you have any new ideas or creativity in your drawings?

6. Results

6.1 Torrance Tests of Creative Thinking (TTCT)

6.1.1 Paired-Sample T-test within Groups

The paired-sample t-test compared pre-test and post-test scores within the experimental and control groups to assess the impact of digital picture books. The results are shown in table 4.

Table 4. *Comparison of Significant Differences Between Pre- and Post-Tests*

Group	Subcategory	Mean Difference	t	p
Experimental Group	Fluency	-10.0	-4.747	**.000****
	Flexibility	-7.5	-3.110	**.005****
	Originality	-19.2	-8.506	**.000****
	Elaboration	-0.6	-0.294	.771
	Total	-9.3	-6.196	**.000****
Control Group	Fluency	-7.0	-3.283	**.002****
	Flexibility	-7.5	-3.825	**.000****
	Originality	-13.4	-6.352	**.000****
	Elaboration	0.1	0.076	.940
	Total	-6.9	-5.157	**.000****

*Indicates $p \leq 0.05$; ** $p \leq 0.005$

The significant differences in fluency, flexibility, originality, and total scores within both groups indicate that digital picture books, whether interactive or not, positively affect creativity. This result aligns with previous studies (Chou W. M., 2005).

6.1.2 The Independent-Sample t-test between Groups

The independent-sample t-test was conducted to compare both groups' pre-test, post-test, and improvement scores. The results are shown in table 5.

Table 5. *Comparison of Significant Differences Between Groups*

Category	Subcategory	t	p
Pre-test	Fluency	-.431	.669
	Flexibility	.107	.915
	Originality	-.675	.504
	Elaboration	-2.762	**.008***
Post-test	Fluency	.722	.474

	Flexibility	.100	.921
	Originality	1.785	.082
	Elaboration	-2.876	**.006***
Improvement	Fluency	1.391	.171
	Flexibility	.000	1.000
	Originality	2.937	**.005****
	Elaboration	.529	.599

*Indicates $p \leq 0.05$; ** $p \leq 0.005$

The results show that the two groups were generally similar on the pre-test except for elaboration. Post-test results showed minor differences, with the experimental group slightly outperforming the control group. The significant improvement in originality in the experimental group highlights the positive effect of interactive behaviors.

6.2 Semi-structured Interview

The study used paper-based responses to understand participants' perspectives and followed up with focus group interviews to gain deeper insights. The following are the essential findings and discussions based on these interviews:

1. How does this digital picture book differ from those you have read before?
Most participants mentioned that they rarely used digital picture books. They observed that digital picture books offer unique features like sound and animations, with comments such as, "It's convenient because one device allows access to many different stories," "It's fun. The story has sound and visual effects," and "The digital format helps to confirm if you found the right answer." These responses indicate a strong understanding of the benefits and uses of digital picture books.

2. What was your favorite part of the activity?
Participants either enjoyed interacting with the digital book or engaging in creative thinking tests. To delve deeper, the interviewer asked, "Do you think this preference is due to different personalities? Some prefer reading stories, while others like expressing their ideas." Many students agreed, acknowledging their preferences. These responses suggest that digital books may not appeal equally to all readers.

3. After reading the book, did you have any new ideas or creativity in your drawings?
Most participants felt that the digital picture book inspired more ideas and creativity, leading to clearer and smoother drawing processes. Some participants also said that the book's theme influenced their work, leading them to draw more food-related images.

These results align with previous studies (Chou W, M, 2005; Lai Y, C, 2018). The interviewer asked, "Why do you think the book inspired creativity?" Participants found this question challenging, but some said it was because the book provided examples to imitate, and they could reimagine or transform. These insights support the idea that teaching creativity is a multifaceted process and that "imitation" and "deconstruction" are vital aspects (Yang Y, W, 2021).

6.3 Behavioral Observations

To understand how students engaged with the activities in this study, teachers completed behavioral observation checklists, which were supplemented with follow-up questions for additional clarity. The observations from teachers of the experimental and control groups are as follows:

1. Experimental Group Teacher
Students were more engaged and showed improvements in creativity and fluency, attributed to the interactive elements of the digital book.

2. Control Group Teacher
Students also completed tasks effectively but showed less motivation for detailed illustrations post-test, possibly due to the reduced novelty of the tasks.
Both groups found the picture books inspiring, but the interactive features in the experimental group led to greater engagement and more effective task completion.

7. Discussion

Based on the research objectives, this study discusses the research results in different orientations for each section as follows:

(1) The self-designed digital picture book "Food Ninja" positively influenced fluency, flexibility, and originality. Specifically, the experimental group showed an average improvement of 10 points in fluency ($t = -4.747$, $p < .005$), 7.5 points in flexibility ($t = -3.110$, $p < .005$), and 19.2 points in originality ($t = -8.506$, $p < .005$). The control group also demonstrated significant improvements, with an average increase of 7 points in fluency ($t = -3.283$, $p < .005$), 7.5 points in flexibility ($t = -3.825$, $p < .005$), and 13.4 points in originality ($t = -6.352$, $p < .005$). Observations showed the experimental group completed tasks more quickly and with greater focus. The semi-structured interviews confirmed that the interactive content enhanced creativity and engagement, aligning with previous findings (Chou, 2005).

(2) The interactive behaviors in "Food Ninja" had a noticeable impact. Data analysis showed no significant differences between the experimental and control groups in

fluency, flexibility, and originality across pre- and post-tests. However, elaboration demonstrated significant differences, indicating some level of homogeneity between the groups. Notably, the experimental group outperformed the control group in overall progress ($t = 2.937$, $p < .005$). The interactive design contributed to this improvement. Interviews revealed that the experimental group valued the ability to immediately check their task completion, unlike the control group, which relied on their own observational skills. This interactive approach led to greater improvement in originality.

(3) Students perceived interactivity in the digital picture book "Food Ninja" as engaging and enjoyable, though this effect did not reach statistical significance. Teachers noted higher levels of focus and engagement among students in the experimental group compared to usual classroom behavior. This observation echoed students' interview responses, indicating an overall positive impact on learning.

8. Conclusion

The transition from paper to digital formats in education offers more than just digital content presentation; it leverages digital tools to enhance teaching effectiveness. This study indicates that interactive digital picture books, like "Food Ninja," significantly impact creativity in fluency, flexibility, and originality. Interactive features integrated with storylines enhance engagement and learning outcomes. Despite the statistically significant increase in originality, overall improvements in the experimental group were notable.

Future research should consider expanding participant age ranges and sample sizes to further explore the effects of interactivity. Additionally, integrating interactive digital picture books with various academic subjects could provide deeper insights into their educational potential.

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