# INTERACTIVE ANIMATION DESIGN TO PROMOTE TRADITIONAL CULTURE LEARNING SKILLS OF CHINESE PRESCHOOL STUDENTS

**JINGYUE ZHANG**

**A Thesis Submitted to the Graduate School of Naresuan University**

**in Partial Fulfillment of the Requirements**

**for the Doctor of Fine and Applied Arts Program Degree in Art and Design**

**2025**

**Copyright by Naresuan University**

# INTERACTIVE ANIMATION DESIGN TO PROMOTE TRADITIONAL CULTURE LEARNING SKILLS OF CHINESE PRESCHOOL STUDENTS

JINGYUE ZHANG

A Thesis Submitted to the Graduate School of Naresuan University

in Partial Fulfillment of the Requirements

for the Doctor of Fine and Applied Arts Program Degree in Art and Design

2025

Copyright by Naresuan University

Thesis entitled " Interactive Animation Design to Promote Traditional Culture Learning Skills of Chinese Preschool Students"

By Jingyue Zhang

has been approved by the Graduate School as partial fulfillment of the requirements for the Doctor of Fine and Applied Arts Program Degree in Art and Design of Naresuan University

**Oral Defense Committee**

…… Chair
(Associate Professor Kittichai Kasemsarn, Ph.D.)

…… Advisor
(Assistant Professor Chayanis Chuenchaichon, Ph.D.)

…… Internal Examiner
(Associate Professor Thaveerat Promrat, Ph.D.)

…… Internal Examiner
(Associate Professor Tatiya Theppituck, Ph.D.)

…… Internal Examiner
(Assistant Professor Thirawut Bunyasakseri, Ph.D.)

**Approved**

……...
(Associate Professor Watana Padgate, Ph.D.)
Vice President for Academic Affairs
Acting Dean of the Graduate School

| | |
|---|---|
| **Title** | INTERACTIVE ANIMATION DESIGN TO PROMOTE TRADITIONAL CULTURE LEARNING SKILLS OF CHINESE PRESCHOOL STUDENTS |
| **Author** | Jingyue Zhang |
| **Advisor** | Assistant Professor Chayanis Chuenchaichon, Ph.D. |
| **Academic Paper** | Doctor of Fine and Applied Arts Program Degree Thesis in Art and Design, Naresuan University, 2025 |
| **Keywords** | Interactive Animation, Preschool Students, Traditional Chinese Culture, Learning Skills |

## ABSTRACT

Using interactive animation technology to enhance the traditional culture learning skills of Chinese preschool students is considered an innovative teaching technique. This study used "Mixed Methods Research (MMR)". The research objectives were:(a) To investigate the design elements of interactive animation appropriate for the cognitive development of preschool children. (b) To explore the key factors influencing the enhancement of their skills to learn traditional Chinese culture, thereby promoting the development of their comprehension and creativity. (c)To design interactive animations aimed at improving preschool children's skills to learn traditional Chinese culture. (d)To evaluate the effectiveness of interactive animations and knowledge for interactive animation designer.

The research methods were divided into the following four phases: (1) Researching interactive animation design elements suitable for preschool students and child cognitive development mechanisms. (2) Selecting traditional Chinese culture content suitable for preschool students to enhance preschool students' comprehension and creativity skills. (3) Interactive animations were designed to enhance preschool students' skills in learning traditional culture. (4) Evaluate the learning effectiveness of interactive animations for preschool students and the satisfaction of relevant personnel with interactive animation design and knowledge for the designer.

The results of the study show that:

• Interactive animation design elements: (1) Characters with exaggerated movements can easily draw children into the plot. (2) Children are more inclined to cartoon characters with high color saturation, and they like animal characters more than

human characters, especially animals with big eyes and oval shapes, which they feel more familiar with. (3) Children are more sensitive to upbeat rhythm accompanying increase children's interactivity. (4) When interacting, children prefer simple click and drag touch buttons.

• Traditional Chinese culture: (1) For students aged 3-4, with an emphasis on language input and comprehension; for students aged 5-6, to develop their creative expression. (2) Traditional cultural festivals are suitable for guiding children's interests through task-based interactive experiences. (3) In character design, using cartoon animals combined with cultural props enhances approachability; (4) “Signature action” help strengthen emotional expression and enhance character recognition.

• Cognitive Development in Children: (1) “animism” promoted the development of children’s imagination and creativity; (2) Intentional attention pays more attention to design details and refinement than unintentional attention. (3) Preschool students' thinking skills tend to be exaggerated visually, voice and animation guidance methods are easier for children to accept and understand.

• Preschool students scored an average compared with pre-test [M=27.14, SD:4.8] and post-test [M=31.35, SD:5.1], a significant overall improvement [MD=4.21, SE: 1.11]. A significant difference between the pre- and post-assessment grades [T=6.47], proving that students' traditional culture learning skills improved significantly through the use of interactive animation [p:$3.35 \times 10^{-6}$, significant, $p<0.05$].

The interactive animation design demonstrated high levels of practicality and effectiveness, as evidenced by the consistently high satisfaction reported by participating preschool students, parents, and teachers during the instructional sessions.

The average student satisfaction score was [$\bar{x} = 4.32$, SD: 0.49]; the average parent satisfaction score was [$\bar{x} = 4.10$, SD: 0.51]; and the average teacher satisfaction score was [$\bar{x} = 4.09$, SD: 0.49]. The data analysis shows that interactive animation has great application potential and that the design framework is practical and effective.

Keywords: Interactive Animation, Preschool Students, Traditional Chinese Culture, Learning Skills

# ACKNOWLEDGEMENT

The Ratchaphruek has blossomed once again, heralding another season of gold. The fragrance of the flowers in Phitsanulok this year is particularly special. In the blink of an eye, I saw the sunlight slanting down, the endless sunlight and the eternal cross intersecting. At this moment, I am grateful for the courage that has given me protection, bravery, enthusiasm, and wisdom, allowing me to learn problem-solving skills in the face of obstacles and challenges in my doctoral career. Over the past few years, the rough edges of my character have been smoothed out, and through each anxious night and moment of joyful progress, I have gradually found my own path.

I am deeply grateful to Naresuan University for providing me with an excellent academic environment and a solid research platform, where I have continuously explored, learned, and grown.

During my time here, I had the privilege of meeting a group of highly respected professors and like-minded peers. I sincerely appreciate the opportunities that Naresuan University has given me to pursue my dreams and to become a qualified PhD.

I would also like to express my gratitude to my advisor, Assistant Professor Dr. Chayanis Chuenchaichon, and Assistant Professor Dr. Thirawut Bunyasakseri. They provided invaluable assistance throughout the entire process of my thesis-from the selection of the topic, through the proposal stage, to the final defense. Their guidance and advice were instrumental in enabling me to successfully complete this research. Additionally, I would like to express my gratitude to Associate Professor Dr. Yutthasak Chuenchaichon for providing grammatical feedback on my academic writing, which helped improve the clarity and accuracy of my paper. Furthermore, I would like to express my gratitude to all the staff members of the Faculty of Architecture, Arts, and Design at Naresuan University for their assistance in completing all the necessary documentation. And, I would like to thank all the reviewers from “Asian Health, Science, and Technology Reports”and “Artseduca“ for their support of my thesis. They provided me with the opportunity to have my thesis published on their public platforms.

Secondly, I want to express my gratitude to my family, Mr. Jianjun Zhang and Mrs. Tiemin Liu, for their unwavering support and assistance throughout my four years of academic pursuits. Your unconditional encouragement and understanding have served

as my steadfast foundation. Your silent sacrifices have granted me the courage to persevere in the face of countless setbacks, enabling me to remain resilient even in times of adversity. It is precisely because of your companionship and tolerance that I have been able to grow steadily throughout this lengthy and challenging doctoral journey.

At the same time, I would like to express my heartfelt gratitude to all the friends I have made in Thailand. It is your companionship and care that have made me feel warm and at home in a foreign land, turning this academic journey into a fulfilling and colorful experience. Your kindness, sincerity, and encouragement have given me an extra measure of composure and resolve when facing difficulties and pressures, and have made my time in Thailand an unforgettable chapter in my life.

Finally, I give my heartfelt gratitude to my husband, Mr. Chao Ma. International flights at dawn are always exhausting and lengthy, yet you have never failed to be there. Every moment we part and reunite at the airport feels all the more precious. You have demonstrated through your actions what true understanding and companionship mean, and you have brought me a sense of security and warmth amidst all the hustle and bustle. When I saw you walking toward me with your luggage at Phitsanulok Airport, the love and companionship that transcend borders suddenly took on a tangible form. It was you who provided the tenderness and strength that supported me throughout my doctoral journey.

Thank you for your consistent tolerance, patience, and support. It is you who gave me the courage to focus on my ideals and give my all to complete this journey.

“If we are afraid, we will not be able to accomplish anything”,this phrase has given me strength in countless critical moments. May every difficulty and growth I have experienced become a lamp before my feet and a light on my path.

Jingyue Zhang

# LIST OF CONTENTS

**Page**

ABSTRACT ..... C
ACKNOWLEDGEMENT ..... E
LIST OF CONTENTS ..... G
LIST OF TABLES ..... K
LIST OF FIGURES ..... L
CHAPTER I INTRODUCTION ..... 1
Background and rationale ..... 1
Problem identification ..... 6
Research objectives ..... 10
Research questions ..... 10
Research hypothesis ..... 11
Research variables ..... 11
Significance of the research ..... 11
Related studies ..... 13
Related scope ..... 14
Operational definitions ..... 15
CHAPTER II LITERATURE REVIEW ..... 21
1. Animation ..... 23
1.1 The concept of animation ..... 23
1.2 Characteristics of animation design ..... 24
1.3 Principles of animation design ..... 26
1.4 Forms of animation creation ..... 28
1.5 Animation elements and emotions ..... 30
1.6 Animation design process ..... 30
2. Interactive animation ..... 32
2.1 Meaning of interactive animation ..... 32
2.2 Design elements for interactive animation ..... 33

2.3 User experience of interactive animation ..... 35
2.4 Interactive animation design principles ..... 36
2.5 Interaction design methods for children ..... 37
3. Interactive animation for children ..... 40
3.1 Definition of interactive animation for children ..... 40
3.2 Design elements of interactive animation for children ..... 41
3.3 Artistic styles of interactive animation for children ..... 43
3.4 Use of interactive animation among preschool students in China ..... 44
3.5 Problems with the design of interactive animation for children in China ..... 46
3.6 Case studies of interactive animation design for children ..... 47
4. Human-Computer Interaction (HCI) ..... 49
4.1 Meaning of HCI ..... 49
4.2 HCI and emotional ..... 50
4.3 Child-Computer Interaction (CCI) and cognitive strategies for children's learning skills ..... 51
4.4 HCI design principles for children ..... 52
5. Traditional Chinese Culture ..... 54
5.1 Content of traditional Chinese cultural ..... 54
5.2 Chinese kindergarten curriculum ..... 55
5.3 The current status of interactive animation applications in Traditional Chinese Culture education ..... 56
6. The current status and educational practices of preschool education in China ..... 56
6.1 The development of preschool education in China ..... 57
6.2 The development of preschool education concepts in China ..... 57
6.3 The Development of preschool education for students in China learning skills ..... 59
7. Children's Cognitive Development ..... 60
7.1 Piaget's Theory of Cognitive Development ..... 60
7.2 Animism ..... 63
7.3 Zone of Proximal Development Theory (ZPD) ..... 64

7.4 Scaffolding ..... 66
7.5 Research on the stages of cognitive, emotional, behavioral, and artistic development in early childhood ..... 66
8. Learning skills ..... 68
8.1 Components of learning skills in preschool students ..... 68
8.2 The role of digital media in promoting learning skills in preschool education ..... 69
8.3 The role of instructional model in promoting learning skills in preschool education ..... 71
9. Comprehension ..... 73
9.1 Meaning of comprehension ..... 73
9.2 The role of interactive animation in cultivating comprehension in preschool students ..... 74
9.3 Overview of strategies for cultivating comprehension in preschool students through interactive animation ..... 76
9.4 Situational Cognition Theory ..... 77
10. Creativity ..... 80
10.1 Meaning of creative ..... 80
10.2 The role of interactive animation in cultivating creative in preschool students 81
10.3 Creative thinking training methods ..... 82
11. The Application of Interactive Animation in Transnational Preschool Education ..... 84
11.1Using interactive animation to support cultural learning in international kindergarten settings ..... 84
12. Conclusion ..... 84
13. Conceptual framework ..... 86
14. Design process ..... 87

CHAPTER III RESEARCH METHODOLOGY ..... 88

Phase I: Using qualitative research, researching interactive animation design elements suitable for preschool students and child cognitive development mechanisms. ..... 92

Phase II: Selecting traditional Chinese culture content suitable for preschool students to enhance preschool students' comprehension and creativity skills 96

Phase III: Based on the results of qualitative research, interactive animations were designed to enhance preschool students' skills in learning traditional culture ..... 102

Phase IV: Using quantitative research, evaluate the learning effectiveness of interactive animations for preschool students and the satisfaction of relevant personnel with interactive animation design ..... 103

CHAPTER IV RESULTS AND DISCUSSION ..... 109

Results ..... 109

Discussion ..... 172

CHAPTER V CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS 175

Conclusions ..... 175

Recommendations for the pratical ..... 177

Recommendations for future research ..... 178

Limitations of the study ..... 179

REFERENCES ..... 180

APPENDIX ..... 209

BIOGRAPHY ..... 240

# LIST OF TABLES

**Page**

Table 1 Summary table of children's interaction methods and cognitive development support pathways ..... 42

Table 2 Comparison of traditional and current educational philosophies..... 58

Table 3 Comparison table of Chinese and English “keywords” in interactive animation element design ..... 93

Table 4 English and Chinese “keyword” tendencies in interactive animation element. design ..... 95

Table 5 Access table for children's learning of traditional culture courses..... 98

Table 6 Interview for kindergarten teachers on traditional culture..... 99

Table 7 Traditional Cultural Activities Teaching Observation and Measurement Form ..... 100

Table 8 Items of dimensions in the satisfaction survey questionnaire..... 105

Table 9 The response effects of different sound effects on children ..... 117

Table 10 Click rate of traditional culture-related animations among Chinese children table (as of 2022) (Ten thousand calculate)..... 124

Table 11 Parents Satisfaction Questionnaire Results..... 169

Table 12 Preschool Students Satisfaction Questionnaire Results ..... 169

Table 13 Teachers Satisfaction Questionnaire Results ..... 169

# LIST OF FIGURES

**Page**

Figure 1 Diagram illustrating the user experience of interactive animation ..... 2

Figure 2 Demonstration of Interactive Animation Information Transfer..... 3

Figure 3 Data from a survey report on children's interactive digital product experiences in Jinshui District, Zhengzhou City, Henan Province ..... 7

Figure 4 The Importance of Interactive Animation in Improving Preschool Students' Traditional Culture Learning Skills..... 9

Figure 5 The Formation Process of Sensory-Based Digital Interactive Animation .... 16

Figure 6 Components of interactive animation that influence learning skills ..... 17

Figure 7 Rhythm Animation Diagram for The Animation Survival Guide..... 27

Figure 8 Animation design process ..... 31

Figure 9 Real-time feedback interactive animation interface..... 36

Figure 10 Interactive animation entertainment interface..... 37

Figure 11 Interactive animation app for children ..... 38

Figure 12 Brainstorming demonstration diagram..... 39

Figure 13 Multimodal interaction gesture diagram ..... 40

Figure 14 Color application for “classical Chinese stories: interactive edition”..... 48

Figure 15 Sound application diagram for Chinese interactive animation ..... 48

Figure 16 Schematic diagram of the HCI process ..... 51

Figure 17 Children's interactive animation user interface ..... 53

Figure 18 Piaget's cognitive development theory framework ..... 60

Figure 19 Logical diagram of the ZPD..... 65

Figure 20 Conceptual framework ..... 86

Figure 21 Design process..... 87

Figure 22 Research Method Flowchart..... 89

Figure 23 Triangulation Method logic diagram..... 91

Figure 24 Interactive animation plot strategy for children aged 3-5 & 6-7..... 110

Figure 25 Different graphics used in animated character design..... 111
Figure 26 Application of traditional Chinese elements in costumes ..... 112
Figure 27 Emotions color ..... 113
Figure 28 Literature on children's color psychology and emotional expression (1969-2025)..... 114
Figure 29 Children's attention span and preference for different colors ..... 115
Figure 30 Color vision in children aged 3–6 ..... 116
Figure 31 Children's touch gestures in interactive animations..... 118
Figure 32 Example of animism theory ..... 119
Figure 33 Comparison of attention graphics in children of different ages ..... 121
Figure 34 Comparison of attention color in children of different ages ..... 121
Figure 35 Demonstration of irreversible thinking ..... 121
Figure 36 Data show children's interest in learning traditional culture ..... 123
Figure 37 Children's preferences for different ways of playing and interacting ..... 123
Figure 38 Interactive animation plot structure diagram..... 127
Figure 39 Interactive animation plot progression diagram..... 127
Figure 40 Visual elements of interactive animation plot..... 128
Figure 41 Interaction design visual prompt diagram..... 129
Figure 42 Interaction design operation and feedback patterns ..... 129
Figure 43 "Spring Festival" interactive animation storyboard ..... 130
Figure 44 "The Mid-Autumn Festival" animation storyboard ..... 131
Figure 45 "Laba Rice Porridge Festival" animation storyboard..... 132
Figure 46 Interactive animation character design..... 133
Figure 47 "Pudgy Rabbit" three-view diagram ..... 134
Figure 48 "Pudgy Rabbit" sketch action design ..... 134
Figure 49 "Pudgy Rabbit" sketch emotion design..... 134
Figure 50 "Pudgy Rabbit" action design ..... 134
Figure 51 "Pudgy Rabbit" emotion design ..... 134

Figure 52 “Sister Luna” three-view diagram ..... 135
Figure 53 “Sister Luna” sketch action design..... 135
Figure 54 “Sister Luna” sketch emotion\\n design ..... 135
Figure 55 “Sister Luna” action design..... 135
Figure 56 “Sister Luna” emotion design ..... 135
Figure 57 “Lucky Rat” three-view diagram ..... 136
Figure 58 “Lucky Rat” character emotions ..... 136
Figure 59 Cultural symbol conversion..... 136
Figure 60 Symbolic gestures “signature action”..... 137
Figure 61 Interactive animation costume design principles ..... 138
Figure 62 Structure diagram of character entrance and exit arrangements ..... 140
Figure 63 Character presentation strategy diagram ..... 141
Figure 64 Differentiated color strategy for different content modules..... 142
Figure 65 “Spring Festival” color card..... 143
Figure 66 “Spring Festival” interactive animation color scheme..... 143
Figure 67 “Spring Festival” scene design..... 144
Figure 68 “The Mid-Autumn Festival” color card ..... 144
Figure 69 “The Mid-Autumn Festival” interactive animation color scheme ..... 145
Figure 70 “The Mid-Autumn Festival” scene design ..... 145
Figure 71 “Laba Rice Porridge Festival” color card..... 146
Figure 72 “Laba Rice Porridge Festival” interactive animation color scheme..... 147
Figure 73 “Laba Rice Porridge Festival” scene design ..... 147
Figure 74 Color matching and children's attention cognition..... 148
Figure 75 Interactive music flowchart..... 150
Figure 76 Music and sound design strategy..... 150
Figure 77 Sound effect duration strategy..... 151
Figure 78 Interactive touch button..... 152

Figure 79 “Spring Festival” background design ..... 153
Figure 80 “The Mid-Autumn Festival” background design ..... 154
Figure 81 “Laba Rice Porridge Festival”background design ..... 154
Figure 82 Interactive text design ..... 155
Figure 83 Interactive button design ..... 156
Figure 84 Interactive shape design ..... 157
Figure 85 Touch element setting ratio ..... 158
Figure 86 “Spring Festival” “click” interactive game interface ..... 159
Figure 87 “The Mid-Autumn Festival” “click” interactive game interface..... 160
Figure 88 “Laba Rice Porridge Festival” “click” interactive game interface..... 161
Figure 89 “Spring Festival” “drag” interactive game interface..... 161
Figure 90 “The Mid-Autumn Festival” “drag” interactive game interface ..... 162
Figure 91 “Laba Rice Porridge Festival” “drag” interactive game interface ..... 163
Figure 92 “The Mid-Autumn Festival” “rotate” interactive game interface ..... 164
Figure 93 Comparison of Pre- test and Post-test Scores..... 165
Figure 94 Horizontal comparison of satisfaction survey data ..... 170

# CHAPTER I

# INTRODUCTION

This chapter constitutes the first chapter of the thesis and aims to establish the foundational framework and theoretical basis for the entire study. This chapter covers ten aspects: Background and rationale, Problem identification, Research questions, Research objectives, Research hypotheses, Research variables, Significance of research, Related studies, Research scope, and Operational definitions. The study will systematically review and analyze the current development status of interactive animation in Chinese preschool education, the content of Chinese traditional culture, the advantages and challenges of preschool students learning traditional culture, identify research entry points, and thereby determine research questions, research objectives, and research significance, leading to further discussion.

This chapter sets out research hypotheses and clearly defines research variables, providing a theoretical basis and directional guidance for subsequent experiments and analyses. At the end of the chapter, we discussed the relevant research conducted by current researchers. we will define the key concepts and terms involved in the research to ensure the clarity of the research logic and consistency in the use of terminology.

**Background and rationale**

The development of digital interactive animation is closely related to the continuous expansion of new media evolving forms. With the progress and development of the digital age, interactive animation has gradually become an important form of expression in digital media (Ouyang, 2016). Compared with traditional animation, interactive animation gives users the initiative in the viewing process.Interactive animation controls the work through event responses and interactive functions during the playback of animation works, enhancing user interaction and participation with the animation work, enabling users to transition from passively receiving information to actively selecting information (Figure 1). Visuality, on the other hand, reflects the innovative and aesthetically pleasing visual themes and styles in the design of digital interactive animation, serving as a key feature that enables digital interactive animation to create a rich and vibrant visual virtual world. Based on this, different types of digital interactive animation have developed distinct creative methods, yet they still maintain

consistency in terms of visuality and interactivity.

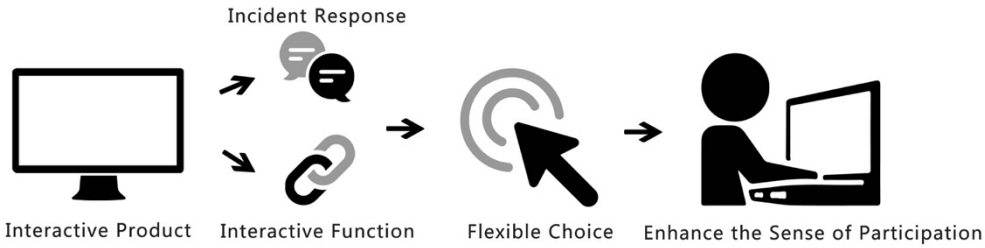



Figure 1 Diagram illustrating the user experience of interactive animation

Source: Ren,2022

Compared to traditional animation, interactive animation relies on graphical, audiovisual, and interactive elements in its design (Gieryic, 2024). Dahlan et al. (2023) argue that the core characteristics of interactive animation include interactivity, feedback, participation, and adjustability. These characteristics align more closely with constructivist and situational learning theories, thereby creating more opportunities for educational applications, particularly in early childhood education. 《Interactive Children's Education Market Forecast 2021–2026》 (Research and Markets, 2021) shows that the global interactive children's education content market is growing at an average annual rate of 10.2%, with particularly significant growth in the Asia-Pacific region. The 2021 survey findings of the China Children's Digital Content White Paper (iResearch, 2021) show that among preschool children aged 3-6, the proportion of those who watch animated programs or use apps with interactive features has reached 73%. With the rapid popularization of interactive animation in preschool education, interactive animation has an impact on children's learning and thinking patterns.

According to psychologist Jean Piaget's (1952) theory of “stages of cognitive development in children,” preschool children aged 3-6 are in the “preoperational stage.” At this stage, children are very sensitive to their sensory systems. Preschool children gradually establish symbolic representations in their cognitive development, using language, movements, images, games, and drawings to represent concepts in reality (Cartwright, 2024). In 2020, Nansen emphasized in his book that digital media can promote children's active exploration and experimentation, and that tactile involvement helps stimulate children's desire to create and their motivation to learn, thereby improving the efficiency of cognitive construction. Anggrasari & Dayu confirmed in

their 2022 study that interactive animation can transform complex and abstract knowledge content into concrete scenarios, thereby reducing the difficulty of children's understanding of information.

Extensive empirical research has demonstrated that interactive animations can provide children with vivid, immersive, and active learning experiences (Aslan et al., 2022). Interactive animations engage children's visual, auditory, and tactile sensory systems, deepening their experiential understanding of knowledge through the direct connection between actions and information (Figure 2). Neumann et al. (2014) mentioned in a journal published in 2014 that children show stronger learning engagement and emotional involvement in interactive touchscreen contexts, with significant improvements in knowledge of shapes, colors, movements, and sequences.

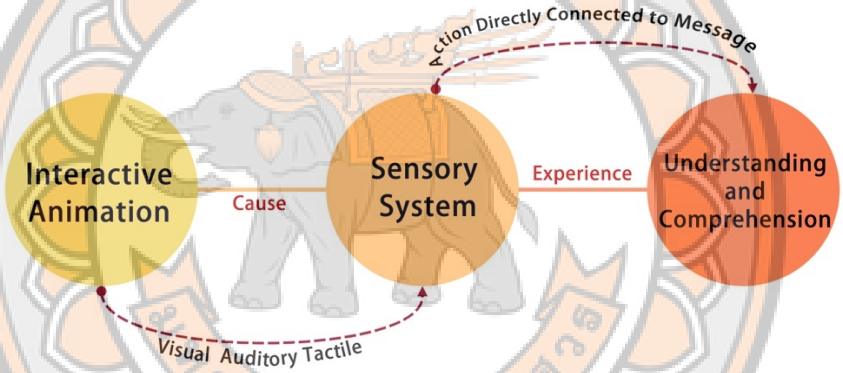



Figure 2 Demonstration of Interactive Animation Information Transfer

Source: Bai,2023

In practical applications, interactive animation is widely used in various preschool education subjects such as Mathematics, English, Science, and Language cognition (Rachmavita, 2020). A joint statement released by NAEYC and the Fred Rogers Center (2012) pointed out that when technology and interactive media are used intentionally and appropriately, they are effective tools for supporting children's learning and development. Danby et al. (2020) pointed out in their research that interactive animation can promote social interaction and meaning construction among young children on digital platforms, thereby not only improving their knowledge acquisition skills, but also developing their cooperation and communication skills.

With China entering the digital information age centered on multimedia and network technology, contemporary children's education has transitioned into a digital

information-based form: interactive technologies such as smartphones, multimedia tablets, and touchscreen computers have become widespread in preschool education. With the integration of information technology into the teaching and learning process in the new information age, the learning environment, learning resources, and learning methods have undergone changes, and the entire educational ecosystem has been restructured due to the introduction of new media technology.

According to research, interactive animations based on network multimedia have a positive impact on the development of Chinese children's learning and thinking skills due to their rich learning resources and advanced multimedia technology and methods (Zhou, 2020). Digital interactive animations have advantages such as fast transmission speed, diverse information presentation methods, and ease of management. Children can choose relevant information and learning paths according to their interests and needs for personalized, expanding their knowledge base, increasing their knowledge reserves, and promoting the development of their sensory functions (Shen, 2025).

In the detailed design phase, some studies emphasize that interactive animation should adhere to the basic principles of clear images, concise language, and moderate rhythm (Chuang & Jamiat, 2023). Children learn through specific visual, auditory, and tactile experiences, so the continuity of the plot, character design, vivid colors, and rhythmic music and sound effects are all important design elements that affect learning outcomes. Son & Butcher further proposed in 2024 the importance of touch elements in interactive animations for children, saying that age-appropriate touch elements can help improve children's memory. The integration of multisensory information combining visual, auditory, and tactile elements not only attracts children's interest but also improves their comprehension skills of the learning content.

However, although interactive animation demonstrates broad application potential and positive educational value in the children's education market, particularly in stimulating children's interest in learning, improving attention span, and promoting sensory coordination, it also faces challenges in actual promotion and application. Among these challenges is the significant gap between design concepts and educational functions (Zeng, 2018). Researchers have found that interactive animation in China lacks awareness of interactive design concepts; the few children's educational animations that do incorporate interactive design lack complex interactive mechanisms

to guide children's thinking transfer, causal reasoning, or problem solving (Wang, 2019), and are essentially still “passive reception” learning media. At the same time, outdated interactive animation content and forms are also important reasons (Liu & Zhang, 2016), such as low image quality, monotonous interactive design, and lack of logic, which fail to effectively attract children's attention. Some designs focus on superficial forms such as images, characters, and colors (Ren, 2022), ignoring the laws of children's psychological and cognitive development (Hao, 2024), resulting in knowledge being conveyed in an overly abstract manner that is difficult for children to truly understand. This understanding limits the cultivation of children's thinking and creative abilities, making it difficult to build a complete and rigorous learning framework for students (Yin & Ding, 2024). Children lack “deep interaction” that builds meaning in interactive animation, and interactive animation does not play a real role (Huang, 2023).

Researcher emphasize that, based on current surveys, the development of interactive animation for children in China lags behind market demand, and relevant designers lack an understanding of interactive design concepts. A small number of children's educational animations that incorporate interactive design only utilize basic interactions such as clicking and swiping in their interactive behavior design, resulting in limited interactive forms and a lack of in-depth exploration of content. Interactive animation holds significant potential, particularly for preschool-aged children. It can serve as an effective supplementary tool to enhance children's education, providing valuable support for home-school learning and education during the preschool stage, as well as offering effective assistance for subsequent school-age education. It can also facilitate teachers in implementing interactive teaching methods, thereby reducing disparities caused by regional educational resource disparities.

In recent years, the “Traditional Chinese Culture” has received increasing attention from the education sector. Integrating traditional culture into preschool education can promote the healthy growth of young children (Niu, 2025). In 2017, the State Council of the Communist Party of China issued the “Opinions on Implementing the Project of Inheriting and developing excellent Traditional Chinese Culture,” which proposed “integrating excellent traditional Chinese culture throughout national education, with a particular emphasis on strengthening traditional culture education in early childhood education and constructing a systematic Chinese culture curriculum and teaching

material system.” However, due to the characteristics of traditional culture, such as its deep history, complex context, and abstract symbols (He, 2025), there is still a lack of mature paradigms and theoretical support on how to effectively transform it into visual content suitable for the cognitive level of children aged 3–6. Based on the above, interactive animation has the characteristic of transforming abstract cultural connotations into visual and tangible forms of expression. Therefore, integrating traditional Chinese culture into the design of interactive animation is an effective means of improving preschool students' traditional culture learning skills.

Some studies have also discussed how to integrate traditional Chinese culture into interactive animation to achieve cultural education and cognitive development for preschool students. However, existing research has also revealed some common problems. According to recent studies, some traditional cultural education topics exceed children's cognitive load (Luo & Lin, 2024). Although interactive animations based on traditional Chinese culture are highly interactive, they lack effective teaching value (Hu, 2021). One important reason for this is that the design lacks systematic principles based on children's cognitive differences, making it difficult to achieve true teaching support. In addition, there is no effective evaluation mechanism for the educational effects of interactive planning, making it difficult to measure the specific paths of promoting children's comprehension and creativity.

Therefore, researchers will consolidate current practical issues and hope to provide an interactive animation design framework for preschool students to learn the Traditional Chinese Culture. The core of the research lies in the adaptability of interactive animation to preschool students, the interest of interactive animation, and the actual teaching effectiveness of interactive animation. Focusing on the practical application value of teaching effectiveness and proving its effectiveness in the form of data will answer the question of how preschool students can improve their traditional culture learning skills through interactive animation.

**Problem identification**

1. Problems of Interactive Animation in Children’s Education

For preschool students,they are still in a stage where image-based thinking predominates, while abstract thinking has not yet fully developed (Piaget, 1952). So, when faced with the relatively complex historical background, ethical concepts, and

philosophical ideas of traditional culture, it's easy for them to lose interest or not fully understand (Li, 2023). Although children generally show a high level of interest in animation, images, games, and other forms of media (Wang, 2024), without effective guidance and educational design, it is difficult to transform this interest into a true understanding of culture and recognition of values.

According to the results of the "Survey Report on Children's Interactive Digital Product Experience in Jinshui District, Zhengzhou City, Henan Province" released in Zhengzhou, Henan in 2023 (Figure 3), Chinese parents believe that the biggest advantages of using interactive digital products on mobile devices are: Learning Interest (70.8%), Rich Content (68.3%), Constantly updated (66.6%). However, Chinese parents are concerned about the negative factors of interactive digital products: Inappropriate Content (43.2%), Cyberbullying and Contact with Strangers (43.6%), and the Quality and Suitability (60.67%).

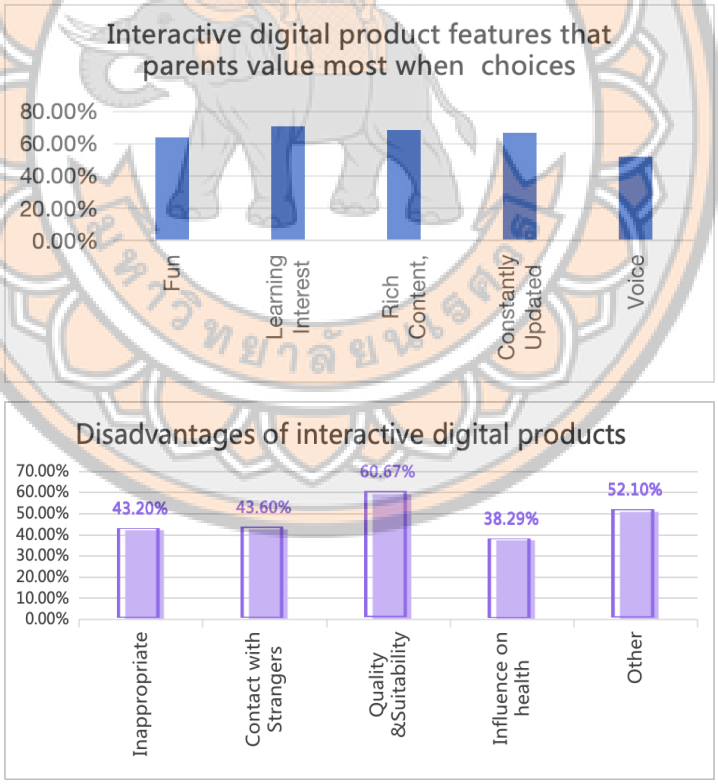



Figure 3 Data from a survey report on children's interactive digital product experiences in Jinshui District, Zhengzhou City, Henan Province

Source: Survey Report on Children's Interactive Digital Product Experience in Jinshui District, Zhengzhou City, Henan Province,2023

Meanwhile, relevant research and practical applications over the past two years

have also revealed several issues requiring resolution in the use of interactive animations for children's education. First, regarding educational objectives, a 2023 survey of 500 parents in Beijing, Shanghai, and Guangzhou indicated that over 57.4% of parents believe interactive animations are overly entertainment-focused and lack clear educational direction (iResearch, 2022).Second, regarding learning effectiveness, approximately 62% of teachers reported that preschoolers easily lose focus during interactive animation use, struggling to maintain attention beyond 15 minutes (Taizhou Investigation Team of the National Bureau of Statistics, 2021).Additionally, regarding content presentation, research indicates that 45.8% of interactive animation products suffer from superficial cultural content, making it difficult to help children form systematic knowledge frameworks (iResearch, 2022). In terms of health and usage habits, data from the China Youth Research Center (2024) points out that nearly 41% of children experience eye strain or delayed sleep when using interactive animation learning products (iResearch, 2022). Morenotably, 52% of parents express concerns about privacy protection and data security risks in interactive animation products (iResearch, 2022). These issues not only constrain the educational potential of interactive animation but also deepen parental apprehensions regarding its quality and value.

2. Problems in Kindergartens' Approaches to Traditional Culture Education

Research indicates that traditional cultural education in kindergarten settings currently exhibits a lack of diversity in teaching methods and a lack of systematicity and cultural logical continuity in teaching content (Deng & Wang, 2025). For example, when designing courses, teachers often focus only on a particular event or superficial form, while neglecting the cultural spirit and values behind it, resulting in children's understanding of traditional culture remaining at an emotional level, making it difficult to form a deep cultural identity (Guo, 2025). There are obvious differences in the implementation and methods of traditional culture education between different regions and different types of kindergartens (Wang & Wang, 2023). Urban kindergartens are relatively rich in resources and have more opportunities to carry out relevant courses and activities, while kindergartens in rural and underdeveloped areas face practical difficulties such as a lack of courses, weak teaching staff, and limited parental awareness, which exacerbates the imbalance of educational resources (Tang, 2024).

3. Issues Related to Teachers' Professional Competence, Resource Shortages, and Regional Development Imbalances

Teacher professionalism also plays a limiting role in the effectiveness of traditional culture education (Chen, 2021). According to a 2021 study, many kindergarten teachers lack a systematic background in traditional cultural knowledge and possess only a superficial understanding of cultural connotations, making it difficult for them to translate abstract cultural content into teaching language and formats appropriate for the cognitive development of preschool children (Chen, 2021).Xiao and Han (2021) found that some kindergartens still rely on monotonous digital resources, and their teaching methods remain confined to traditional approaches such as storytelling, rote memorization, and imitation, which fail to stimulate children's deeper engagement.

Therefore, in light of current challenges in traditional culture education,such as monotonous teaching methods (Li, 2020), lack of systematic content (Chen, 2024), insufficient teacher competence and limited resources, uneven regional development (Chen, 2021), mismatches between children's cognitive characteristics and instructional content (Cheng, 2025), and parents' incomplete trust in interactive animation, Designing interactive animations appropriately and effectively avoiding the aforementioned issues is a highly practical approach. interactive animations not only align more closely with children's cognitive characteristics in terms of teaching format but also demonstrate significant advantages in teaching effectiveness (Figure 4).

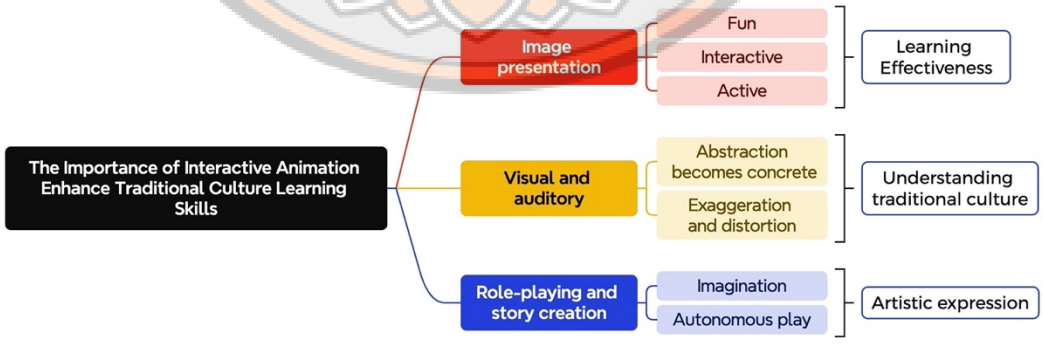



Figure 4 The Importance of Interactive Animation in Improving Preschool Students' Traditional Culture Learning Skills

Source: Huang, 2024; Li et al.,2022

Interactive animation educational content is rich and diverse, covering multiple disciplines such as language, mathematics, science, and art (Rachmavita, 2020). Developed countries such as Europe, the United States, and Japan are increasingly integrating interactive animations into classroom teaching as an innovative educational tool (Liu & Pan, 2022). This interactive animation educational content includes educational software and applications designed specifically for children, as well as online educational platforms and resource libraries (Martzoukou, 2022).

Accordingly, this study will construct interactive animation designs suitable for preschool students to learn traditional culture, focus on combining children's cognitive development characteristics with interactive animation, as well as effectively sorting and screening traditional Chinese culture to adapt to interactive animation production. These questions will answer how interactive animation can promote the improvement of preschool students' traditional culture learning skills. Additionally, the interactive animation design will integrate experiences and cultural expression forms from interactive animation designs across multiple countries, providing educators, policymakers, and design professionals both domestically and internationally with a practical approach to address theoretical gaps in this research field.

**Research objectives**

1. To investigate the design elements of interactive animation appropriate for the cognitive development of preschool children.

2. To identify elements of traditional Chinese culture that are suitable for interactive animation design, with the aim of enhancing preschool children’s comprehension and creative skills.

3. To design interactive animations elements aimed at improving preschool children’s skills to learn traditional Chinese culture.

4. To evaluate the effectiveness of the designed interactive animations in enhancing preschool children’s learning of traditional Chinese culture.

**Research questions**

1. What design elements of interactive animation effectively support the cognitive development of preschool children?

2. What elements of traditional Chinese culture are most suitable for incorporation into interactive animation design to enhance preschool children’s comprehension and

creative skills?

3. What interactive animation elements can be designed to improve preschool children's skills in learning traditional Chinese culture?

4. What is the satisfaction with the design of interactive animations?

**Research hypotheses**

This research proposes the following hypothesis:

Interactive animations designed based on the cognitive development patterns of preschool children can effectively enhance their understanding of traditional Chinese culture and learning outcomes.

**Research variables**

The independent variables are the design factors of interactive animations, specifically including whether they incorporate the cognitive development patterns of preschool children, whether they integrate elements of traditional Chinese culture, and the type of interaction. The dependent variables are preschool children's comprehension, learning interest, and creativity in traditional culture learning, with the aim of exploring the impact of different interactive animation design strategies on children's learning outcomes.

**Significance of research**

This study project is guided by interactive animation design thinking, with Chinese traditional culture as its design content. It integrates Piaget's theory of children's cognitive development stages to construct an interactive animation design framework suitable for Chinese preschool students, thereby enhancing children's learning outcomes and educational functions through interactive animation media in the study of traditional culture.

Compared with traditional teaching models, incorporating interactive animation can help preschool students improve their interest in learning, enhance their comprehension skills and creativity, and stimulate their interest and creativity, thereby increasing their commitment to learning. Traditional learning focuses more on the transmission of knowledge and the cultivation of skills, which to a certain extent limits the development of children's imagination. Interactive devices allow students to learn in a relaxed and free manner, and they can freely choose paintings that interest them to create. By studying the design elements of interactive animation and gradually

designing traditional cultural content, preschool students are more likely to develop a long-term interest in and be influenced by what they learn.

In addition, interactive animation adds interactive and feedback mechanisms to learning, placing greater emphasis on children's experience and participation (Olaz, 2022), providing children with richer, more diverse, interesting, and scientific scenario-based teaching activities (Bai, 2023). With preschool children as the main subject, it follows the laws of child psychological development, fully respects children's psychological feelings and participation, emphasizing children's physical and mental interaction and experiential sense, and achieving educational objectives through more active interactive forms in the animation experience.

With the development of science and technology and social progress, parents' demand for interactive devices in kindergartens has gradually increased (Wang & Hu, 2025). They hope that these devices will provide more learning resources and educational content to promote the learning and development of young children. According to research, one of the reasons for the lack of widespread use of interactive devices in Chinese kindergartens is that interactive media devices do not meet the learning needs of children (Yue, 2020), which has led to parents' conservative attitude towards interactive media devices. Currently, interactive animated content for children on the market may lack depth and educational value, with more emphasis on commercialization and entertainment, resulting in uneven content quality, which may have a negative impact on children's psychology and behavior.

This phenomenon also indirectly demonstrates the significant development potential of interactive animation in early childhood education. If interactive animation and its associated media devices are designed and applied in a scientific and reasonable manner, in accordance with preschool children’s cognitive development patterns, aesthetic preferences, and learning behaviors, they can not only enhance children’s interest and initiative in learning, but also facilitate the internalization of knowledge, culture, and values,especially within the field of traditional cultural education, which is both content-rich and of profound significance.

Selecting Chinese traditional culture as the content for interactive animations helps children gain a direct understanding of stories from Chinese traditional culture. By presenting the story content, it cultivates children's aesthetic emotions and creativity.

Through interaction, traditional book illustrations come to life on the device, enhancing preschool students' understanding. Through interactive animation learning, children can appreciate and understand the beauty of these art forms and stimulate their creativity and imagination. This helps them to better understand and appreciate different cultural works in their future learning and life (Zhao et al., 2024).

This study will construct a system of design elements suitable for preschool students to learn traditional culture, fill the gap in “child-centered” interactive animation design, explore the specific mechanisms and paths of children's comprehension and creativity, and integrate an interactive animation design framework that combines education, cognitive adaptability, and design practicality. The study not only addresses the practical needs of responding to parental expectations and market demands but also drives the technological development of preschool education. Additionally, the researchers hope this study will be helpful to other design institutions, serving as a research guide and enabling implementation in other schools.

**Related studies**

Existing research has confirmed that interactive animation, as a new form of media that integrates visual, auditory, and tactile elements, has a positive effect on improving children's learning motivation, concentration, and knowledge acquisition (Aydoğdu, 2022). Especially in preschool education, children's cognitive characteristics are mainly based on visual thinking and concrete operations. Interactive animation can guide children to actively construct knowledge and improve learning efficiency through dynamic expression and contextualized exercise in an immersive experience.

In the field of children’s learning of traditional culture, as early as 2015, scholars had begun to explore how multimedia technologies could be integrated with Chinese traditional culture to enhance children’s interest and understanding. For example, Hao (2015) pointed out that reinterpreting traditional festivals and classic stories through technologies such as animation, games, and virtual reality can facilitate early cultural enlightenment for children in an engaging and relaxed environment.

However, most existing studies remain focused on the content level, with a noticeable lack of in-depth exploration into how interactive animation formats can be aligned with the cognitive development patterns of young children.

In specific interactive animation design research, Baikulova et al (2024) proposed

that highly interactive digital content promotes children's cognitive transfer and learning initiative more than static teaching materials. Chinese scholar Yang (2016) attempted to construct an interactive animation design model for preschool children based on Piaget's cognitive development theory, emphasizing the introduction of an “operation-feedback-motivation” mechanism in animation to enhance the continuity and effectiveness of learning.

Although existing research has preliminarily explored the advantages of interactive animation in children's education, studies combining children's cognitive development patterns with interactive design strategies in the context of traditional cultural learning for Chinese preschool children remain relatively scarce. Particularly in terms of systematic design methods, structured expression of educational content, and the integration of cultural depth and aesthetic appeal, there is a lack of mature theoretical frameworks and practical guidance. Therefore, based on previous scholarly research, this study further explores how to design interactive animation content based on the cognitive characteristics of preschool children to enhance their traditional culture learning skills, providing new theoretical perspectives and design frameworks in this field.

**Research scope**

The study subjects were middle-class students at Hongyuan Kindergarten in Zhengzhou, Henan Province, China.

The study focused on 20 kindergarten middle class students. In the first stage, Hongyuan Kindergarten in Zhengzhou City, Henan Province, was selected as the research site, and one of the middle-class classes was specifically selected as the sample source. Middle class students were chosen as the main subjects of the study because their cognitive abilities, language expression abilities, and operational skills are more mature than those of small class children at this stage, and they have not yet entered the systematic cognitive training stage of the large class, making them more suitable for interactive animation teaching experiments and observations. In the second stage, in order to ensure the relevance and controllability of the study, small class students (whose cognitive and language skills are still at a preliminary stage) and large class students (who are about to enter the elementary school transition stage, with heavy learning tasks and many distractions) were excluded to reduce the impact of extreme

differences in the development levels of the sample on the experimental results. Children in the middle class are typically aged 4–5 years old, a critical stage of transition from intuitive-action thinking to preliminary logical thinking. Their cognitive patterns are primarily based on imagery thinking and concrete operations, which align well with interactive animation as a teaching medium characterized by visual guidance and hands-on interaction.

In the third phase, prior to designing the interactive animation, researchers extensively sought input from multiple professional sources to ensure the scientific accuracy and appropriateness of the animation content in terms of artistic expression, educational significance, and children's cognitive development. The individuals who provided feedback primarily included experts in children's interactive animations, child psychologists, and representatives from parents of students. Researchers initially contacted relevant parties via telephone and organized online interviews and opinion solicitation sessions, engaging in in-depth discussions regarding the presentation of animation content, interactive formats, selection of cultural elements, and visual styles. The design was developed based on feedback from children's interactive animation designers, child psychologists, and parents of preschool students.

In the evaluation stage of interactive animation learning effectiveness, before the start of the course, 20 middle school students were organized to participate in a “Learning Competency Evaluation Sheet” assessment to evaluate their initial learning ability levels. After the course ended, these 20 students were organized to participate in another “Learning Competency Evaluation Sheet” assessment to verify the teaching effectiveness. “Satisfaction Questionnaire” was distributed to understand the overall satisfaction of students, parents, and teachers with the teaching design framework, including 20 parents of students and 10 middle kindergarten teachers.

**Operational definitions**

The keywords used in this study are explained below according to their meanings in this study.

1. Interactive animation

Interactive technology is a branch of new media, encompassing film and television animation, exhibition animation installations, scene animation interaction, web interface animation, and mobile interface animation interaction (Li & Wang, 2015).

Based on the artistic form and creative methods of digital interactive animation, it can be divided into sensory-type digital interactive animation, cathartic-type interactive animation, and immersive-type interactive animation.

This study specifically refers to film and television animation that is dominated by "sensory-based interactive digital animation", which can include button click feedback, page transition effects, dynamic changes in elements, etc. This type of animation enhances user interaction with the animated work and promotes active communication between users and the human-computer interface (Figure 5). Such interactive animation possesses a certain degree of visual artistry, which is reflected in various aspects such as design, color coordination, and visual presentation. In the visual design of human-computer interaction film and television animation, animation plays the role of visual communication and interpretation, including character images, scene design, action language, and voice-over narration, and to a certain extent determines whether this type of interactive animation can optimally convey information to users (Akwukwuma et al., 2024).

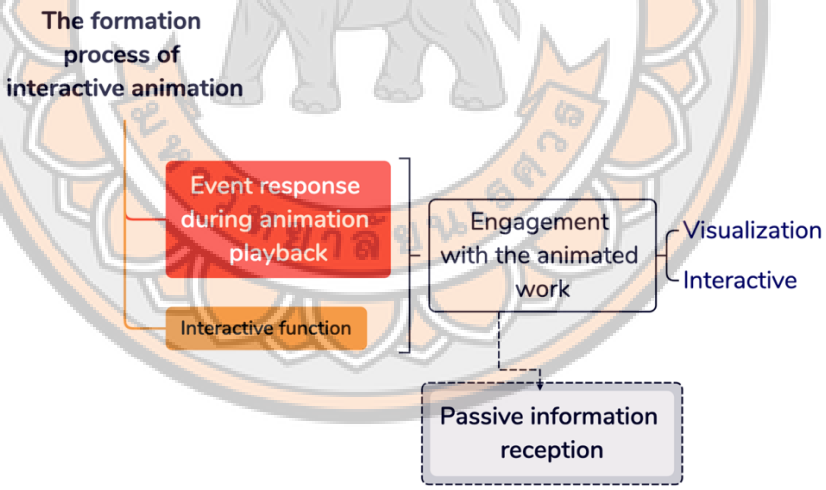



Figure 5 The Formation Process of Sensory-Based Digital Interactive Animation

Source: Akwukwuma et al.,2024

This interactive experience allows users to feel that their actions on the interface have a real effect, thereby enhancing user engagement. Emotional design of animations can provide users with more emotional details, using visual impressions, functional feedback, and interactive exploration to stimulate emotions and provide users with a good operating experience, thereby increasing user participation and realizing the communication function of the interactive interface (Chen & Ibrahim, 2023).

2. Learning skills

Learning skills encompasses multiple aspects such as cognitive, emotional, and motivational factors, and plays a significant role in the development and cultivation of learning skills. In preschool, learning skills are mainly developed through interaction. Preschool students are curious but have short attention spans (Jirout et al., 2024), so learning activities need to be designed to be short and fun. Through language acquisition, social skills training, and hands-on activities, preschool students can build a foundation for learning in a relaxed and enjoyable environment (Prins et al., 2023).

The learning skills referred to in this study encompasses two aspects: promoting children's comprehension and creativity (Figure 6). Comprehension refers to the ability to understand language, context, stories, and images. Children develop an understanding of story plots and characters through activities such as listening to stories and viewing picture books (Zhang et al., 2024). children gradually develop their understanding of visual information by observing images and charts. Interactive animations create effective contexts to showcase knowledge or concepts related to traditional Chinese culture and tell interesting stories, integrating traditional Chinese cultural stories into the context. Through narrative expression, students can more easily understand abstract concepts and establish associations and memories of knowledge in the stories.

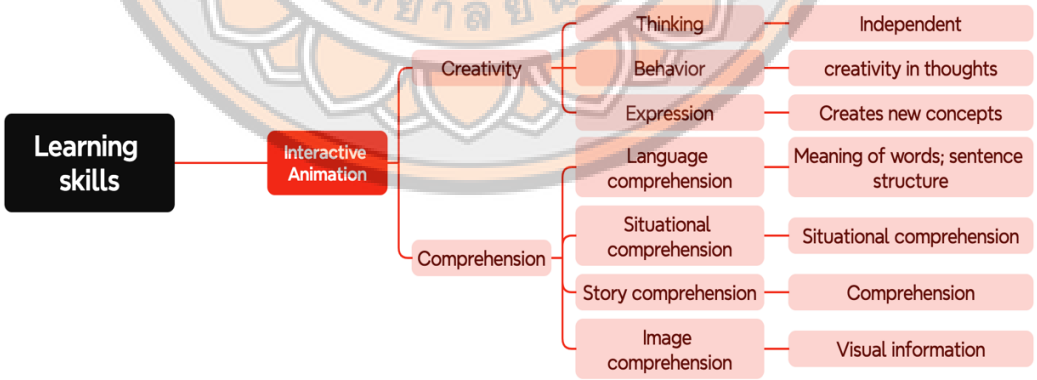



Figure 6 Components of interactive animation that influence learning skills

Source: Zhang et al.,2024; Zheng& Yang, 2003 ; Kartika et al.,2019

Creativity refers to the creative abilities that children demonstrate in their thinking, behavior, and expression. These skills include independent and creative problem solving, the ability to generate new perspectives and ideas, and the ability to create new

concepts, stories, pictures, etc., and express them creatively through various media. Interactive animation can be used to cultivate creativity in preschool students by presenting creative and imaginative scene designs to stimulate their creativity (Kartika et al., 2019), including creating fantastical worlds, moving storylines, or unique character designs, allowing students to generate new ideas through interactive participation. This requires effective student interaction, allowing them to influence the development of the animation through actions such as selecting, clicking, or dragging. Such interactivity encourages students to think actively, explore different possibilities, and cultivate their creative thinking skills.

3. Traditional Chinese Culture

Chinese traditional culture encompasses a wide range of elements, including traditional values, moral principles, artistic forms, and social customs (Zhang & Fang, 2004). This study adopts Chinese traditional culture as the theme for interactive animation design, with a focus on selecting cultural materials suitable for animated interactive expression to ensure the expressiveness and educational effectiveness of the content. For example, the "Chinese Traditional Festivals" theme, such as the Spring Festival, Qingming Festival, Dragon Boat Festival, and Mid-Autumn Festival, allows users to learn about the origins, celebration methods, and cultural significance of these festivals through interactive animation; the "Traditional Chinese Painting" theme incorporates basic techniques of traditional Chinese painting into interactive animations, allowing children to directly experience traditional Chinese painting; Under the theme of "Chinese classic stories", traditional narratives such as *Mencius' Mother Moves Three Times*, *The Monkey King's Battle with the White Bone Demon,* and *The Cowherd and the Weaver Girl* were integrated into the design of interactive animation.

Integrating traditional Chinese culture into contextualized education through interactive animation helps create a more concrete and vivid learning environment for preschool children. For example, simulating ancient life scenes or traditional festivals, virtual handicraft tasks, and story-driven cultural exploration training can enhance cultural identity. Through narrative expression, students can more easily understand abstract concepts and establish associations and memories of traditional culture in stories.

4. Preschool students

Preschool students refer to children aged 3-6 who are not yet enrolled in school. Children at this stage are usually in kindergarten or preparing to enter kindergarten. They are undergoing early education preparation, which typically focuses on cultivating basic skills, improving social skills, and developing cognitive abilities (Chen, 2011). They need comprehensive education, including language enlightenment, cognitive enlightenment, and social skills training, to lay the foundation for future formal school education.

The preschool students in this study needed to have basic language communication skills to express simple needs and emotions, including using simple vocabulary, sentences, and body language to communicate. In addition to basic language communication skills, they also need to have cognitive abilities to understand simple instructions and rules, and be able to recognize and confirm them through simple instructions and rules. During the experiment, children can focus on simple activities and tasks, and are able to recognize basic concepts such as numbers, colors, and shapes, maintaining a certain level of attention and concentration in simple activities in order to effectively participate in experimental teaching activities and tests.

5. Applications of design interactive animation

This study utilized Adobe Photoshop and Adobe Illustrator software to create the graphic design components during the animation production process, encompassing elements such as character design, costume design, prop design, scene design, button design, and component design,all integral to interactive animation elements.

Adobe Premiere Pro and CapCut were used for quick editing and sound effects production of interactive prototypes to meet the visual rhythm and emotional needs of preschool children's video presentations. The dialogue within the interactive animations was recorded using online voice-over. The interactive animation touchscreen components were created using software such as Sketch, Figma, and Principle. This involved designing vector graphics, creating page layouts using editing software, adding interactive elements, and defining events to trigger animations, thereby achieving various interactive animation effects.

This chapter provides a general overview of the basic framework of the study. In summary, this study focuses on interactive animation design and application practices centered on traditional Chinese culture. Through scientific design methods and systematic empirical analysis, it explores effective ways to improve preschool children's traditional culture learning skills. The next chapter will further sort out the theoretical basis and related research on which this study relies, providing support and direction for subsequent research design.

# CHAPTER II

# LITERATURE REVIEW

This chapter reviews the latest literature on interactive animation, traditional Chinese culture, cognitive development in preschool children, and interactive animation for children and improving learning skills. This chapter also outlines how interactive animation and traditional Chinese culture can be integrated into the learning of preschool students to achieve the educational goals and expected objectives of cultivating traditional Chinese culture. Through an extensive search of relevant literature, including research journals, books, theories, and models, the following useful information is provided.

**1. Animation**

1.1 The Concept of animation

1.2 Characteristics of animation design

1.3 Principles of Animation Design

1.4 Forms of animation creation

1.5 Animation elements and emotions

1.6 Animation Design Process

**2. Interactive animation**

2.1 Meaning of interactive animation

2.2 Design elements for interactive animation

2.3 User experience of interactive animation

2.4 Interactive Animation Design Principles

2.5 Interaction Design Methods for Children

**3. Interactive animation for children**

3.1 Definition of Interactive Animation for Children

3.2 Design Elements of Interactive Animation for Children

3.3 Artistic styles of interactive animation for children

3.4 Use of interactive animation among preschool students in China

3.5 Problems with the design of interactive animation for children in China

3.6 Case Studies of Interactive Animation Design for Children

**4. Human-Computer Interaction (HCI)**

4.1 Meaning of HCI

4.2 HCI and Emotional

4.3 Child-Computer Interaction (CCI) and cognitive strategies for children's learning skills

4.4 HCI Design Principles for Children

**5. Traditional Chinese Culture**

5.1 Content of Traditional Chinese Cultural

5.2 Chinese Kindergarten Curriculum

5.3 The current status of interactive animation applications in Traditional Chinese Culture education

**6. The current status and educational practices of preschool education in China**

6.1 The development of preschool education in China

6.2 The development of preschool education concepts in China

6.3 The Development of preschool education for students in China learning skills

**7. Children's Cognitive Development**

7.1 Piaget's Theory of Cognitive Development

7.2 Animism

7.3 Zone of Proximal Development Theory (ZPD)

7.4 Scaffolding

7.5 Research on the stages of cognitive, emotional, behavioral, and artistic development in early childhood

**8. Learning skills**

8.1 Components of learning skills in preschool students

8.2 The role of digital media in promoting learning skills in preschool education

8.3 The role of instructional model in promoting learning skills in preschool education

**9. Comprehension**

9.1 Meaning of comprehension

9.2 The role of interactive animation in cultivating comprehension in preschool students

9.3 Overview of strategies for cultivating comprehension in preschool students through interactive animation

9.4 Situational Cognition Theory

**10. Creativity**

10.1 Meaning of creative

10.2 The role of interactive animation in cultivating creative in preschool students

10.3 Creative thinking training methods

**11. The Application of Interactive Animation in Transnational Preschool Education**

11.1 Using Interactive Animation to Support Cultural Learning in International Kindergarten Settings

**12. Conclusion**

**13. Conceptual framework**

**14. Design process**

**1. Animation**

**1.1 The Concept of animation**

Animation is an art form that uses various means such as painting, imaging technology, and computer technology to create vivid and expressive visual effects. It uses painting and other forms of visual art as the main means of expressing character and environmental space, employing exaggeration, resemblance, and deformation and relying on fantasy, imagination, and symbolism to reflect people's lives, ideals, and desires. It is a highly hypothetical cinematic art form (Briggs, 2004).

Animation is typically measured in frames or cells, with 24 frames per second. The movement in animation is not created by camera movement or live-action performance, but rather by the visual and physiological illusions produced when a sequence of hand-drawn frames, including animated “characters” and “scenes,” is played back. Animation expresses a kind of transformation, which is not only a change in elements or position, but also a change in tone or rhythm (Sheng, 2015). From a more specific perspective of each frame, animation expresses the relationship between each frame that is created and their relationship with time.

Animation creation is a multidisciplinary art form, which organically combines

artistry and technology. In the process of creating vivid and expressive animated works, artistry and technology complement and intertwine with each other. Through their organic combination in animation creation, animated works can vividly convey emotions and stories while attracting audiences with high-quality visual and sound effects.

Currently, animation is broadly categorized into two main types: traditional animation and modern animation. Traditional animation mainly includes hand-drawn, paper-cut, and puppet types, in which creators use tools such as brushes, paper, and pigments to create their artwork. It can convey the creator's ideas and emotions through elements such as lines, colors, and composition. In animation creation, hand-drawing techniques are often used in character creation, scene sketching, and key frame drawing (Chen, 2012).

Modern animation primarily employs technologies such as computer-aided design (CAD) and computer graphics (CG) to create works through digital means. It can achieve detailed expressions and rich color variations through digital image processing technology. In animation creation, digital painting techniques are commonly used in areas such as character concept art, scene concept art, and special effects production (Zhang, 2020).

With the continuous advancement of technology, especially the application of new technologies such as virtual reality (VR), augmented reality (AR), and artificial intelligence (AI), animation production methods are also constantly innovating (Xu, 2025). These new technologies have improved the efficiency of animation production, enriched the forms of animation expression, and made animation works more attractive and enjoyable to watch.

**1.2 Characteristics of animation design**

The production characteristics of animation refer to the core features and essential attributes of animation as an art form. The production characteristics of animation can be analyzed from multiple perspectives, including technical, artistic, multidisciplinary, interactivity, and hypotheticality.

1. Technical

Animation relies on advancements in science and technology (Wells, 1998). With the development of computer technology, animation production software has been continuously updated and upgraded, providing animators with more efficient and convenient creative tools. For example, software such as Adobe Animate, Maya, 3ds Max, and Blender are widely used in animation production. In addition, animation production

also has specific technical characteristics, manifested in the sequential production and processing process. Animation involves a large amount of drawing work, including character design, scene drawing, storyboard sketches, etc. These links require animation production personnel to have rich professional knowledge and skills to ensure the quality of the animation work.

2. Artistic

As an art form, animation has unique aesthetic value and artistic expressiveness. The aesthetic characteristics of animation include the aesthetics of plastic arts, the aesthetics of movement and mood, and the aesthetics of sound elements. Animation production requires animators to demonstrate a high level of artistic skill in their work, including lines, colors, composition, and camera use. Artistry is an important factor in attracting audiences to animated works, and it is also an important criterion for measuring the level of animation production.

3. Multidisciplinary

Animation encompasses a variety of art forms, such as painting, sculpture, music, and dance. Integrating these elements is an important feature of animation production. Animated works cover a wide range of techniques, styles, and themes, and are highly diverse. This allows animation to satisfy audiences of different ages, cultural backgrounds, and aesthetic preferences.

When designing animations, animators often incorporate rich cultural connotations and philosophical reflections, reflecting the creators' observations and thoughts on real life (Han & Yu, 2024). This gives animated works high ideological value and communicative significance. Because animations can be drawn using a variety of materials, some experimental animated works often have an innovative and experimental spirit (Zheng, 2014), with creators constantly experimenting and breaking new ground in terms of technique, style, and story.

4. Interactivity

Through the design of the plot, characters, and scenes, animated works resonate with the audience and stimulate their desire to participate (Xue, 2021). The audience can actively participate in the discussion and creation process of animated works, putting forward their own opinions and ideas, thereby making the animated works more attractive. With the development of the Internet and virtual reality technology,

animation production has begun to focus on the interactive experience of the audience, and interactive animation has gradually become a trend. Viewers can participate in animated works through touch screens, VR, AR, and other devices, changing the progress and ending of the animation, making viewers part of the animation creation, and increasing the fun and sense of participation in viewing (Du, 2024).

5. Hypotheticality

Animation has hypothetical characteristics, namely the virtual nature of animated characters and scenes. Animated works often employ techniques such as fiction, exaggeration, and hypothesis to create a world full of fantasy and imagination. In this world, inanimate static symbols can be transformed into animate dynamic images. Animation demonstrated expressive power that transcends reality, providing viewers with a rich space for imagination.

**1.3 Principles of animation design**

The principles of animation design form the core foundation of animation creation. They encompass not only techniques for visual expression but also the construction of narrative logic and the audience's emotional experience. As early as 1981, Disney animators Thomas and Johnston articulated the “Twelve Principles of Animation” in The Illusion of Life, explicitly stating that animation must adhere to specific rules regarding exaggeration, preparatory action, timing control, and scene composition to ensure the believability and expressiveness of characters and plots. This principle system was later further summarized and promoted by Lasseter (1987) and is recognized as a fundamental guideline for modern animation design.

In color design, research indicates that color not only serves an aesthetic function but also influences viewers' emotions and cognition on a psychological level (Suk & Irtel, 2010).For instance, warm color palettes are frequently used in children's animations to create an atmosphere of intimacy and joy, while cool color schemes are better suited for portraying quiet and mysterious scenes. Simultaneously, color choices are closely linked to character development,red is often associated with passion and strength, whereas blue conveys calmness and rationality.

Composition design, as a vital component of animation principles, emphasizes the organization and spatial distribution of visual elements to ensure visual focus and narrative flow. Compositional elements such as hue, value, and contrast not only influence the

aesthetic appeal of a frame but also impact audience attention and information comprhension.Williams (2019) notes that effective composition not only enhances visual appeal but also improves narrative efficiency through gaze guidance and layered arrangement. Particularly in children's animation, simple and directional compositions can effectively reduce children's visual load and enhance their comprehension of storylines.

Rhythm and timing control are crucial elements in animation design that determine visual impact and emotional tension. The realism of motion largely depends on mastering rhythm. Williams (2001) emphasizes in The Animation Survival Manual that appropriate timing intervals render movements natural and fluid, while variations in rhythm enhance dramatic tension and capture audience attention.This includes techniques such as Squash and Stretch, Anticipation, Timing, Overlap & Follow-through, and Exaggeration (Figure 7).

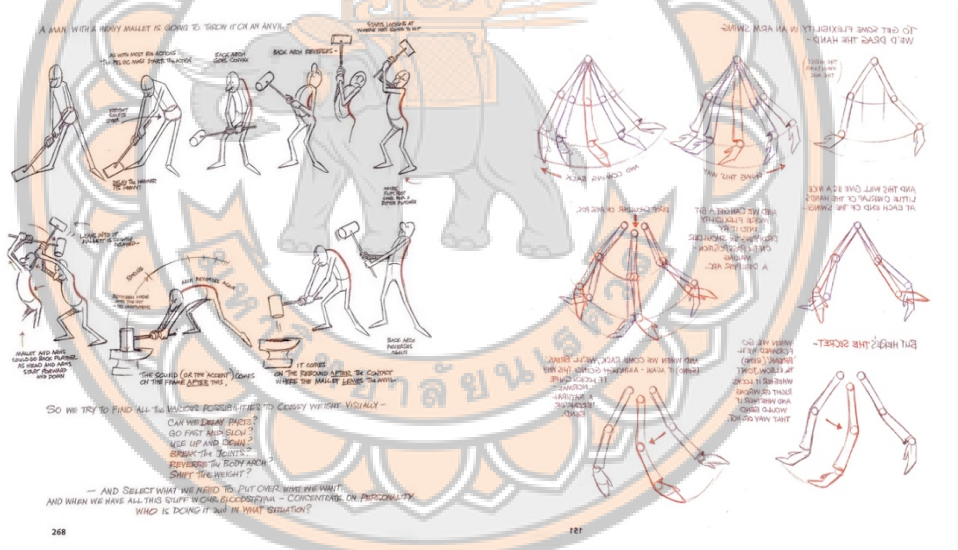


Figure 7 Rhythm animation diagram for the animation survival guide

Source: Williams, 2001

In rhythm design, controlling the pace of movements and the rate of scene transitions is particularly crucial in animation and educational applications. Research indicates that children exposed to fast-paced animations experience short-term negative effects on their executive functions, such as self-control and working memory. Furthermore, for infants and young children, images with higher switching frequencies are more likely to draw visual attention toward “stimulus salience.”Related studies also indicate that in educational animations, appropriate pacing helps sustain preschoolers' attention, preventing cognitive

difficulties caused by overly fast or slow movements (Zanolli et al., 1995).

**1.4 Forms of animation creation**

The creative form of animation refers to the comprehensive factors such as the expression techniques, technical means, and artistic styles used in animated works, which determine the visual effects and aesthetic characteristics of animated works (Zou, 2010). Different expression techniques or technical means can produce different animation effects. In addition, artists often incorporate unique artistic styles to highlight the uniqueness and recognizability of their works. In recent years, popular animated artworks have been innovative in their narrative styles, such as linear narrative, non-linear narrative, and experimental narrative. Different narrative styles can affect the plot expression and audience experience of animated works. The following is a classification of animation creation forms:

1. Hand-drawn animation

Hand-drawn animation is the most traditional form of animation creation, in which artists draw each frame of the animation by hand and then film it. This form of animation creation has a unique artistic style and aesthetic value, but the production process is relatively cumbersome and time-consuming.

2. Digital painting animation

Digital painting animation is a form of animation creation using computer software. Artists use digital drawing tablets, digital pens, and other tools to draw animation frames on a computer, which are then processed through animation software for compositing, layering, rendering, and other operations. Digital painting animation offers high creative efficiency and convenience, enabling a variety of artistic effects.

3. Stop-motion animation

Stop-motion animation is a form of animation created by filming the movement of physical models, toys, and other objects. Creators craft objects in various shapes and poses, then capture each frame with a camera, before compositing and processing the footage using a computer. Stop-motion animation places no restrictions on materials, allowing artists to select suitable materials based on their creativity and practical needs, such as clay, wood, metal, paper, sand, glass, and more. Stop-motion animation has unique visual effects and is suitable for creating fantasy and childlike animation works (Sun, 2024).

4. Computer-generated animation (CGI)

CGI is a form of animation created using computer graphics technology. This type of animation is entirely computer-generated and features highly realistic visual effects and three-dimensional spatial representation. Computer-generated animation is widely used in fields such as film, gaming, and advertising (Li, 2024).

5 Experimental animation

Experimental animation is a form of animation creation that emphasizes innovation and exploration, often using unconventional materials, techniques, and concepts. Experimental animation is not limited by fixed aesthetics and techniques, and can showcase rich creativity and individuality (Xu, 2023).

6. Short-form animation video

Short-form animation video animation is a form of animation characterized by its short duration. It requires creators to convey a clear storyline, character images, and thematic ideas within a limited time frame, presenting a high degree of creative challenge.

7. Interactive animation

Interactive animation is a creative form that combines animation with interactive technology. Viewers can participate in the animation process through touch screens, VR, AR, and other devices, changing the progress and outcome of the animation. Interactive animation enhances viewer engagement and interactive experience.

8. Short animated film

Short animated film is animation characterized by short storylines, independent themes, and a limited number of characters. Animated shorts offer a high degree of creative freedom and experimentation, and are often the first step for many animators.

9. Serial animation

Serial animation is a form of long-running animation, usually divided into television animation and film animation. Serial animation requires creators to have the ability to create continuously, with a focus on character development, plot development, and worldview construction.

10. Transmedia animation

Transmedia animation is a form of animation creation that involves multiple media platforms, such as animated films, TV series, online animation, and games. Cross-media animation requires creators to have cross-disciplinary knowledge and skills to achieve an

organic combination of multiple media forms (Xing, 2023).

**1.5 Animation elements and emotions**

As a multidisciplinary art form that combines painting, imaging technology, and audiovisual media, animation has a powerful emotional impact. Its vivid and expressive visual effects are not only reflected in the characters' images, movements, and expressions, but also in various other elements such as scene settings, color usage, and background music. Through multimodal expression techniques, animation constructs a concrete and emotionally resonant narrative space, conveying the creator's emotional experiences and ideological perspectives through the progression of the storyline, character development, and environmental depiction.

Animation usually has strong narrative qualities and effectively stimulate emotional resonance in the audience through vivid plots, character performances, and emotional expressions. Driven by storytelling, animation not only presents clear thematic ideas but also carries the creators' profound reflections on issues such as life, society, and human nature, possessing a certain degree of ideological and critical depth. This prompts audiences to engage in value judgments and moral reflections during their aesthetic experiences, thereby enhancing their aesthetic literacy and cultural understanding.

When watching animation, audiences mainly receive and interpret the meanings and emotions conveyed through sensory channels such as sight and hearing (Sheng, 2015). This sensory stimulation evokes the audience's emotional instincts, causing them to react immediately on a perceptual and emotional level, thereby perceiving and understanding the images and meanings of the animation. As a highly intuitive art form, animation provides viewers with compensatory psychological satisfaction, allowing them to release their emotions and identify with the characters while watching. The emotional expressions and situational performances of animated characters often prompt viewers to identify with the characters through a mechanism of “empathy” (Uhrig, 2019). Viewers form emotional connections with the characters while watching, resonating with the emotional core conveyed by the work and thus achieving a deep interactive experience.

**1.6 Animation design process**

The animation design process serves as the core framework for animation creation (Figure 8). It is not merely a collection of technical steps, but rather a layered

transformation of creativity, narrative, and visual expression. Many researchers agree that a systematic animation design process helps teams transition abstract concepts into concrete visual realizations, thereby ensuring the narrative integrity and artistic expressiveness of the work.

The animation design process typically begins with the concept development stage. This phase involves proposing story concepts, character designs, and defining the target audience. Parry(2024)emphasize in The Illusion of Life that the core of animation lies not merely in depicting visual motion, but in constructing a believable “sense of life” through characters and narrative.

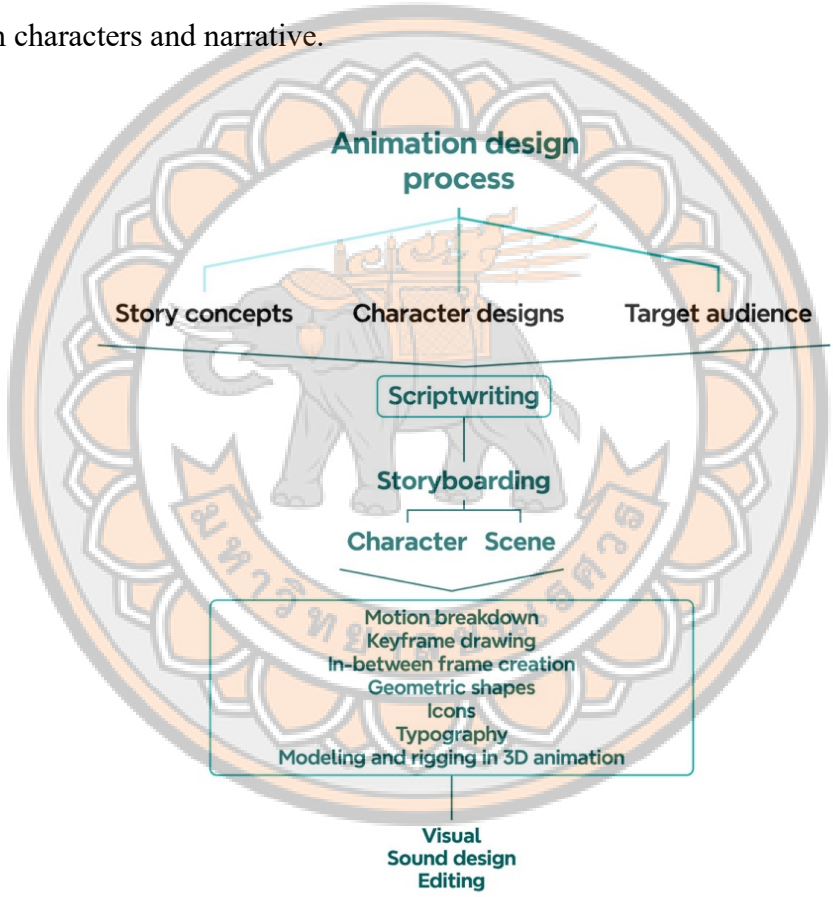



Figure 8 Animation design process

After the concept is formed, the process moves into scriptwriting and storyboarding. The script provides the narrative framework, while storyboarding concretizes the story's pacing and visual language through visual representation. Mou et al (2013) notes that storyboards serve not only as visual planning tools but also as communication devices between directors, animators, and voice-over teams, enhancing production efficiency.In educational application research, Truong(2006) found that concise and intuitive

storyboard designs help children better comprehend story contexts and learning content.

Character and scene design are pivotal steps in establishing an animation's visual style. Systematic planning of color, form, and setting not only imbues characters with distinct personality traits but also conveys cultural connotations through symbolism and metaphor.

The production stage involves motion breakdown, keyframe drawing, in-between frame creation, geometric shapes, icons, and typography, as well as modeling and rigging in 3D animation.

Post-production encompasses visual rendering, sound design, and editing. Voice acting and music design play a crucial role in animated expression, not only complementing the visual narrative but also intensifying emotional impact.

**2. Interactive animation**

**2.1 Meaning of interactive animation**

Interactive animation is an art form with event response and interactive functions. During the playback of an animated work, the audience can control it in a certain way so that the animation plays according to the audience's instructions. This interactivity gives the audience the right to participate in and control the animation, allowing them to change from passive acceptance to active choice. Interactive animation has a wide range of applications, including FLASH animation and APP interface design.

Interactive animation is a form of expression that combines animation and interactive design. With the development and popularization of Internet technology and users' increasingly high demands for online experiences, interactive animation has gradually become an important design trend.

With the emergence and development of Flash technology, interactive animation has begun to be widely used. As a powerful multimedia creation tool, Flash allows designers to easily create animated works with interactive functions. During this period, interactive animation has been widely used in many fields such as web design, advertising, and online education.

With the popularity of smartphones and tablets, interactive animation is increasingly being used in mobile applications. Designers have begun to apply interactive animation to app interface design to improve user experience and interaction effects. In addition, with the continuous advancement of UI design concepts, interactive

animation has also achieved remarkable development in emerging fields such as virtual reality and augmented reality.

With continuous technological innovation, the forms of expression and interaction methods of interactive animation are becoming increasingly diverse. For example, motion sensing technology allows users to control animations through body movements, enhancing the fun and realism of the interaction (Du, 2022). In addition, AR and VR technologies have brought a whole new experience to interactive animation, allowing users to immerse themselves in a brand new virtual world. In addition to continuous technological innovation, the application of interactive animation continues to expand, covering many fields such as games, advertising, education, medicine, and art. In these fields, interactive animation not only enriches the form of content expression, but also improves user engagement and experience (Tidwell, 2020).

**2.2 Design elements for interactive animation**

Design elements are an important part of the interactive animation design process. The reasonable use of various design elements can improve the visual effects, interactivity, and user experience of animations. In 2020, Wang divided interactive animation design elements into visual elements, dynamic elements, interactive elements, sound elements, and story elements.

1. Visual elements

Visual elements are the basis of interactive animation, including shapes, colors, textures, fonts, etc. Shapes include geometric figures, lines, contours, etc. Shapes can be used to represent objects, areas, paths, etc. Through different combinations of shapes, diverse visual effects can be created. Colors can help distinguish different elements, express emotions and atmosphere, and enhance the visual appeal of animation. During the design process, color matching, light and dark tones, and saturation should be considered to make the animation colors harmonious and layered. Textures can add a sense of three-dimensionality, depth, and realism to animations. The reasonable use of visual elements can create attractive and recognizable animation effects. During the design process, the principles of unity, coordination, and contrast should be followed to make the animation visual effects more outstanding.

2. Dynamic elements

Dynamic elements are the core of interactive animation, including animation effects, transitions, transformations, etc. When designing, attention should be paid to the dynamic design of elements, such as the movement and scaling of objects, color changes, and occlusion. Through vivid and interesting dynamic effects, the viewing and interactivity of the animation can be enhanced (Wang, 2019). When designing, consider the fluidity, rhythm, and rationality of the dynamics to enhance the user experience.

3. Interactive elements

Interactive elements are key to interactive animation, including buttons, menus, gestures, etc. The design of interactive elements should suit user habits and needs, and be easy to recognize and operate (Dudley & Kristensson,2018). At the same time, attention should be paid to interactive feedback, so that users can receive timely and clear feedback during operation. In the interactive animation design application process, it is necessary to control the reasonable amount of interaction and test the entire design application results as soon as they are completed. It is clear that overuse of animation effects will cause confusion and overlap in the entire interactive animation, making it impossible to control the overall information hierarchy and affecting the substantive value of the interactive animation.

4. Sound elements

Sound elements can enhance the atmosphere, emotion, and guidance of animations. By controlling the rhythm (tempo, pitch, etc.) of sound, sound designers can use abstract notes to create dynamic visuals in people's minds (Yin & Yuan). Designers enrich the imagination of users during the design process through narrative sound design. During the design process, it is essential to consider the compatibility between sound and animation content, as well as user experience. For example, setting appropriate sound effects for different animation states can enhance the entertainment value and interactivity of the animation.

5. Story elements

The story elements are a form of interactive animation that can attract the audience to immerse themselves in it (Lebowitz, 2011). The form of interactive animation differs from the directorial narrative approach of traditional animation. Interactive animation creators provide audiences with multiple possibilities, guiding them to participate

through a non-linear narrative style. The development of the story plot can be random based on the program design (Murray, 1997), branching out in a networked or tree-like structure. This enhances the uncertainty of the story's conclusion in interactive animation, creating different outcomes for the animation's process and results.

**2.3 User experience of interactive animation**

The user experience (UX/UE) of interactive animation refers to the feelings and experiences that users obtain when interacting with animated products, systems, or services that have interactive functions. Interaction mainly refers to a type of communication behavior that involves the two-way transmission of information between people, between people and machines, and between machines through certain activities (Wang, 2020). Due to the non-linear nature of interactivity, there is a certain degree of uncertainty, randomness, and incidentality in any interaction between people, and not everything is under the control of the creator (Lebowitz & Klug, 2011). Interactive works are usually incomplete at the beginning, or even fragmented, similar to point-to-point transmission, line-to-line communication, and face-to-face summaries, which eventually converge into a complete work.

Its main components are “information” and “participation” (Lebowitz & Klug, 2011). Interactive works receive external information during the process of interacting with users and, through real-time processing of the information, accept and provide feedback to users. Creators design the sensory experience process and the final presentation effect of the work based on the creative concept, and translate it into a language that computers can understand through logical thinking, thereby designing the interaction mode and allowing users to achieve the effect of participating in interactive animation.

Designers must consider the behavioral patterns of relevant user types and the real actions, emotions, and attitudes users exhibit in specific contextual states,that is, how users respond to external stimuli,to infer how users will behave and what experiences they will have in different environments and scenarios. This is known as “contextual design” (Beyer & Holtzblatt). These user experiences must be consciously designed, with designers gradually guiding users to generate emotional experiences through interactive animations.

### 2.4 Interactive animation design principles

Interactive animation, as a multimodal medium integrating animation art with human-computer interaction technology, follows design principles that extend beyond aesthetics and storytelling. Its core lies in enhancing learner engagement and comprehension through effective interactive mechanisms. Particularly in preschool education, design principles must simultaneously consider user experience, feedback systems, and cognitive development characteristics to ensure interactive animations both spark interest and facilitate learning.The foremost principle of interactive animation is user-centered design. In educational settings for children, this means interfaces and interaction logic must align with children's operational habits and perceptual capabilities. For instance, simplifying interaction paths, using large icons, and employing intuitive touch controls can reduce cognitive load for young learners.

Research indicates that immediate feedback effectively enhances children's learning motivation and willingness to engage (Muis et al., 2005). In interactive animations, this manifests through animated responses, auditory cues, or reward mechanisms that reflect user actions. For instance, when children successfully complete tasks, positive reactions from animated characters not only heighten engagement but also reinforce learning behaviors (Figure 9).

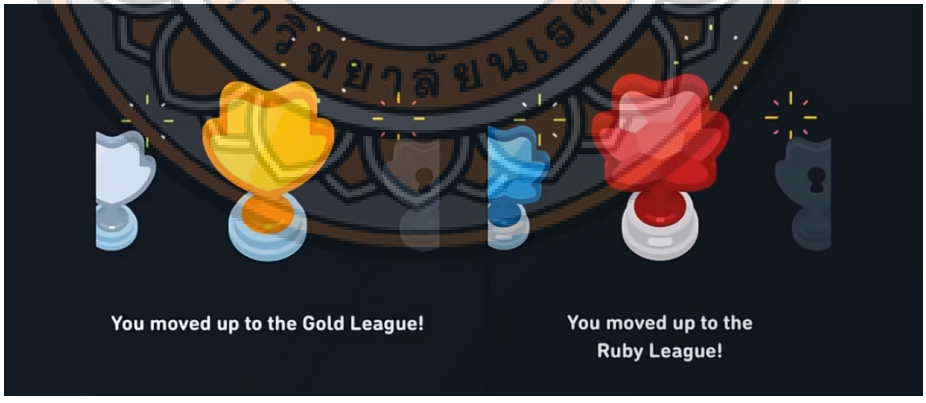



Figure 9 Real-time feedback interactive animation interface

Source: “XiaoHongshu” application from China, 2023

Furthermore, interactive animations serve both entertainment and educational purposes. Overemphasizing entertainment can obscure learning objectives, while overemphasizing knowledge transfer may diminish children's interest (Figure 10). Therefore, design principles should achieve a dynamic balance between fun and

education through storytelling, character interaction, and reward mechanisms.

Figure 10 Interactive animation entertainment interface

Source: “XiaoHongshu” application from China, 2022

Interactive animations require the integration of multimodal elements such as visual, auditory, and tactile components to enhance immersion and learning outcomes (Mayer, 2009). For instance, synchronized visual and auditory cues significantly improve children's comprehension and memory. In mobile device environments, interactive methods like touch and drag further enhance active learning.

In traditional Chinese cultural education, interactive animations must account for regional and cultural contexts. For instance, incorporating localized symbols and festive scenes can strengthen children's cultural identity and learning engagement.

**2.5 Interaction design methods for children**

With the advancement of Human-Computer Interaction (HCI), children as a distinct user group have increasingly garnered attention from both academia and industry. Children's cognitive development levels, emotional needs, and physical operational characteristics differ significantly from those of adults. Therefore, interaction design targeting children requires specialized methodologies and research paradigms (Hourcade, 2008).Preschool children, in particular, are in a stage dominated by exploration and intuitive thinking. Interaction design approaches for this age group must place greater emphasis on sensory experiences, contextualized operations, and supportive learning environments.

The core principle of children's interaction design is “child-centeredness.” (Figure 11)This requires researchers and designers to fully understand children's interests, capabilities, and limitations throughout the development process. For instance, Stålberg et al. (2016) emphasize that children should participate in the design process as “design

partners" rather than passive users. In this approach, children not only provide feedback but also actively engage in concept generation and interface iterations.

Figure 11 Interactive animation app for children

Source: "XiaoHongshu" application from China, 2022

Participatory design emerged from this design methodology (Figure 12). Research by Van Mechelen et al. (2016) indicates that when children are directly involved in brainstorming, prototyping, and testing, products tend to better align with their actual usage needs. Furthermore, participatory design enhances children's sense of self-efficacy and creative expression.

Interaction design for children should fully consider their socio-cultural and educational contexts. Masood & Thigambaram (2015) propose that usability testing should employ contextual tasks rather than abstract operations to more authentically reflect children's usage experiences. Concurrently, experience-based design emphasizes engaging children through role-playing, scenario simulations, and narrative approaches to enhance learning motivation and immersion.

Figure 12 (Cont.):

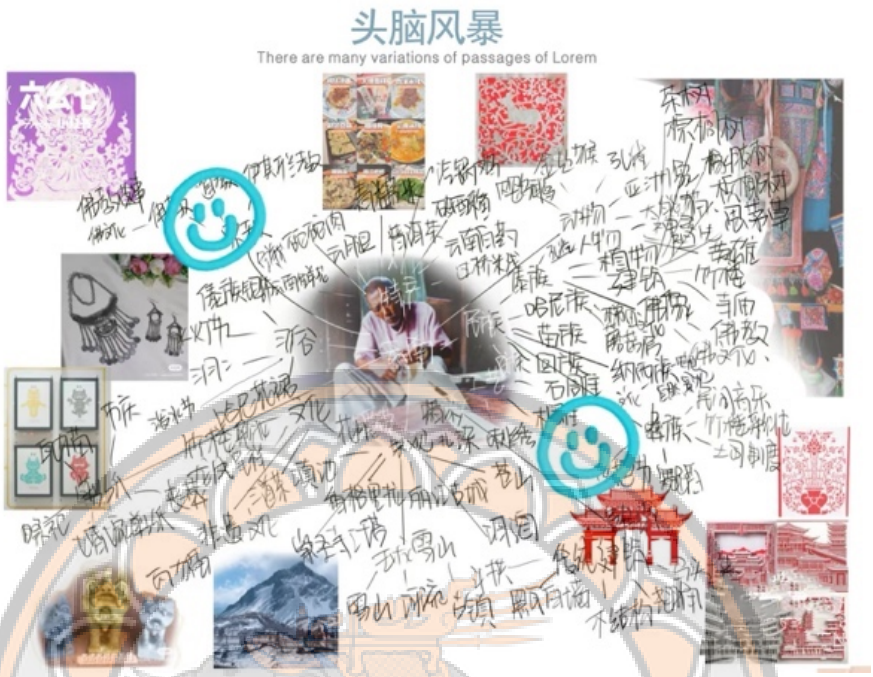



Figure 12 Brainstorming demonstration diagram

Source: “XiaoHongshu” application from China, 2020

Given children's limited cognitive and attentional capacities, some researchers emphasize integrated designs incorporating multimodal interactions (Dritsas et al., 2025).For instance, in interactive animations for mobile or tablet platforms, drag-and-drop actions, taps, and auditory feedback can effectively enhance children's focus and learning outcomes. Furthermore, gamification is widely applied in children's interaction design, using points, rewards, and virtual character companionship to foster sustained learning engagement (Figure 13).

Figure 13 (Cont.):

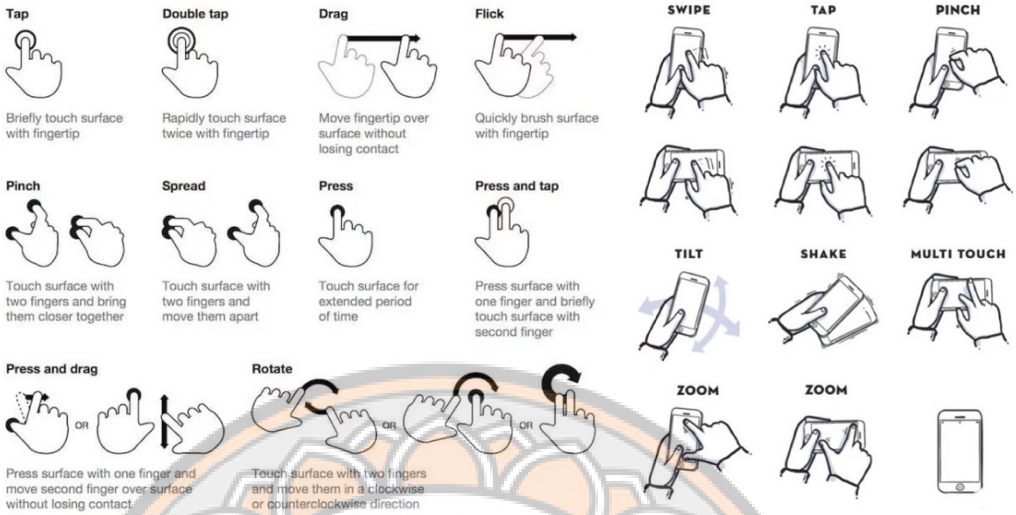



Figure 13 Multimodal interaction gesture diagram

Source: “XiaoHongshu” application from China, 2021

Additionally, interactive objectives and content must align with children's age, experience, and developmental stage. As digital products become increasingly prevalent, researchers have also raised sustainability concerns,such as how to prevent excessive screen time, protect privacy, and balance online and offline learning.

**3. Interactive animation for children**

**3.1 Definition of interactive animation for children**

Children's interactive animation refers to a form of animation designed specifically for children that has interactive functions and combines education with entertainment. According to the design principles of interactive animation for children, interactive animation for children should suit the age characteristics, cognitive skills, and interests of children. Based on Piaget's theory of the “preoperational stage,” preschool children mainly rely on language, images, and actions to express their thoughts. Therefore, interactive animation not only serves as a bridge for children's emotional connections in its design, but also more deeply reflects the characteristics of their cognitive development stage (Fan et al., 2022).

Research shows that the design of elements in interactive animation has a significant impact on children's cognitive, emotional, and behavioral development (Chen, 2022). In this case, the design of interactive animation not only needs to take into account teaching objectives, but also needs to be designed according to children's

cognitive development characteristics and aesthetics (Li et al., 2022). Interactive animation relies on graphic, audiovisual, and operable elements in its design (Gieryic, 2024). Dahlan et al. (2023) believe that the core characteristics of interactive animation include interactivity, feedback, participation, and adjustability. These characteristics differ from traditional linear animation and are more suitable for constructivism and situational learning theory. In practical applications, these characteristics are not only reflected at the technical level, but also in educational value through interaction (Barut & Dursun, 2022). For example, when interactive machines play the role of "teachers," friends, or "animals," children respond in an emotional way, provoking thought and integrating themselves through language and behavior. This immersive symbolic interaction stimulates children's language expression, emotional recognition, and social comprehension (Hikmah et al., 2024).

**3.2 Design elements of interactive animation for children**

In specific designs, some researchers emphasize the basic principles of clear images, concise language, and moderate rhythm (Chuang & Jamiat, 2023). Children learn through specific visual, auditory, and tactile experiences, so the coherence of the animated plot, character design, vivid colors, and rhythmic music and sound effects are all important design elements that affect learning outcomes. Son & Butcher further proposed in 2024 the importance of tactile elements in interactive animations for children, suggesting that age-appropriate tactile elements can help improve children's memory. Cheng et al. (2024) also pointed out that simple and easy-to-use operations, such as tapping or swiping, can help children concentrate better and complete learning tasks. The integration of multisensory information combining visual, auditory, and tactile elements not only attracts children's interest but also improves their comprehension of the learning content.

In 2020, Lin carefully divided interactive animation into Storyline, Character, Color, Music, and Sound (Lin, 2020). Then, in 2021, a theory was proposed on the role of Touch Element integration in interactive animation. In order to better integrate the research results, researchers sorted through the research theories of many scholars and provided a comprehensive design framework (Table 1). Based on the classification of interactive animation elements, children's ages, and children's cognitive dimensions (Perception, Attention, Thinking Skills) (Piaget, 1952), they explored the interactive

methods suitable for children at each stage and their cognitive support paths.

Table 1 Summary table of children's interaction methods and cognitive development support pathways

| | | Perception ■ Attention ● Thinking Skills ▲ | | | |
|---|---|---|---|---|---|
| **Interaction Elements** | **Age** | **Cognitive skill** | **Age** | **Cognitive skill** | **References** |
| | **3-4** | **Applicable** | **5-7** | **Applicable** | |
| Plot | • Repetition<br>• Cause and Effect | ▲ | • Exploration<br>• Tasks | ▲ | Fan et al.,2021<br>Korat et al.,2016 |
| Character | • Round/Ellipse | ● | • Triangle, Square | ● | Calvert,2020<br>Lillard et al.,2015 |
| | • Passive | ▲ | • Active | ▲ | |
| | • Simple Props<br>• Props follow the Plot | | • Complex Props<br>• Props Upgrade | | |
| Color | • Basic Colors | ● | • Distinguish between Distinct Color Luminance | ● | Ji et al.,2025<br>Hou & Huang,2017 |
| | • Perceived Emotional Warmth | ■ | • Perceive Complex Emotions | ■ | |
| | • Obvious Psychological Implied | ▲ | • Obvious Psychological Implied | ▲ | |
| | • High Brightness | ● | • High Brightness | ● | |
| Music and Sound | • Receive Music | | • Recognizing Music | | Wang,2018 |
| | • Expressing Emotions | ■ | • Expressing Emotions | ■ | |
| | • Clarity of Sound | ● | • Guided by Sound Effects | ● | |
| | • Sound Effects should not be too Long | | Sound Effects should not be too Long | | |

| | | | | | |
|---|---|---|---|---|---|
| Touch Element | • Click<br>• Drag | ● | •Click<br>• Drag<br>• Slide<br>• Rotate | ● | Li et al.,2022 |

Source: Fan et al.,2021 ; Korat et al.,2016 ; Calvert,2020; Lillard et al.,2015; Ji et al.,2025; Hou & Huang,2017; Wang,2018; Li et al.,2022

**3.3 Artistic styles of interactive animation for children**

The artistic stylization of interactive animation for children refers to the unique characteristics presented in visual expression, character design, and plot in animated works primarily aimed at children. This style aims to satisfy the aesthetic needs, cognitive abilities, and psychological development of child audiences. The artistic stylization of interactive animation for children can be broadly divided into the following styles:

1. Form style

The stylistic form of children's interactive animation is more aligned with children's aesthetic preferences. Compared to general interactive animation, children's interactive animation features a more pronounced stylistic form. For instance, children tend to prefer vibrant colors, so animation design should employ rich color combinations to make the visuals more appealing (Li, 2025). For example, red typically symbolizes passion, vitality, and love, while blue represents calmness, composure, and melancholy.Through the use of color, children's interactive animation works can create a unique emotional atmosphere (Ma, 2023), which is also a consensus among creators. Additionally, in the selection of stories, attention should be paid to guiding children toward correct values. The artistic style should adhere to principles of safety and health, avoiding violent, terrifying, or other inappropriate content to ensure the mental and physical well-being of children.

2. Content style

Children's interactive animations first expose children to the characters within the animation. The characters in children's interactive animations should be created through visual representation, personality traits, and behavior to be attractive and influential. Children' prefer characters with cute and lively characteristic. Therefore, character designs should feature vivid, interesting shapes and movements. Since children have weaker comprehension abilities and attention spans compared to adults, character

designs should be simple and clear to facilitate recognition and memory (Sun, 2009). When designing characters, creators should ensure that each character has unique personality traits, behaviors, and language styles, making them easy for children to understand and imitate (Sun, 2009). Characters in children's interactive animations should possess a certain level of imagination to inspire children's thinking and creativity.

3. Cultural style

When designing interactive animations for children, designers should place greater emphasis on inspiration and education. Animations rich in cultural content can serve as educational tools, helping children learn knowledge in a more vivid and intuitive manner (Wei, 2023). Additionally, children's interactive animations exhibit cultural diversity, and those with multicultural characteristics can help children understand different cultures and cultivate cross-cultural communication skills (He et al., 2015).

**3.4 Use of interactive animation among preschool students in China**

The use of electronic devices among preschool students in China has gradually increased in recent years (Zhou et al., 2023). With the development of technology and the popularization of smart devices, more and more preschool children are beginning to come into contact with and use electronic devices such as tablets, smartphones, and televisions.

According to surveys, preschool students are spending more and more time using electronic devices (Xiao, 2018). They may use electronic devices at home to watch cartoons, play games, etc., or they may use electronic devices in preschool institutions for learning and entertainment activities. Some preschool institutions have begun to use electronic devices as teaching tools (Zhang, 2024). They may use electronic devices for teaching activities such as playing educational videos and using educational software.

The use of electronic devices in early childhood education varies depending on the educational objectives set by different kindergartens. In comparison, more developed regions in China are better equipped to utilize electronic devices in teaching, while less developed regions, constrained by economic factors, have lower usage rates (Xu & Yan, 2022). Additionally, teachers' differing pedagogical philosophies and teaching styles influence their attitudes toward the use of interactive animation.Some teachers may prefer using interactive animations to stimulate children's learning interest, while others may place greater emphasis on hands-on experiences and practical activities.

With the development of technology and social progress, parents' demand for interactive media devices in kindergartens has gradually increased. They hope that these devices can provide more learning resources and educational content to promote children's learning and development. Specifically, this includes the following aspects:

1. Diversification of equipment types

The interactive media devices used in kindergartens are now diverse, including electronic whiteboards, smart TVs, and tablet computers. These devices can provide rich educational resources and multimedia content to help young children better understand and learn knowledge.

2. Changes in instructional methods

The use of interactive media devices has transformed teaching methods in kindergartens (Wang, 2016). Traditional lecture-based teaching is gradually being replaced by game-based teaching, experiential teaching, and inquiry-based teaching. Young children can participate in teaching activities through interactive media devices, actively learning and exploring.

3. Diversification of educational resources

Interactive media devices provide kindergartens with more educational resources (Qian, 2019). Teachers can access rich educational content and learning resources via the Internet, providing young children with more learning opportunities and experiences.

According to research, the primary reasons for the lack of widespread use of interactive media devices in Chinese kindergartens include traditional educational concepts (Guo, 2022), financial and equipment constraints (Huang, 2024), insufficient technical skills and training among teachers (Guo, 2025), uneven distribution of educational resources (Qian, 2019), and parental attitudes and needs.Parents hold conservative attitudes toward the use of interactive media devices in kindergartens, expressing concerns that overreliance on such devices may hinder children's learning and development. Additionally, interactive animated content for children may lack depth and educational value, instead prioritizing commercialization and entertainment, resulting in varying content quality. Such content may have negative impacts on children's psychological and behavioral development.

According to a 2019 questionnaire survey of kindergartens in county-level cities, kindergartens expressed the following views on teachers' attitudes toward interactive

media: Interactive animation for children can be used as an educational tool to help young children learn and master knowledge. Through vivid and interesting animated content, it can stimulate children's interest in learning and improve their learning outcomes. However, interactive animation for children can serve as an auxiliary teaching tool but should not replace traditional teaching methods and practical activities.

**3.5 Problems with the design of interactive animation for children in China**

Chinese interactive animation for children has made significant progress in recent years. With the continuous advancement of animation production technology, Chinese interactive animation for children has seen significant improvements in visual effects and image quality. Chinese families place great importance on their children's education, which has led to enormous market potential for interactive animation for children. Parents are willing to purchase educational and entertaining animation products for their children, creating a broad market space for the animation industry.

However, some common issues have also emerged in terms of design approach. In China's interactive animation market for children, many works rely too heavily on foreign animation and lack original content with Chinese characteristics. This weakens the competitiveness of Chinese animation in the international market and makes it difficult to establish a distinctive brand presence (Mao, 2023). Many interactive animations for children feature repetitive plotlines, such as love stories between princes and princesses or brave heroes on adventures, lacking novelty and innovation.In children's interactive animation, character design is often overly simplistic, lacking personality and distinctiveness. This makes it difficult for characters to leave a lasting impression on children and fails to stimulate their imagination.

Additionally, some interactive animations targeting children currently face an imbalance between educational and entertainment content design (Fan et al., 2022). On one hand, some animated works overly emphasize educational functions, leading to simplistic plot structures and visually unappealing designs, thereby weakening the works' entertainment value and visual appeal. Such animations, due to deficiencies in narrative strategies and aesthetic experiences, often fail to sustain children's attention and reduce their actual educational effectiveness. On the other hand, some animated works, in an effort to cater to children's sensory stimulation and entertainment needs, overly emphasize formal fun and dynamic expression while neglecting their essential

functions of knowledge transmission and value guidance (Du & Liu, 2012). While such animations may generate high viewing interest in the short term, they lack deep educational content and are unable to play a positive role in children's cognitive development and value formation.

Although interactive animation in China has made progress in both technology and content in recent years, there is still a certain gap compared to developed countries (Yang, 2019). Int eractive animation for children in China is still immature in terms of distribution, promotion, and profit models, making it difficult to meet market demand. This limits the dissemination of excellent animated works and further affects the development of the animation industry (Yang, 2019).

**3.6 Case studies of interactive animation design for children**

With the advancement of interactive technology and digital education, interactive animations for children have gradually emerged as a vital medium for promoting preschool education and cultural heritage. Analysis of representative domestic and international case studies reveals that interactive animations are not merely functional tools; their significance lies in how comprehensive design elements,including color schemes, character, costume, and sound effects,align with children's cognitive and aesthetic characteristics.

Taking the BBC's CBeebies Storytime as an example, this interactive animation app emphasizes high color saturation and contrast. Research indicates that approximately 76% of preschool children prefer bright, highly saturated reds, yellows, and blues in color selection.Character designs predominantly feature rounded geometric shapes, aligning with the “anthropomorphism tendency” observed in child psychology and aiding emotional resonance (Piaget, 1962). Regarding audio, the BBC design team specifically prioritizes gentle female narration paired with soft background music. Research indicates this sound profile effectively extends children's average attention span by approximately 18% (Lee, 2010).

In China, the interactive version of “Classical Chinese Stories: Interactive Edition” (Figure 14), a collaboration between Himalaya and CCTV Kids, serves as a prime example. Its color design extensively employs high-contrast hues like traditional Chinese red, blue-green, and gold, conveying cultural symbols while catering to children's psychological preference for vivid colors.Character designs lean toward

cartoon-style historical figures, using simplified lines and exaggerated expressions to make complex cultural knowledge more accessible to children. In sound design, the product emphasizes blending Peking Opera elements with nursery rhyme melodies. Research indicates this "culture-entertainment fusion" sound style significantly enhances children's recall of traditional cultural elements (Zhao, 2019).

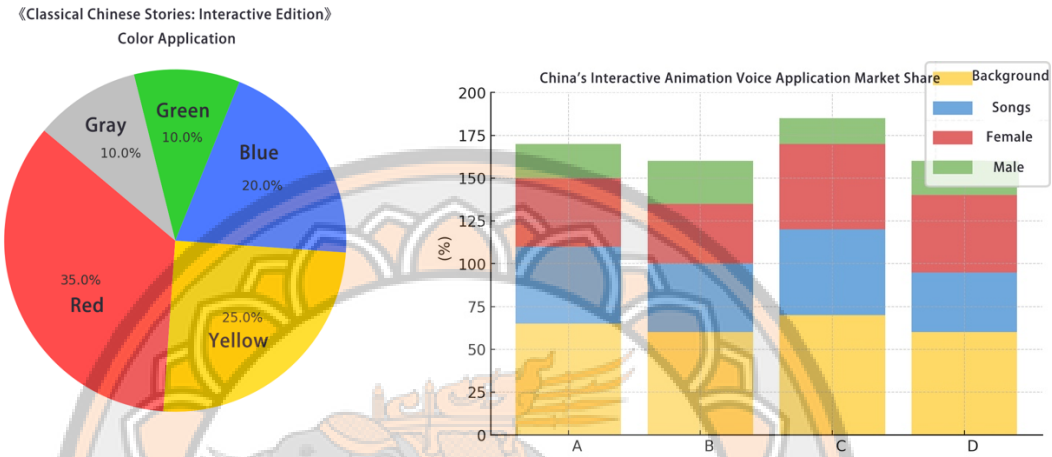



Figure 14 Color application for "classical Chinese stories: interactive edition"

Figure 15 Sound application diagram for Chinese interactive animation

Source: Himalaya & CCTV Kids, 2022

Analysis of multiple case studies reveals that color schemes in interactive animations for children predominantly feature high saturation and strong contrast (with an average of 68% of products using red, yellow, and blue as primary hues). Character costumes frequently incorporate cultural symbols, such as cloud patterns, auspicious clouds, and Hanfu elements in Chinese examples, alongside superhero attire and animal-themed anthropomorphic costumes in Western cases.

Sound not only serves a narrative function but also reinforces interactive feedback. For instance, Sesame Street Interactive in the U.S. plays 3–5-second reward sound effects (applause or laughter) when children complete tasks. In China, Dr. Panda Learn Chinese Characters provides learning contexts through multi-voice nursery rhymes, enabling children to naturally acquire Chinese character structures through song.Research indicates that female narrators in children's interactive animations resonate more deeply than male voices, likely because softer tones are more readily accepted by preschoolers.Figure 15 presents the audio analysis tables for Chinese interactive animations: "Classical Chinese Stories: Interactive Edition" (A), "Dr. Panda

Learns Chinese Characters" (B), "Big Head Son & Little Head Dad Interactive Stories" (C), and "Baby Bus" (D). The tables reveal that background music is the most prevalent sound type, appearing in approximately 65% of cases, highlighting its importance in sustaining children's attention and creating a learning atmosphere.The usage rate of nursery rhymes/children's songs approaches 50%, reflecting a trend in children's interactive animations to integrate cultural elements or language learning through music. Female voiceovers are more frequently employed than male ones.

These characteristics indicate that outstanding interactive animations for children typically spark interest through the appeal of colors and imagery, then sustain attention and learning motivation with sound and feedback mechanisms. This insight provides a practical approach for interactive animation design, particularly in traditional cultural education where cultural identity can be enhanced through symbolic costumes, music, and narrative styles.

**4. Human-Computer Interaction (HCI)**

**4.1 Meaning of HCI**

Human-computer interaction (HCI) refers to the interaction between humans and machines. It is a medium of communication characterized by interactivity, digitization, and personalization. Digitization is the essence, interactivity is the form of expression, and personalization is an extension. The essence of HCI lies in the mutual interaction between the two parties. This interactivity enables communication in the public domain to have not only the characteristics of mass communication but also those of interpersonal communication (Hassan et al., 2024).

Multimedia technology integrates information in various forms, such as text, graphics, images, animation, and sound, and processes and controls them through computers to support a series of interactive operations (Johannsen, 2009).In HCI, multimedia technology plays a crucial role, enriching the interactive experience and making interactions more vivid and effective. HCI is widely applied in various scenarios, such as smart homes, virtual reality, gaming, education, and healthcare. With the continuous development of artificial intelligence technology, HCI will become increasingly prevalent.

### 4.2 HCI and emotional

HCI refers to the communication and interaction between humans and machines, while emotional enhancement refers to the use of technological means to enhance people's emotional experiences and emotional communication (Sun et al., 2019). In HCI scenarios, emotional enhancement technology can simulate human emotional expressions, providing users with richer and more authentic emotional experiences. This helps improve user satisfaction and encourages users to become more engaged in the human-computer interaction process. Emotional enhancement technology can simulate human emotions (Tang et al., 2024), helping people better express and understand emotions, thereby enhancing interpersonal communication. For example, in virtual reality and gaming scenarios, emotional enhancement technology can create stronger emotional resonance between people and virtual characters, enhancing the realism and immersion of interactions. Through emotional enhancement technology, people can more accurately understand their emotional states (Tang et al., 2024) and take appropriate measures to adjust their mindset and behavior. With the development of artificial intelligence technology, the application of emotional enhancement technology in human-machine interaction will become more widespread in the future.

When the theoretical frameworks of HCI are integrated into cultural expressions such as political communication, advertising, and product design, HCI serves as a means of emotional expression and propaganda. This provides an opportunity for the development of HCI content, making it a tool for cultural exchange and communication in the context of new media (Lewis et al., 2019).For example, human-machine interaction can be further explored in terms of audiovisual language and the expression of social emotions. Highly immersive human-machine interaction employs virtual narrative techniques to place viewers in a lifelike environment (Wang, 2024). This sense of identification can become a new form of cultural expression, reinforcing emotional memory through immersive aesthetic experiences and transforming passive reception into active engagement or even active creation of beauty.

The development of HCI goes through five stages: connection, integration, interaction, transformation, and presentation (Figure 16) (Preece et al., 2015). First, HCI connects the observer with the interactive device, enabling the observer to interact with others through the system and convert their intentions into the machine. This results in

the emergence of new images, requiring the observer's full engagement throughout the process. Next, HCI involves the processes of interaction and transformation. These two processes are a means of producing beauty, transforming the visual experiences gained through HCI into emotional interactions with virtual reality. This is a process of forming aesthetic visual perceptions through interaction with machines and transforming them into emotional interactions. The significance of this lies in the transformation of emotions from the real world through a series of interactive behaviors. Finally, the presentation of human-machine interaction is a process of aesthetic and cognitive perception. This requires human-machine interaction to have mass appeal. Creators must consider the audience's internal psychological structure and emotional experiences after the experience when initially designing the interaction. Only then can creators achieve spiritual resonance with the audience.

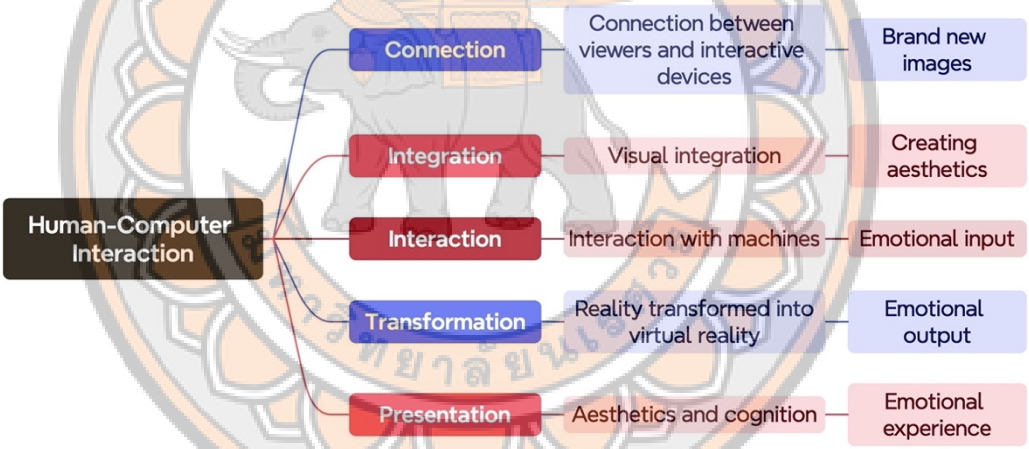



Figure 16 Schematic diagram of the HCI process

Source: Preece et al., 2015

**4.3 Child-Computer Interaction (CCI) and cognitive strategies for children's learning skills**

HCI has become a key component of current digital technology development, especially in virtual scenario applications that emphasize user experience and emotional expression. According to the “HCI cognitive psychology” perspective, HCI systems can recognize and respond to user emotions (Gupta et al., 2022). It has been observed that when users actively participate in the interaction process, they exhibit higher satisfaction and loyalty (Zheng et al., 2024).

Against this backdrop, the emotional connection between children and machines is believed to stem from young children's intuitive experiences with social behavior, verbal communication, and socio-emotional interactions. These early experiences are increasingly simulated through multimodal interaction technologies, thereby activating children's social cognition toward interactive machines (Rohlfing et al., 2022).

Children in the "preoperational stage" can express their thoughts through symbols such as language, images, and actions. Child-Computer Interaction (CCI) systems are well-suited to provide highly symbolic and concrete interactive objects for children in the preoperational stage. The language system within CCI has also been shown to aid children in developing thinking processes, thereby promoting the development of language symbols and expressive skills (Ale et al., 2022). When children interact with virtual characters within the system, they assign them a certain "role" identity, which facilitates deep emotional connections and cognitive transfer.

**4.4 HCI design principles for children**

Compared to adult users, children exhibit significant differences in cognitive abilities, operational habits, attention span, and learning motivation. These differences impose specific requirements on interface design. First, children's cognitive development is characterized by distinct stages and diversity, primarily manifested in attention, memory, language comprehension, and problem-solving abilities (Piaget, 1952).Research indicates that children of different age groups process information differently: Preschoolers (3–6 years) primarily rely on concrete imagery thinking and have limited comprehension of abstract symbols and complex instructions; younger elementary school children (6–9 years) gradually develop logical reasoning abilities but remain susceptible to information overload (Piaget, 1952).Addressing these characteristics, HCI design should prioritize simplified information presentation and reduced visual and operational load. Visual aids such as images, animations, or sounds can enhance comprehension (Hatira & Sarac, 2024). Intuitive interactions like dragging and touch controls leverage children's sensory experiences to facilitate learning and operation.Integrating visual, auditory, and tactile feedback helps children comprehend interface functions and operational outcomes. Interface content and task difficulty should align with children's age and cognitive abilities, avoiding excessive complexity or monotonous repetition.(Figure 17).

Figure 17 (Cont.):

Figure 17 Children's interactive animation user interface

Source: “XiaoHongshu” application from China, 2020

Children exhibit distinct operational habits when using electronic devices, such as preferring direct finger touch over precise tapping, favoring large icons and vivid colors, and tending to overlook complex menus and multi-step procedures.Additionally, children often exhibit exploratory behaviors during operation, including random tapping, repeated attempts, and rapid task switching. Therefore, buttons in children's interactive animations should feature enlarged dimensions and larger interactive areas to minimize accidental taps. Complex tasks should be broken down into manageable subtasks, making them easier for children to understand and complete.

Feedback mechanisms are an indispensable component in children's HCI. They not only provide information about the results of actions but also enhance learning motivation and interface usability. Immediate, intuitive feedback,such as sounds, animations, or visual changes,helps children understand the outcomes of their actions while encouraging exploration. It also allows for timely correction of errors, preventing frustration caused by negative feedback.Interactive animations combine visual, auditory, and tactile feedback to enhance information delivery and enrich the interactive experience. Adjusting feedback frequency and format according to children's operational habits and cognitive levels improves interface adaptability and educational effectiveness.

**5. Traditional Chinese Culture**

**5.1 Content of traditional Chinese cultural**

Chinese traditional culture refers to the collective term for the ideas, value systems, artistic forms, moral standards, and social customs accumulated by ancient China. Chinese traditional culture possesses profound connotations and a deep historical foundation. With its unique characteristics and value concepts, it has exerted a profound influence on Chinese society. Chinese traditional culture encompasses a wide variety of artistic forms, such as music, opera, dance, calligraphy, painting, and sculpture. It is also renowned for its vibrant festivals and customs, including the Spring Festival, Qingming Festival, Dragon Boat Festival, and Mid-Autumn Festival. These festivals and customs not only serve as occasions for celebration and worship but also play a crucial role in the transmission and promotion of traditional culture (Zhang, 1996).

The learning of traditional Chinese culture is an important subject for preschool students in China (Xie, 2025). From early childhood, family members provide children with home education. When children reach preschool age, traditional Chinese culture courses are also offered in kindergartens and other institutions, and these courses account for a large proportion of the curriculum (Li, 2024).

Preschool children primarily engage with Chinese traditional culture through several key areas. First, they learn about the origins and celebration practices of traditional festivals such as the Spring Festival, Qingming Festival, Dragon Boat Festival, and Mid-Autumn Festival, gaining an understanding of the cultural meanings embedded in these occasions. They are also introduced to traditional customs such as pasting Spring Festival couplets, making zongzi (rice dumplings), and moon-gazing during the Mid-Autumn Festival.

Some tutoring institutions offer specialized classes in calligraphy, painting, and dance. Preschool children learn about the characteristics and techniques of traditional Chinese painting, master basic brushstrokes and calligraphy styles, and gain an understanding of traditional musical instruments and the fundamentals of dance movements. In terms of books, most parents of preschool students purchase stories and legends about Chinese traditions, such as 《The Stories of Confucius》 and 《The Legend of the White Snake》. Through reading and retelling these stories, students learn about moral education and cultural values. Many preschool parents choose to tell

these stories to their children in a narrative manner. Kindergartens also offer some handicraft courses to help preschool students better understand traditional Chinese culture, such as paper cutting, embroidery, and clay modeling.

**5.2 Chinese kindergarten curriculum**

The Chinese kindergarten curriculum refers to educational content designed for children aged 3-6, aimed at promoting their comprehensive development. The content and structure of kindergarten curricula vary significantly among kindergartens, primarily based on their actual implementation (Zhu, 2014). However, every kindergarten has a basic curriculum framework, such as:

1. Language: Language learning in kindergarten mainly includes the learning of the mother tongue (such as Mandarin Chinese) and foreign languages (such as English). Mother tongue learning aims to help young children master basic language skills and communication skills, including training in listening, speaking, reading, and writing (Angong, 2015). Language learning focuses on cultivating young children's language sense, phonetic imitation skills, and basic language communication skills (Cheng, 2013).

2. Mathematics: Mathematics is an important component of preschool education, aimed at helping young children gain an initial understanding of basic mathematical concepts such as numbers, quantities, positions, and shapes. Kindergartens have courses designed to develop children's mathematical thinking and problem-solving skills, such as recognizing numbers, counting, classifying, sorting, comparing, and measuring. Children are also able to use these concepts to make simple inferences and judgments. The study of numbers includes the recognition and understanding of natural numbers, as well as simple addition and subtraction operations.

3. Chinese classical studies: The curriculum may include historical stories, myths and legends, folk art, seasonal festivals, and poetry and prose. These topics can broaden children's horizons and thinking, and stimulate their curiosity and desire for knowledge. During the teaching process, kindergartens may use storytelling, singing nursery rhymes, and playing games to allow children to experience the noble virtues of traditional culture in a relaxed and joyful atmosphere, thereby subtly cultivating good moral habits (Li, 2019).

4. English: The content of English learning in kindergartens is usually relatively simple, mainly consisting of everyday expressions, simple vocabulary, and sentence

patterns. During the teaching process, kindergartens may use methods such as scenario simulation, role-playing, songs, and games to allow young children to learn English in a relaxed and enjoyable atmosphere, thereby enhancing their interest and enthusiasm for learning (Li & Han, 2019). At the same time, kindergartens also focus on cultivating young children's interest in learning English and building their confidence, laying a solid foundation for their future English learning.

5. Science: Scientific inquiry aims to stimulate children's curiosity and cultivate their observation and hands-on skills through exploration in areas such as life science, material science, and earth and space science (Su et al., 2025).

**5.3 The current status of interactive animation applications in traditional Chinese culture education**

With the advancement of technology and the widespread use of smart devices, an increasing number of preschool children are beginning to use electronic devices. The amount of time preschool students spend using electronic devices is gradually increasing, and research and practice on “interactive animation + cultural education” are also becoming more diverse, gradually revealing the potential of interactive animation in promoting cultural enlightenment and cognitive development in preschool education (Bai, 2023).Some studies have also confirmed that interactive animation has a positive effect on promoting cultural learning among preschool students (Wang, 2021).

However, existing research has also revealed some common issues. Recent studies have shown that some cultural and educational content exceeds children's cognitive load (Luo & Lin, 2024). Interactive animation works should be created with a full consideration of the cognitive characteristics of preschool students, such as concrete imagery thinking, animism tendencies, and language development levels.While interactive animations in China currently feature strong interactivity, they lack effective educational value (Hu, 2021). One key reason lies in the absence of systematic design principles based on children's cognitive differences, making it difficult to achieve genuine educational support. Furthermore, the educational outcomes of interactive designs lack effective evaluation mechanisms, making it challenging to measure the specific pathways through which they enhance children's understanding and creativity.

**6. The current status and educational practices of preschool education in China**

### 6.1 The development of preschool education in China

With the continuous improvement of China's education system, the status of early childhood education within the national education framework has been gradually elevated, showing a trend of comprehensive development characterized by greater accessibility, diversity, and quality (Sun, 2025).The government has placed high importance on the expansion of early childhood education. According to data from the China Education Development Strategy Society (2024), by the end of 2024, the gross enrollment rate in preschool education nationwide had reached 92%, achieving the target set for 2025 in the 14th Five-Year Plan ahead of schedule. This indicates a significant expansion in the coverage of early childhood education.

However, despite the continuous increase in enrollment rates, there remain significant regional disparities in the distribution of educational resources. First-tier cities and economically developed regions enjoy relatively superior resource allocation, while rural and underdeveloped areas continue to face severe resource shortages (Tan et al., 2025).Meanwhile, improving the quality of preschool education has become a key focus of national policy. In recent years, the Chinese Ministry of Education has actively promoted the transformation of preschool education from a "care-oriented" to an "education-oriented" model, achieving certain results in areas such as teacher training and curriculum optimization (Official website of the Ministry of Education of the People's Republic of China, 2023).

Families are increasingly valuing preschool education, with more and more parents paying attention to the quality of early childhood education and actively choosing high-quality preschool education institutions. Against the backdrop of constantly evolving educational concepts, local governments and educational institutions in many places are also actively exploring paths for educational reform, such as promoting small class sizes and developing distinctive courses for kindergartens, with a view to building a more diversified and personalized preschool education system (Official website of the Ministry of Education of the People's Republic of China, 2023).

### 6.2 The development of preschool education concepts in China

With the development of China's economy and changes in education policy, China has shifted from a traditional, single teaching model to a diversified teaching model (Zhou, 2024). The most significant influence has been the change in educational

philosophy in Chinese kindergartens. The traditional Chinese kindergarten educational philosophy focused on teaching, explaining knowledge, and learning skills.

Now,the primary focus is on child-centered, comprehensive development, emphasizing play and experience, fostering creativity and social skills, and cultivating the overall quality of young children (Zhou, 2024). This includes play-based teaching, experiential teaching, and inquiry-based teaching. Learning and development are promoted through hands-on experience and practice (Table 2).

Table 2 Comparison of traditional and current educational philosophies

| | Traditional Teaching | Modern Teaching |
|---|---|---|
| Educational Philosophy | • Focus on knowledge transfer<br>• Disciplinary training<br>• Listening and obeying | • Child-centered<br>• Attention to the development of individual differences and interests of young children<br>• Focusing on the development of comprehensive qualities and abilities of young children |
| Teaching Method | • Didactic teaching<br>• Teachers focus on explanations and demonstrations<br>students are passive recipients | • Teaching with games<br>• Experiential teaching<br>• Inquiry-based teaching |
| Content | • Transmission of basic knowledge | • Pluralism；<br>• Language, math, science, art, physical education, etc.<br>• Creativity, social skills and general qualities |
| Teachers' Roles | • Role of knowledge transmitter and disciplinarian<br>• Discipline and order | • Interaction and communication<br>•Attention to individual differences in young children |

| | | |
|---|---|---|
| | | •Individualized instruction based on the developmental characteristics and needs of young children |

Source: Zhou, 2024

**6.3 The development of preschool education for students in China learning skills**

Currently, schools are placing greater emphasis on the cultivation of comprehensive literacy (Gao, 2018), focusing on developing students' literacy, including language, cognitive, social, and emotional development, and emphasizing the cultivation of students' independent learning skills and creativity. This includes cultivating students' language expression and communication skills through a variety of language activities; Through diverse games and practical activities, such as puzzles, classification, and exploration, students' observation skills, thinking abilities, and problem-solving capabilities are developed (Song, 2025); through group activities and teamwork, students' cooperative awareness, team spirit, and social skills are cultivated (Xu, 2021); through emotional education and emotional experience activities, such as emotional expression and emotional communication, students' emotional cognition and emotional regulation capacities are enhanced; Encourage the development of divergent thinking, imagination, and creativity. Through activities such as art, crafts, and games, cultivate students' creative thinking and creative expression skills.

Another significant development in education is the growing emphasis on the role of family education in China's preschool education (Yang, 2024). Kindergartens and educational institutions encourage parents to actively participate in school activities, providing students with guidance and support in family education to achieve educational objectives. For example, schools regularly organize parent-teacher meetings and parent training sessions to impart educational knowledge and parenting experience to parents, helping them better understand students' developmental needs. They also provide educational resources and activities, such as homework assignments, parent-child reading, and family games, to facilitate parental involvement in education and promote the in-depth development of family education (Chen, 2024).

In recent years, China's preschool education has also begun to focus on students with special educational needs, providing personalized educational services, including

special education support for children with disabilities and developmental delays (Li, 2024).Preschool education institutions tailor individualized education plans for students with special needs, which include customized learning plans, teaching methods, and instructional materials to meet their learning needs and development potential. These institutions also employ specialized special education teachers who possess the necessary professional knowledge and skills to effectively educate and support the learning and development of students with special needs (Cai & Shen, 2024).

**7. Children's Cognitive Development**

**7.1 Piaget's Theory of Cognitive Development**

1. Theoretical concepts

Piaget divided children's development into four stages: Sensorimotor stage (0–2 years), Pre-operational stage (2–7 years), Concrete operational stage (7–11 years), Formal operational stage (11 years and older) (Figure 18).He defined cognitive development as the process by which individuals, from birth onwards, adapt to their environment through activities that involve the cognition of objects and the demonstration of thinking patterns and skills in response to problem situations, with these skills changing as they grow older. He viewed children's cognitive development as a proactive process of construction that takes place through interaction with their living environment, emphasizing the interaction between internal and external factors.

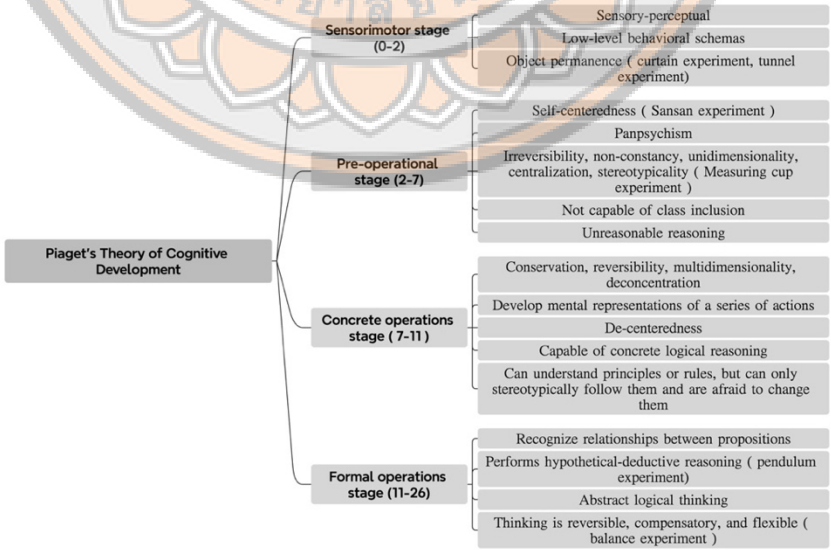



Figure 18 Piaget's cognitive development theory framework

Source: Piaget, 1952

Piaget's cognitive development theory includes several core concepts, namely “schema”, “assimilation”, “accommodation”, and “equilibration”.

1. 1 Schema: A schema is a fundamental concept in Piaget’s theory, referring to a structured pattern of behavior or thought. It enables individuals to respond to stimuli by organizing and categorizing information. Schemas help individuals make sense of the world by systematizing and structuring incoming information for comprehension and interpretation.

1.2 Assimilation: Assimilation is the process by which an individual incorporates elements of the environment into existing cognitive structures. In psychological terms, it refers to integrating external information into an existing or developing cognitive schema without altering the schema itself.

1.3 Accommodation: Accommodation involves modifying one’s existing cognitive structures in response to new stimuli that cannot be assimilated. When new experiences do not fit within current schemas, the individual adjusts or reconstructs those schemas to better align with the environment.

1.4 Equilibration: Equilibration is the process through which individuals maintain cognitive balance by shifting from one level of stability to a more advanced one. Cognitive development in children occurs through continuous cycles of assimilation and accommodation, helping them reach increasingly complex levels of understanding and maintain cognitive equilibrium.

2. Cognitive Development Characteristics of Children in the Pre-operational Stage

Pre-operational stage primarily occurs between the ages of approximately 2 and 7 (specific age ranges may vary slightly across different sources). During this stage, children are in the critical period of early childhood education and are highly sensitive to their sensory systems (Piaget, 1952). Researcher indicates that preschool children gradually develop symbolic representations during cognitive development, using language, actions, images, play, and drawing to represent concepts in the real world (Cartwright, 2024). However, their thinking remains relatively concrete and cannot yet engage in abstract operational thinking (Brouse & Chow). Characteristics of this stage include animism, egocentrism, inability to understand the relationship between the whole and its parts, and the irreversibility of thought.

First, during the pre-operational stage, children begin to develop symbolic representations through language, imitation, imagination, symbolic play, and symbolic drawing (Wu, 2013). They are able to transform external objects into internal symbols for storage and use in representational thinking, though this process is still somewhat rudimentary. However, they have already begun to develop the ability to use “symbolic” symbols (Callaghan & Corbit). Children’s begin to frequently use mental symbols (such as linguistic symbols and symbolic symbols) to replace external objects. This process is called internalization. The emergence of internalization represents a major intellectual advancement in children, enabling them to engage in “mental thinking” using symbolic formats within their minds. Therefore, this stage is also referred to as the mental thinking stage.

Secondly, children at this stage still rely heavily on concrete images and direct experiences for their thinking, making it difficult for them to engage in abstract logical reasoning (Robson, 2012). They tend to view the world solely from their own perspective, struggle to understand others' viewpoints, and have difficulty grasping the relationship between the whole and its parts. When a child's attention is focused on one aspect, they cannot simultaneously attend to other aspects. They can only grasp the static aspects of things and find it difficult to understand that things are dynamic, changing, and have intermediate states. They also struggle to comprehend the relativity of things. During thinking processes, children find it challenging to engage in reverse or inverted thinking (Gopnik, 2012). Children in the preoperational stage fail to recognize that when the superficial characteristics of an object change, its essential characteristics remain unchanged.

Finally, children at this stage can develop their logical thinking skills through experiential games and stories, helping them gradually overcome cognitive limitations such as egocentrism and rigidity.Research has confirmed that role-playing games are an effective method for understanding the development of children's symbolic abilities (Wirahandayani et al., 2023). If children can accurately portray various roles or use substitutes in games, it indicates that their symbolic abilities have developed to a certain extent.

In the cognitive development dimension of children, perceptual, attention, and thinking are considered the three core components. Perceptual serves as the foundation for children's understanding of the external world and plays a decisive role in their ability to accept new information. The development of attention influences preschool children's sustained learning skills and task completion capacity. Thinking cultivate preschool children's problem-solving skills and logical reasoning abilities. These dimensions are widely applied in the fields of psychological development and early childhood education, providing theoretical support for the design of digital teaching media (McLelland, 2024).

3. Pre-operational Stage of visual perception development in children's art

Children in the preoperational stage increasingly develop the ability to use mental representations (Halford, 2014), a phenomenon that is particularly evident in the artistic works they create (Itczak, 2022). Children in this stage understand the world through symbolic representational schemas, using these schemas to express their emotions and ideas. Their sensitivity to visual stimuli gradually increases,they begin to observe and understand the world around them in greater detail. Children in the preoperational stage possess rich imagination and creativity, enabling them to create new worlds and scenarios through imagination and symbolic play.

Previous studies have demonstrated that visual, auditory, and tactile senses are the three primary sensory elements influencing children's learning experiences in interactive animations (Deng, 2023). These elements not only form the foundational framework of interactive animations but also serve the function of conveying information and emotions to children (Parma et al., 2022). In 2020, Nansen emphasized in his book that digital media can promote children's active exploration and experimentation, and the involvement of touch can stimulate children's desire to persist and their learning motivation, thereby enhancing cognitive construction efficiency.

**7.2 Animism**

Animism is a typical characteristic of children in the preoperational stage, where children perceive certain unnamed objects as conscious, living, and sentient. They believe that everything in the external world is alive, perceiving, feeling, and possessing human-like qualities (Tylor, 1871). They often project human consciousness, motives, and intentions onto inanimate objects, such as treating toys as real companions in play

and talking to flowers, trees, and even the air.

Animism was first proposed by Taylor and later adopted by Piaget to describe a way of thinking characteristic of the early stages of children's cognitive development. Animism refers to the tendency of children in the preoperational stage to perceive non-living objects as possessing subjective consciousness (Piaget, 1952). Children's animations frequently feature various non-human characters such as animals, plants, and objects, which are often endowed with human emotions and will, possessing distinct personalities and characteristics.They all possess complex emotions such as joy, anger, sadness, friendship, and love, similar to humans. This easily evokes children's emotional resonance and projection.When children watch animation, they project their own emotions onto these characters, thereby gaining emotional satisfaction and comfort. In CCI, this animistic tendency is not only preserved but further activated by the development of interactive devices. It is precisely under this cognitive tendency that children are more willing to trust machines and establish a psychological foundation (Beran et al., 2011).

**7.3 Zone of Proximal Development Theory (ZPD)**

The Zone of Proximal Development（ZPD）(Figure 19) was proposed by Soviet psychologist Lev Vygotsky (1978). He believed that children's development occurs at two levels: the current level of development, which represents the level of development a child can achieve when solving problems independently; and the potential level of development, which represents the level of development a child can achieve with the assistance of adults or more capable peers. ZPD refers to the range between these two levels. The lower limit of the ZPD includes the most challenging tasks that children can already solve independently. The upper limit consists of tasks that children cannot solve even with significant assistance from others,these tasks require psychological functions that children have not yet begun to internalize. The psychological functions required for tasks within the ZPD are those that children have begun to internalize but have not yet fully developed.

ZPD is dynamic and constantly changing as children internalize more and more psychological functions. Effective mediators within the ZPD naturally shift its boundaries upward. Adults interact with children by asking them challenging questions and helping them solve problems. At first, adults may need to provide a lot of help, but

once children gradually learn how to solve these problems, the upper limit becomes the lower limit.

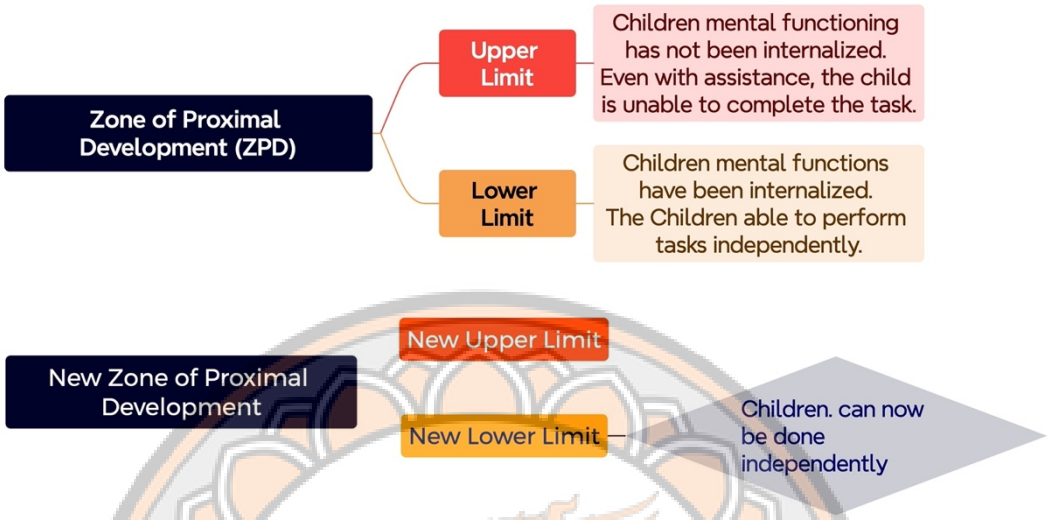



Figure 19 Logical diagram of the ZPD

Source: Vygotsky,1978

Vygotsky stated that the most effective way to educate children is to provide them with challenging materials and help them master these materials. Although children may initially require a great deal of assistance, as long as these challenges do not exceed the upper limit of their ZPD, they can facilitate cognitive development (Chaiklin, 2003).There is also a technique for assessing or testing children: the most effective test is not one where children complete a task independently, but rather one where they are given some assistance to complete a task. Such tests "not only assess the mature problem-solving methods that children have already developed," but also take into account "the problem-solving methods that are in the process of forming, maturing, and developing."

ZPD refers to the range of tasks that children can complete with the help of capable individuals. It represents the potential space for cognitive growth (Vygotsky, 1978). Research theories have confirmed that ZPD provides a dynamic, dynamic, and dynamic space for cognitive growth in CCI.The ZPD refers to the range of tasks that children can complete with the assistance of a more capable individual. It represents the potential space for cognitive growth (Vygotsky, 1978). Research has confirmed that the ZPD provides a dynamic and personalized feedback mechanism in CCI, thereby promoting

the development of children's cognitive and language abilities (Bodrova et al., 2024).

**7.4 Scaffolding**

The “scaffolding” was proposed by Bruner and developed and popularized under the influence of Vygotsky's “ZPD”.The “scaffolding” emphasizes that external support plays an indispensable role in children's cognitive development or task learning. When children are developing a particular cognitive function or attempting to complete a specific task, temporary, supportive assistance provided by teachers, parents, or more experienced individuals (Mermelshtine, 2017) is essential. This assistance includes guidance, prompts, encouragement, and demonstrations, with the aim of helping children complete tasks that are currently beyond their independent capabilities.The principle of scaffolding is similar: it provides support to children (the “construction workers”) as they develop the cognitive abilities (the “building”) needed to complete a task. It can take various forms, such as completing part of the task for the child, simplifying difficult aspects of the task, or speaking to the child or providing prompts during the task (van Kuyk, 2011). These actions help children complete the task and, in turn, help them navigate the necessary steps.Just like scaffolding in construction, cognitive scaffolding is not permanent but a temporary support structure that is gradually dismantled as children's cognitive functions mature (Verenikina, 2003).

**7.5 Research on the stages of cognitive, emotional, behavioral, and artistic development in early childhood**

The cognitive development process in children is complex and critical. During this stage, children's sensory perception gradually strengthens and develops rapidly, enabling them to better perceive and understand the world around them. Their vision and hearing gradually improve, allowing them to see objects and details more clearly, perceive colors more sensitively, and distinguish the direction and distance of sounds more accurately. Their sensitivity to language also increases (Siegler et al., 2017).

At the same time, children begin to be able to remember more information, with unintentional memory dominating (Cornoldi, 2013). They may unconsciously remember some information, such as songs or advertisements, while intentional memory gradually develops. They begin to consciously remember certain information, such as teachers' instructions or parents' reminders. As their memory capacity develops, they start using simple memory strategies, such as repetition and association

(Gathercole & Pickering, 2000). Language skills gradually improve, enabling them to express their thoughts and emotions more accurately. Their vocabulary expands, allowing them to master more words and phrases. Grammatical structures also become more refined, enabling them to use more complex sentences to express their thoughts (Nelson, 2014). Simultaneously, their ability to express emotions and feelings improves, allowing them to convey their thoughts and emotions more accurately (Denham, 2007).

Children's emotional development also tends to mature at this stage. Compared with the emotional characteristics of children under the age of 3, children at this stage are better able to accurately identify, express, and regulate their emotions (Denham, 2007). They begin to learn to use more complex language to describe their feelings and are able to understand the relationship between emotions and behavior (Hyson, 2004).

Children in the later stages of preschool also begin to develop self-awareness, able to reflect on their emotional responses and attempt to address emotional challenges in more positive ways (Denham, 2006). They experience intense emotional fluctuations, are easily influenced by external factors, and have limited self-regulation. Preschool children can express a variety of emotions such as happiness, sadness, anger, and surprise. These emotional expressions are typically direct and authentic, without hiding or masking, and their emotional fluctuations are often very intense and change rapidly. This intense emotional fluctuation is related to the fact that their cognitive and emotional systems are not yet fully developed and are easily influenced by external environments. They often rely on adult assistance and guidance to cope with various emotions.

Children's behavior primarily refers to their performance and development in social interactions and daily activities. During this period, children gradually form their own social skills through observation, imitation, and internalization of others' behavior (Bornstein, 2010). At the same time, children also exhibit a strong desire to learn and express their emotions. Their writing and calculation abilities can be guided through extensive reading and training, and they begin to learn to control their emotions, though their self-control remains limited.

Artistic enlightenment is an important educational process for children. Through art, children can promote the development of their overall cognitive, emotional, and social abilities. Artistic enlightenment during this period mainly goes through three

stages:

1. Squiggle stage (1.5-3 years old): Children's movements are uncoordinated, and they will randomly scribble on paper. This is a way for them to explore and control their hand movements.

2. Symbolic stage (3-5 years old): Children begin to use simple shapes to express their ideas, such as circles to represent heads and lines to represent arms and legs.

3. Schematic stage (ages 5–7): Children gradually develop relatively stable forms of expression and use repetitive patterns and colors to depict the world they know.

Through artistic, children can develop cognitive abilities, such as understanding the cause-and-effect relationships between pattern creation, and enhance fine motor skills: activities such as holding a paintbrush and using paint help develop the muscles involved in fine motor skills, which will help children manipulate objects with greater flexibility (Hojnor et al., 2024). At the same time, artistic education encourages children to express themselves freely and imagine, which helps stimulate their creativity.

**8. Learning skills**

**8.1 Components of learning skills in preschool students**

The learning skills of preschool students is a multidimensional and comprehensive concept encompassing cognitive, emotional, behavioral, and social aspects, forming the foundation for their early learning development .Zeng & Yu (2021) pointed out that learning skills refers not only to an individual's ability to acquire new knowledge and skills but also to their ability to apply them flexibly in new contexts. This skills is not merely an intellectual manifestation but depends more on factors such as strategies, motivation, perseverance, curiosity, critical thinking, and innovative awareness.

From a cognitive perspective, learning skills mainly include memory and thinking. Memory is the foundation for preschool children to accumulate knowledge and experience, and good memory facilitates effective encoding and retrieval of information. Thinking include logical thinking, abstract thinking, and creative thinking, which are important tools for children to solve problems and perform cognitive processing (Fuhs et al., 2020).

The emotional dimension is equally important in learning skills. Ryan & Deci (2000) divided emotional into three major aspects: motivation, attitude, and emotion management. Learning motivation is manifested in children's curiosity and desire to

explore knowledge, learning attitude reflects their sense of responsibility and persistence in learning, and emotion management is related to children's emotional regulation and coping skills when facing setbacks. All of these directly affect the continuity and effectiveness of the learning process.

In terms of behavioral skills, Sawyer (2014) proposed that independent learning skills, cooperative skills, and problem-solving skills are key elements. Independent learning is manifested in children's ability to complete tasks independently and choose learning methods; cooperative skills emphasize working with others to complete tasks and share experiences; and problem-solving skills reflect children's ability to apply knowledge and strategies when faced with challenges.

In addition, there are some basic abilities that also constitute learning skills, such as language expression and preliminary mathematical cognition, which lay the foundation for children's future formal education (Weiland & Yoshikawa,).

**8.2 The role of digital media in promoting learning skills in preschool education**

The learning and application of digital media are widely prevalent among preschool students in China today. Digital media can create vivid visual learning resources such as images, animations, and videos, which can capture the attention of preschool students and help them better understand and remember key concepts (Sihotang, 2020).Research shows that digital media effectively supports the development of preschool children's cognitive, emotional, and behavioral abilities by providing a multisensory, interactive, and personalized learning experience (Drigas et al., 2015). Presenting teaching content in a visual way can stimulate students' interest in learning and increase their motivation (Gilakjani, 2012). Digital media covers a wide range of knowledge areas, including science, art, and language, providing preschool students with diverse learning content. This diversity helps meet students' different learning needs and interests, promoting their comprehensive development.

Digital media provides preschool students with a platform for creation and expression (Behnamnia et al., 2020). Students can express their ideas, opinions, and emotions through digital art creation, such as painting and animation, thereby cultivating their creativity and expressive abilities (Kavak et al., 2024). The virtual environments and characters in digital media can also stimulate students' imagination,

encouraging them to engage in creative thinking and exploration. This creative thinking process is of great significance for the intellectual development of preschool students.

At the cognitive level, digital media presents information through multiple modalities such as animation, images, and audio, which helps stimulate children's attention and interest in learning and improves their understanding and memory of knowledge. Vivid content can help children establish connections between the concrete and the abstract, promoting the development of logical and creative thinking (Eckhoff & Urbach, 2008).

Emotionally, digital media can stimulate children's learning motivation and positive emotions through gamified learning (Lamrani & Abdelwahed, 2020).For example, through storylines, virtual characters, and feedback mechanisms, digital tools can enhance children's sense of self-efficacy and achievement, thereby improving their learning initiative and persistence. Additionally, some smart educational tools with emotion recognition functions can help children recognize and regulate their emotions, improving their emotional management skills (Fernández Herrero et al., 2023).

The digital media promotes children's independent learning and problem-solving skills (Fikriyah et al., 2021). Intelligent learning systems can provide personalized recommendations based on children's learning levels and rhythms, enabling them to independently choose learning content and paths. In the future, the digital media will become an important tool for preschool education. However, there are still many challenges that need to be addressed, such as the lack of appropriate content, the lack of appropriate teaching methods, and the lack of appropriate teaching methods.

According to previous research, the integration of digital media with interactive technology creates interactive learning experiences. Students can interact with virtual environments or virtual characters through the use of interactive software, virtual reality, and augmented reality technologies, thereby enhancing the fun and engagement of learning. Through interactive design elements such as clicking, dragging, and matching, children can deepen their understanding of knowledge while participating, fostering positive learning experiences. This interactive learning experience can also be personalized according to students' learning progress and interests, making learning more tailored to students' needs and ability levels. Parents and teachers can use digital media as an educational tool to provide students with more vivid and interesting

learning materials. At the same time, they can also use digital media to supervise and guide students' learning process to ensure learning effectiveness.

**8.3 The role of instructional model in promoting learning skills in preschool education**

Teachers' instruction models have a significant impact on the formation and development of children's learning skills (Kikas et al., 2016). Instruction models not only determine the presentation and organizational structure of teaching content, but also profoundly influence children's learning motivation, cognitive engagement, social interaction, and problem-solving skills. Research shows that diverse, interactive, and inspiring teaching methods can effectively promote the development of preschool students' learning skills in multiple dimensions, such as cognition, emotion, and behavior (Kalina & Powell, 2009).Teachers can help children master key learning skills and knowledge through effective teaching strategies and methods, ensuring they acquire essential foundational knowledge and skills, explain complex concepts, and transform abstract knowledge into easily understandable forms. By setting clear learning objectives, providing timely feedback, and offering rewards, teachers can motivate children to learn (Popovska Nalevska & Kuzmanovska, 2020).

Through systematic teaching, preschool teachers help children master subject knowledge and skills, laying a solid foundation for their subsequent learning. This includes not only book knowledge, but also practical skills and problem-solving abilities. At the same time, teachers focus on cultivating children's critical thinking and innovation abilities in the teaching process, encouraging them to think independently and explore courageously, which is crucial for the long-term development of children in the pre-operational stage.Multiple studies have shown that preschool teachers play a crucial role in fostering the development of good habits in children through systematic guidance and behavioral modeling in a collective educational environment. Their effects are particularly evident in specific behavioral domains, where they demonstrate a more significant advantage compared to family education (Pérez-Ferra et al., 2020).

Teachers continuously explore and implement diverse and innovative teaching methods and strategies to effectively enhance teaching quality and children's learning outcomes.Especially in the small class instruction model commonly implemented in the preschool stage, teachers are able to pay more attention to each child's learning feedback

and individual differences, and observe their performance and reactions in activities in real time. This teaching environment helps teachers make dynamic adjustments based on the specific learning situation of children and optimize teaching strategies and content to better suit their cognitive development level and interests. Also, teachers gradually establish a scientific and systematic learning assessment and feedback mechanism during the teaching process. They not only understand children's learning progress through observation, conversation, and work analysis, but also identify difficulties and problems in their knowledge understanding, skill mastery, or behavioral habits in a timely manner. Based on the assessment results, teachers can provide targeted guidance and individualized suggestions to help children make continuous progress on their existing foundation.

Currently, kindergarten teachers prepare a variety of learning materials, such as books, toys, and teaching aids, to satisfy children's curiosity and desire to explore and stimulate their interest in learning. Structured and gamified instruction models are widely recognized as important ways to promote children's cognitive growth (Satybaldiyeva et al., 2024).Ireland & Mouthaan (2020) proposed a “spiral curriculum structure,” emphasizing that repeatedly presenting concepts and gradually increasing cognitive depth helps children master abstract knowledge through concrete operations.

In practical teaching, teachers stimulate children's active thinking and logical reasoning abilities through storytelling, hands-on activities, and guided games, thereby improving their memory and language expression abilities. In addition, supportive instruction models used by teachers, such as emotional support, positive feedback, and individualized guidance, have been proven to effectively improve children's learning motivation and emotional regulation abilities (Merritt et al., 2012).Janson & King (2006) noted that emotionally warm teaching interactions can enhance children's sense of belonging and security, thereby promoting their active exploration and sustained learning. In a gentle and guiding environment, children are more willing to express their ideas, participate in activities, and develop positive learning attitudes.

In current Chinese early childhood education, cooperative learning and project-based learning are gradually becoming key teaching strategies in preschool education (Xiao, 2023). Teachers enhance children's collaborative awareness and problem-solving skills through group tasks, role-playing, and exploratory activities. This type of

instruction model emphasizes children's knowledge construction through social interaction in real or simulated situations, thereby exercising their independent learning and practical skills.In particular, teachers use small group activities, role-playing, and inquiry-based activities to help children develop their problem-solving skills and creativity. Heuristic and reflective instruction models have also been proven to help stimulate children's critical thinking and creativity (Paul, 2013). Teachers use questions, guidance, and encouragement to ask questions and express themselves, prompting children to think deeply about and develop their own understanding of the content. Compared with traditional indoctrination-based teaching, this type of model focuses more on children's subjectivity and the learning process, emphasizing “learning to study” rather than simply “what to do.”

Preschool teachers promote the comprehensive development of preschool students by understanding their interests and strengths, providing personalized guidance and support, promoting their cognitive development, stimulating their interest in learning, guiding their learning methods, improving their learning skills, and supporting their emotional and social development.

**9. Comprehension**

**9.1 Meaning of comprehension**

Comprehension refers to an individual's ability to accurately grasp the meaning, relationships, and underlying logic and intent of information when receiving, analyzing, and processing it (Cain & Oakhil, 2013). It is a core cognitive ability that is important for learning, communication, problem solving, and making informed decisions (Connor, 2016). Comprehension is divided into four areas: literal comprehension, contextual comprehension, logical comprehension, and deep comprehension.

1. Literal comprehension is the foundation of comprehension and involves the basic interpretation of words, symbols, or language. It requires individuals to accurately identify and understand the meaning of words, sentences, and paragraphs.

2. Contextual comprehension is based on literal comprehension, whereby individuals need to be able to connect information with its environment, background, or context in order to understand its meaning more comprehensively.

3. Logical comprehension requires individuals to analyze and understand logical relationships between pieces of information, such as cause-and-effect relationships,

comparative relationships, and classification relationships.

4. Deep understanding is a higher level of comprehension that involves in-depth analysis and interpretation of information to reveal underlying intentions, motivations, or deeper meanings.

Comprehension is crucial in learning. During the learning process, comprehension serves as the foundation for acquiring new knowledge and mastering new skills (Cain & Oakhil, 2013). Without strong comprehension skills, individuals may struggle to effectively learn and apply new knowledge. When faced with problems, individuals must first understand the essence and context of the problem to effectively develop solutions. When making decisions, individuals need to assess the advantages, disadvantages, and risks of different options based on accurate information and understanding.

Methods to enhance comprehension include: active reading, critical thinking, and engaging in questions and discussions with others on specific topics. These practices help individuals understand information from multiple perspectives, identify potential misunderstandings or ambiguities, and apply learned knowledge or understanding to real-world contexts. This process facilitates deeper comprehension and retention of the material (Rahmi, 2024). Reflecting on and summarizing one's learning process and understanding experiences can help individuals identify their understanding blind spots and improve their understanding strategies (Zimmerman, 2002).

**9.2 The role of interactive animation in cultivating comprehension in preschool students**

Comprehension is an essential part of the cognitive process, involving the reception, analysis, and application of information. For preschool students, this period is a critical stage in the rapid development of their cognitive abilities. Cultivating comprehension skills helps them to better understand the world around them and lays a solid foundation for their future learning and life.

Comprehension skills can enhance language and thinking abilities, and comprehension skills are closely related to language skills (Mustoip et al., 2023).During the process of understanding language information, preschool students not only expand their vocabulary but also learn how to use language to express their thoughts and feelings. This helps them improve their oral and written communication skills. By

cultivating comprehension skills, preschool students can learn how to analyze problems, make inferences, and develop more mature thinking patterns (Abdul Malik, 2024).

Digital media plays a significant role in enhancing preschool students' comprehension skills (Sovia & Silvio, 2024). Compared to traditional teaching methods, digital media utilizes various forms such as images, animations, sounds, and interactive operations to concretize and vividly present abstract knowledge, thereby helping preschool children construct more intuitive cognitive understanding of objects.Multi-sensory information input methods stimulate children's sensory systems, enhance their attention and engagement with learning content, thereby improving their ability to receive and process information.For example, in language learning, through digital picture books, voice recognition interactive programs, and other forms, children can not only hear standard language input, but also deepen their understanding of vocabulary and sentence meaning by combining images and scenes. In science education, virtual reality (VR) and augmented reality (AR) technologies can simulate real-world phenomena to help children establish preliminary cause-and-effect relationships and logical concepts, thereby improving their comprehension and reasoning abilities (Shaaban & Mohamed, 2024).

Digital media support feedback-based learning mechanisms, enabling children to receive immediate system prompts or corrective information during their interactions, thereby forming a learning cycle of “understanding,practice,feedback,re-understanding” (Bangert-Drowns, 1991).

Teachers can also use digital tools to monitor students' learning status and understanding levels in real time, providing timely personalized guidance (Gm et al., 2024). This flexible, adjustable learning environment not only enhances learning autonomy and adaptability but also provides more inclusive and targeted support for the development of comprehension skills.

Improved comprehension skills can help preschool students gain a deeper understanding of knowledge content and, to a large extent, stimulate their interest in learning and improve their learning efficiency (Sovia & Silvio, 2024). In this process, digital media plays a key role as an important teaching aid. Digital media can transform abstract or complex knowledge into intuitive and easily understandable learning resources, helping children form a deep understanding of knowledge in a relaxed and

enjoyable environment. This enables them to better comprehend and master the content they learn, thereby stimulating their interest in learning (Sovia & Silvio, 2024).

**9.3 Overview of strategies for cultivating comprehension in preschool students through interactive animation**

Interactive animation is an effective teaching strategy for improving the comprehension of preschool students. Preschool students are at a stage where concrete thinking dominates, and their knowledge is often based on vivid sensory stimuli and practical experience (Piaget, 1952). Interactive animation effectively meets the cognitive development characteristics of preschool students by making static knowledge content dynamic and contextualized, and giving students space for active exploration. This technology provides preschool students with intuitive and vivid learning materials, thereby stimulating their interest in learning and promoting a deeper understanding and memory of knowledge.

Interactive animations can provide intuitive teaching materials by playing relevant videos or animations to simulate real-life scenarios or experimental processes, helping students better understand and retain the knowledge they have learned. For example, through the use of vivid colors, concrete characters, and realistic scenes, interactive animations can make abstract concepts more concrete, enabling children to establish intuitive cognitive schemas through observation. For instance, the natural phenomenon of “day & night” can be demonstrated through animated storyboards, allowing children to understand the cause-and-effect relationship behind time changes from the perspective of the characters, thereby deepening their understanding.

To enhance preschool students' active participation in the learning process, after watching videos or images, interactive animations guide students to participate in the story plot through virtual characters (Barut Tugtekin & Dursun, 2022), setting key points to trigger students' thinking and choices, and asking relevant questions to guide them.This “immersive” learning experience stimulates children's cognitive engagement, enabling them to actively construct their understanding of knowledge while solving tasks or completing challenges (Bredeweg et al., 2023). When children operate an interactive animation that requires sorting, matching, or causal judgment, they are attracted by the plot and gradually deepen their mastery of knowledge points through trial and error and feedback.

Multimodal input and real-time feedback mechanisms enhance the responsiveness of learning and the coherence of understanding (Yan et al., 2024). Various forms of input, such as audio cues, text labels, image changes, and animated responses, work together to enable children to understand information from multiple perspectives in a short period of time and adjust their cognitive strategies in a timely manner through error feedback (Mayer, 2009). This immediate feedback can stimulate their interest and motivation in learning, promoting a deeper understanding and mastery of knowledge. In interactive animation learning, interactive animations typically allow students to choose their own learning paths and content based on their interests and needs. This autonomy enhances students' motivation and independence, encouraging them to actively engage in the learning process (Tarigan et al., 2023). Like, when learning basic cognitive stuff like shapes or counting, the instant voice and animation feedback from the system can help kids quickly spot mistakes and then transfer their understanding.

Personalized paths and repeated reinforcement strategies are also widely used to support the development of comprehension skills among students at different levels. Interactive animations provide learning resources and exercises of varying difficulty levels based on individual student differences. Students can choose learning content that suits their learning skills and interests, thereby increasing their motivation to learn.

Using multimedia technology's intelligent recommendation function, relevant learning resources are recommended based on students' learning behavior and feedback. This helps students discover content that interests them and learn more about it. Some high-quality interactive animation programs have the ability to intelligently adjust the difficulty of content based on children's learning progress, ensuring that each student is challenged appropriately within their “zone of proximal development” and achieves deep understanding through repetition and contextual changes.

**9.4 Situational Cognition Theory**

Situated Cognition Theory is one of the most important theories in the fields of cognitive psychology and education. It emerged alongside constructivism as another significant research paradigm following behaviorism's “stimulus-response” learning theory and cognitive psychology's “information processing” learning theory. This theory emphasizes that cognitive activities do not occur in isolation within an individual but are embedded within specific social and cultural contexts. This theory was proposed

by Jean Lave and Etienne Wenger in the 1980s as a critique and development of the traditional cognitive theory's “internal processing model.”

Situational cognitive theory posits that knowledge does not exist independently of context but is instead constructed as an interactive state through the interaction between individuals and their environment (Marougkas et al., 2023). It emphasizes the interactivity between knowledge and action, asserting that effective knowledge learning must be acquired in real-world contexts and through specific actions, and continuously applied and developed in diverse contextual activities (Reddy & Revathy, 2024). This theory has widespread applications in the field of education, particularly in instructional system design and learning environment development.

The theory of situational cognition has three core concepts:

1. Situational cognitive theory emphasizes that knowledge and context are inseparable; knowledge cannot exist abstractly outside of an activity context. Learning is not a process of transferring abstract knowledge from teachers to students' brains, but rather a process by which individuals gradually construct knowledge through interaction with the environment, anderen, tools in specific contexts. Learning should be understood and internalized through contextualized activities.

2. This theory holds that learning is a social process of participation in practice, and that practice promotes learning and understanding. Individuals gradually integrate into the community of practice through participation in real activities (such as cooperation, dialogue, and manipulation), developing from “legitimate peripheral participants” to “core practitioners.” Learners actively participate in various tasks and activities in real learning situations, thereby promoting the improvement of their cognitive abilities.

3. Situational cognition theory holds that tools and environments are extensions of cognition. Tools (such as language, digital media, animation, and symbolic systems) are not only vehicles for transmitting knowledge, but also part of cognitive activities. Human understanding and problem-solving abilities often depend on external resources.

Brown, Collins, and Duguid (1989) argued that “knowledge should be acquired in practical contexts” and proposed the concept of “cognitive contextuality.” Jean Lave and Etienne Wenger (1991) introduced the concepts of “legitimate peripheral participation” and “community of practice,” emphasizing that learning is a socialization

process. Vygotsky's “Zone of Proximal Development” (ZPD) theory and sociocultural learning perspective also provided a theoretical foundation for situated cognition.

Situational Cognition Theory has been widely applied in educational practices such as constructivist teaching, project-based learning, task-based teaching, problem-based learning (PBL), and digital media design. Specifically, this includes: teaching content should be closely aligned with real-life or practical contexts, enabling students to learn knowledge through application;Fostering social interaction and collaborative learning: Encouraging students to collaborate and share experiences in group or cooperative settings (Salmons & Wilson, 2023); Utilizing media and tools to support learning: Employing digital media (such as interactive animations, virtual reality, etc.) to simulate real-world scenarios, helping students understand knowledge through visualization and hands-on activities (Barut Tugtekin & Dursun, 2022).

The theory of situational cognition has had a profound impact on the field of education, transforming traditional teaching concepts and methods. In early childhood education, the theory emphasizes providing children with meaningful learning contexts through activities such as games, stories, role-playing, and interactive animations, enabling them to acquire knowledge and skills through natural, authentic, and social interactions.By adopting this approach, teachers create specific contexts that allow children to learn and master knowledge through hands-on activities, thereby enhancing their understanding and application of the learned material. Simulating real-life or interesting scenarios can stimulate children's interest in learning, encouraging them to actively explore and learn in a joyful environment.

Children are in a critical period of cognitive development. They recognize and comprehend the world through perception, manipulation, and experience. The application of situational cognition theory enables the learning process to be more closely aligned with children's actual lives, which helps stimulate their interest in learning and promotes cognitive development.

Interactive animation combines the fun and interactivity of animation to provide preschool children with rich learning resources. It attracts children's attention through vivid images, interesting storylines, and diverse interactive methods, thereby stimulating their motivation to learn. Interactive animation can also be dynamically adjusted based on children's feedback and learning progress to provide a personalized

learning experience. Interactive animation can create scenarios that are closely aligned with preschool children's life experiences and cognitive characteristics (Papadakis et al., 2021). These scenarios help children better understand and apply the knowledge they have learned, thereby enhancing their cognitive abilities and social adaptability.

Interactive animations in real-life scenarios stimulate curiosity and exploration in children, encouraging them to participate more actively in the learning process. By learning and applying knowledge in real or simulated situations, children can gain a deeper understanding and mastery of the material, forming long-term memories. Interactive animations can be customized and adjusted according to the different needs and cognitive levels of children, providing personalized learning paths and resources to meet the learning needs of different children.

**10. Creativity**

**10.1 Meaning of creative**

Creativity is the ability of an individual to generate novel, unique, and valuable ideas, perspectives, methods, or works during cognitive activities (Plucker et al., 2004). It is not exclusive to the arts but is widely present in various cognitive and practical activities such as language expression, problem-solving, scientific inquiry, and social interaction. Creativity reflects an individual's ability to break away from conventional thinking, think flexibly, and integrate information, serving as a key indicator of higher-order cognitive functions (Pasarín-Lavín et al., 2023).

According to Guilford's (1950) theory of intellectual structure, creativity is the core characteristic of divergent thinking in intellectual structure, primarily comprising elements such as fluency, flexibility, originality, and elaboration. Creative is a concept that not only manifests in the ability to generate multiple solutions but also emphasizes the novelty and applicability of these solutions (Guilford, 1950).

From the perspective of developmental psychology, Vygotsky pointed out that children's creativity does not arise spontaneously, but is gradually constructed through social interaction, linguistic symbols, and cultural environments. Especially in the preschool stage, children freely express and explore themselves through forms such as play, drawing, and storytelling, which is a critical period for the initial manifestation and development of their creative potential (Vygotsky, 1978).

Cultivating children's creativity primarily refers to a series of targeted and systematic

educational activities and methods designed to stimulate children's innate creative potential, helping them develop unique ways of thinking, imagination, and problem-solving skills (Behnamnia et al., 2020).This process encourages children to boldly try new things, break free from traditional notions and rigid thinking patterns, independently generate novel and valuable ideas, and transform these ideas into concrete works or actions through practice.

Cultivating creativity in preschool students means more than just improving their artistic expression and craft skills. More importantly, it means cultivating their innovative thinking, critical thinking, and problem-solving skills (Chen & Li, 2021) so that they can be more flexible and confident when facing future challenges. At the same time, it is also an important process for promoting children's personality development and enhancing their self-expression and self-confidence.

The specific methods for cultivating creativity are diverse and encompass multiple aspects, including stimulating creative desire, breaking free from fixed thinking patterns, fostering multiple intelligences, promoting continuous learning and practice, and creating an innovative environment.

Increasingly, kindergartens are integrating multimedia teaching into their curricula (Li, 2022). By utilizing various media forms such as animations, audio, and video, combined with the internet and digital technology, multimedia provides preschool children with a vibrant and creative learning environment, thereby effectively stimulating their creativity and imagination.

**10.2 The role of interactive animation in cultivating creative in preschool students**

As an emerging art form, interactive animation increases the sense of interaction and participation in the learning of preschool students. Multimedia teaching platforms usually have human-computer interaction functions, allowing children to interact with teaching content by touching the screen, operating the mouse, or using the keyboard. This type of interaction not only increases children's sense of participation, but also cultivates their problem-solving skills and creativity through operation and exploration.

Interactive animations can also simulate real or fictional scenarios, enabling children to engage in role-playing and problem-solving activities within a virtual environment. This scenario-based simulation approach helps children apply their learned knowledge to real-world situations while fostering their creativity and practical skills. This method inspires

children's creative awareness through showcasing creative works and telling creative stories.These activities help guide children to pay attention to creative elements in life and cultivate their observation and imagination (Revenko et al., 2024). Provide customized learning resources and paths based on children's learning progress and ability levels (Chen, 2008). This personalized learning approach helps meet the different learning needs of children and stimulate their motivation and creativity.

**10.3 Creative thinking training methods**

Creative thinking training methods refer to a series of approaches and strategies designed to stimulate and cultivate an individual's creativity and innovative thinking (Torrance, 1972). These methods encompass various aspects, including observation and discovery, questioning and doubting, association and analogy, criticism and analysis, and risk-taking and innovation. They are often implemented through techniques such as brainstorming, scenario switching, role-playing, and diagramming (Runco, 2007). In the context of rapid digital technology development, the integration of this method with interactive animation provides preschool children with an imaginative, participatory, and exploratory learning platform, further stimulating their creative potential.

Preschool students can stimulate their imagination and divergent thinking through effective creative thinking training methods. Interactive animation can use dynamic scenes and anthropomorphic character designs to set up problematic situations or unfinished stories, guiding children to think about questions such as “What will happen next?” or “What other solutions are there?”This question-driven mechanism, combined with the visual guidance of animation, can effectively stimulate children's divergent thinking, improve their logical thinking skills, and stimulate preschool students' interest in learning. They will be more willing to participate in learning activities and enjoy the fun of exploring knowledge.

In interactive animations, introducing multiple task selection paths and open-ended interfaces provides children with the freedom to explore and construct, which is an important strategy for fostering creative thinking (Kampylis & Berki, 2014). Children can choose character behaviors, design storylines, and combine different colors and objects, thereby developing their flexibility and combinatorial innovation skills.

Interactive animation enables the visualization of graphical interfaces (Ouyang, 2016). Animation systems provide features such as drag-and-drop card manipulation, voice input,

and character placement, helping children to materialize their ideas. This not only encourages them to express their imaginative ideas but also enables mutual inspiration through observing others' solutions.For example, in interactive animations for science education, students can drag and drop characters or objects in the animation to understand scientific principles or natural phenomena, thereby promoting their cognitive development. Many interactive animations are designed with logical problems or challenging tasks that students must solve through observation, thinking, and reasoning. This training method not only helps cultivate students' logical thinking abilities but also enhances their problem-solving skills (Clemente-Suárez et al., 2024). For example, in the animated series “Special Agent Oso,” the panda agent Oso guides children through simple three-step tasks that cover teamwork, critical thinking, and detail management, effectively enhancing students' overall abilities.

Interactive animation also encourages students to use their creativity to explore the unknown world by freely combining and creating new elements. For example, Mickey Mouse Clubhouse has lively and interesting content and dynamic music that stimulates children's different senses, allowing them to learn basic skills such as numbers, shapes, and logical thinking in a fun atmosphere.“Ricky Baby” promotes the balanced and comprehensive development of babies' abilities across four major areas: cognitive and exploratory, emotional and social, artistic and creative, and physical and rhythmic. Science-based educational animations use science knowledge as their theme, conveying scientific concepts to children through animated formats to foster their spirit of exploration and curiosity. An example is “The Octonauts”. Emotional and social animation: This type of animation tells warm and touching stories to help children develop emotional awareness and social skills. For example, Peppa Pig's minimalist animation style, humorous dialogue, and educational storylines not only allow preschoolers to learn knowledge, but also help them develop good habits from an early age (Rezeki & Utami). English language learning animations, such as “Super Simple Songs,” feature clear and simple lyrics, joyful melodies, and are suitable for children aged 2-4 for English language introduction.

**11. The Application of Interactive Animation in Transnational Preschool Education**

**11.1 Using interactive animation to support cultural learning in international kindergarten settings**

Many countries are increasingly emphasizing the importance of using interactive animation to preserve and transmit local culture during the preschool education stage. In Japan and South Korea, interactive animation is widely used in early childhood cultural education, with a strong focus on early cultural input and behavioral mimicry. The design of interactive animation tends to prioritize gamified interactive experiences, such as experiencing "seasonal rituals" in a virtual environment (So et al., 2018).In contrast, interactive animations in Nordic countries like Finland focus on content construction and aesthetic experiences in visuals. These works typically use fairy tale structures and open-ended interactions to stimulate children's emotional engagement and imagination, with cultural transmission being more implicit. For example, the Finnish interactive animation series "Moominvalley" is a representative work of Nordic interactive animation design philosophy. In the United States and Canada, emphasize children's participation and exploratory interaction, introducing "non-linear exploration" and "interactive narrative" in plot design (Kabir, 2013), with a strong emphasis on "task-driven" approaches.

**12. Conclusion**

A review of the relevant literature shows that existing studies have explored the development of animation and interactive animation, children's psychology and learning cognition, the educational value of digital media, and the integration of traditional culture into preschool education from multiple perspectives. These research results provide a solid theoretical and practical basis for this study and reveal the potential of interactive animation in promoting preschool students' interest in traditional culture. Despite some exploration, traditional cultural education resources developed for preschool students are relatively monotonous, lacking diversity and depth, and unable to meet the comprehensive development needs of preschool children. At the same time, based on an investigation of the current state of preschool education and education in China, researcher believe that it is necessary for teachers to introduce multimedia teaching methods to enable students to actively participate in learning activities.

It is on this basis that this study, from the perspective of interactive animation design, provides new ideas and methods for improving the effectiveness of traditional culture learning among preschool children, and offers useful theoretical supplements and practical references for related fields.

In the new media environment, interactive animation, as a learning tool, has been introduced into preschool students' traditional Chinese culture courses to enhance their interest and motivation in learning, promote cognitive development, and improve learning effectiveness and efficiency. As a new media technology, interactive animation can break the constraints of time and space, bring a variety of rich educational resources into the classroom, break traditional teaching concepts, and enable high-quality educational resources to be shared on a wider scale. Through exposure to a variety of new media content, preschool students can continuously broaden their thinking boundaries and stimulate their innovative thinking and imagination. Interactive animation helps preschool students understand the content of traditional Chinese culture more vividly, thereby promoting their comprehension and innovation.

Interactive animation introduces preschool students to traditional Chinese culture, thereby promoting their learning of traditional Chinese culture. From the perspective of teachers, it improves teaching efficiency and effectiveness, enriches teaching methods and resources, and allows students to cultivate their comprehension and innovation skills while expanding their knowledge of traditional Chinese culture.

Chapter 2 discusses the literature based on the keywords of this research paper, focusing on interactive animation, preschool students, and traditional Chinese culture(Figure 20). The arguments presented are representative of the research results in recent years. These findings hold significant importance and practical application value for the content of this study. Through the literature review, it is evident that interactive animation demonstrates substantial application potential in supporting preschool children's learning and cognitive development, particularly in traditional culture courses,.The theoretical research in this area has design value for interactive animation design (Figure 21). The next chapter will provide a detailed exposition of the research methods, design process, and data collection and analysis strategies employed in this study.

## 13. Conceptual framework

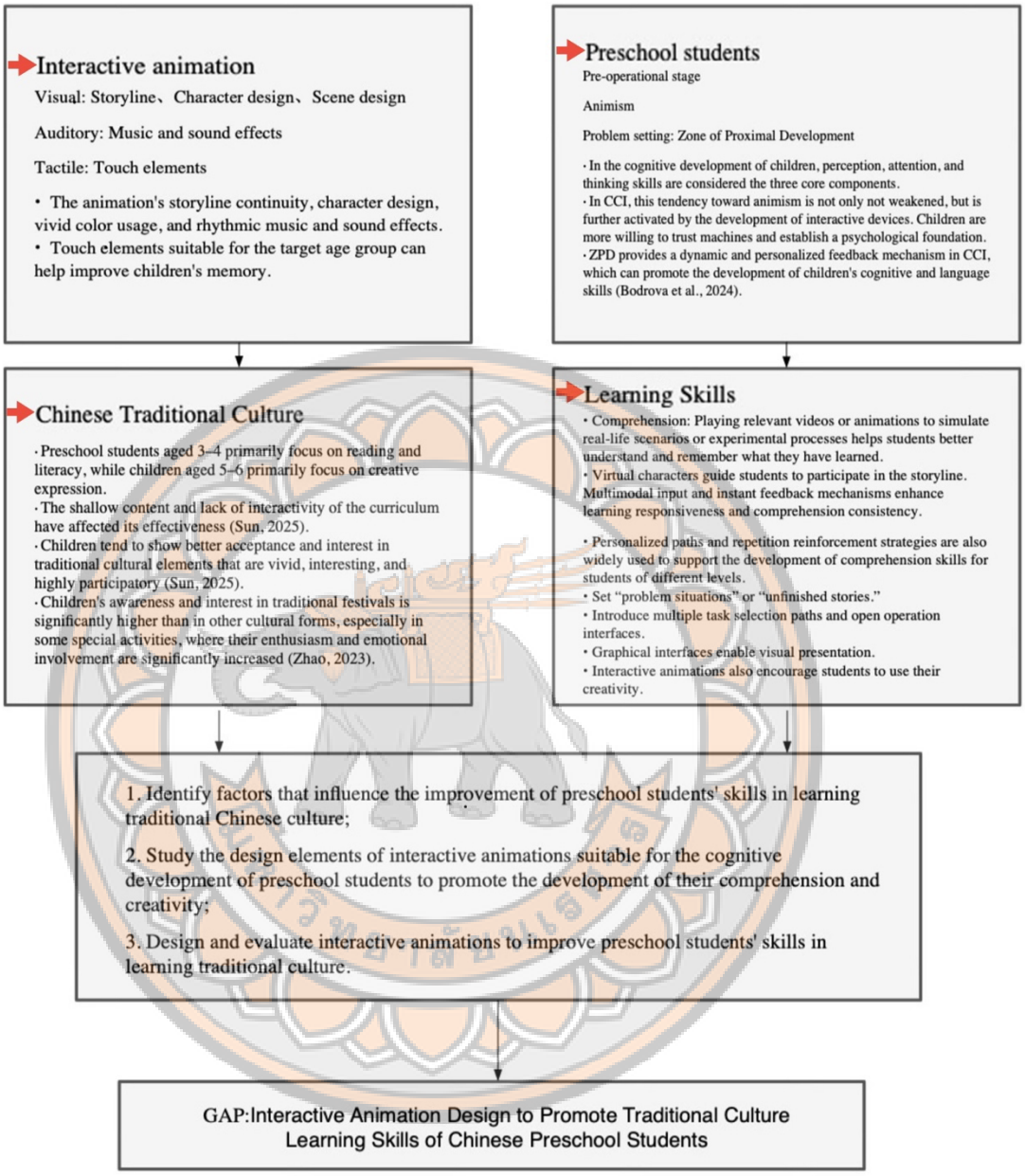



Figure 20 Conceptual framework

Summary: studies have examined interactive animation design, preschool children's cognitive development, traditional Chinese culture, and the cultivation of learning skills. However, this research lacks a design-oriented framework that systematically integrates the above research. Thus, this study adopts an interactive animation design perspective and, in alignment with preschool children's cognitive development, constructs and validates an interactive animation design pathway to enhance preschool children's learning skills in traditional Chinese culture.

## 14. Design process

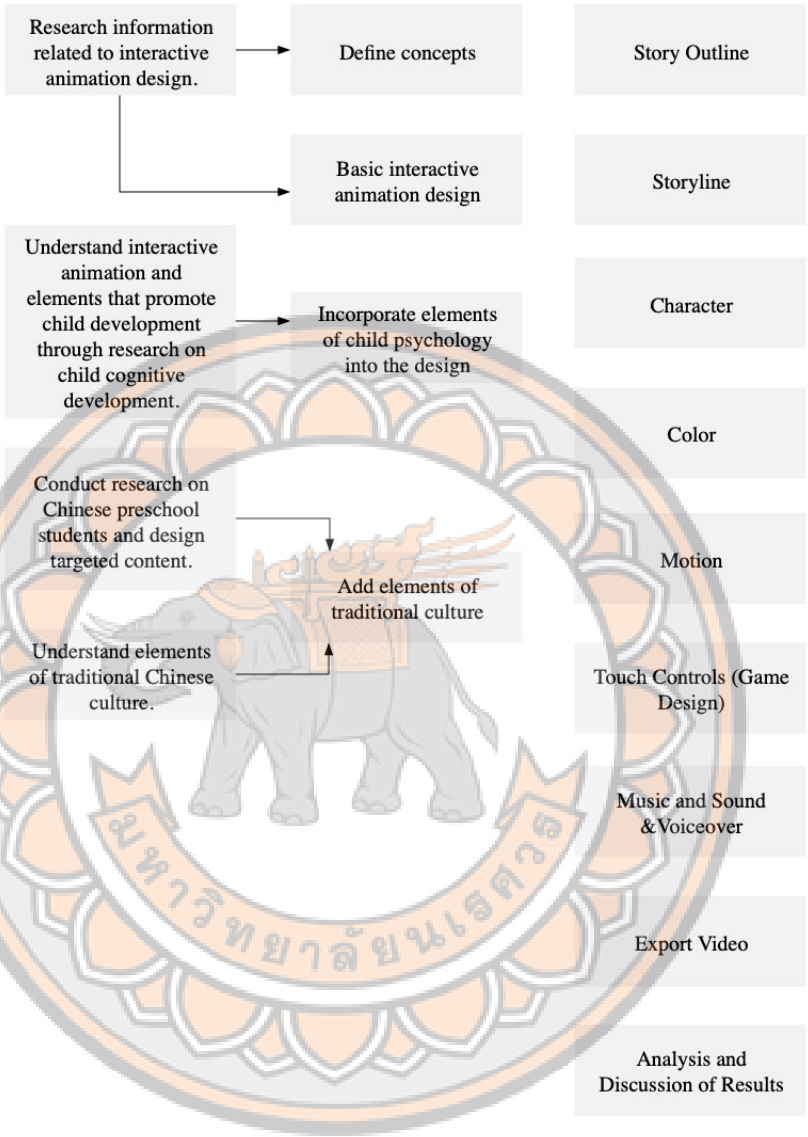



Figure 21 Design process

Summary: This study adopts interactive animation design as its core, beginning with a review of relevant research to define key concepts and establish a basic narrative structure. Design elements informed by preschool children's cognitive development and traditional Chinese culture are then integrated into the animation. Finally, the interactive animation is produced through the synthesis of storyline, characters, visual and auditory elements, and touch interaction, followed by an analysis of the design outcomes.

# CHAPTER III

# RESEARCH METHODOLOGY

This chapter primarily describes the research methods used in this study and elaborates on the research process (Figure 22), including research design, research subjects, data collection, and analysis methods. Through rigorous research procedures, this chapter reveals the issues addressed in this study and the basic experimental process, ensuring the reliability and validity of the results and providing a solid foundation for subsequent data analysis and conclusions.

This study employs Mixed Methods Research (MMR), involving the collection, analysis, synthesis, and integration of quantitative and qualitative research methods to gain a comprehensive understanding and achieve the research objectives. The research objectives are divided into four stages:

Phase I: Using qualitative research, researching interactive animation design elements suitable for preschool students and child cognitive development mechanisms.

Phase II: Selecting traditional Chinese culture content suitable for preschool students to enhance preschool students' comprehension and creativity skills.

Phase III: Based on the results of qualitative research, interactive animations were designed to enhance preschool students' skills in learning traditional culture.

Phase IV: Using quantitative research, evaluate the learning effectiveness of interactive animations for preschool students and the satisfaction of relevant personnel with interactive animation design.

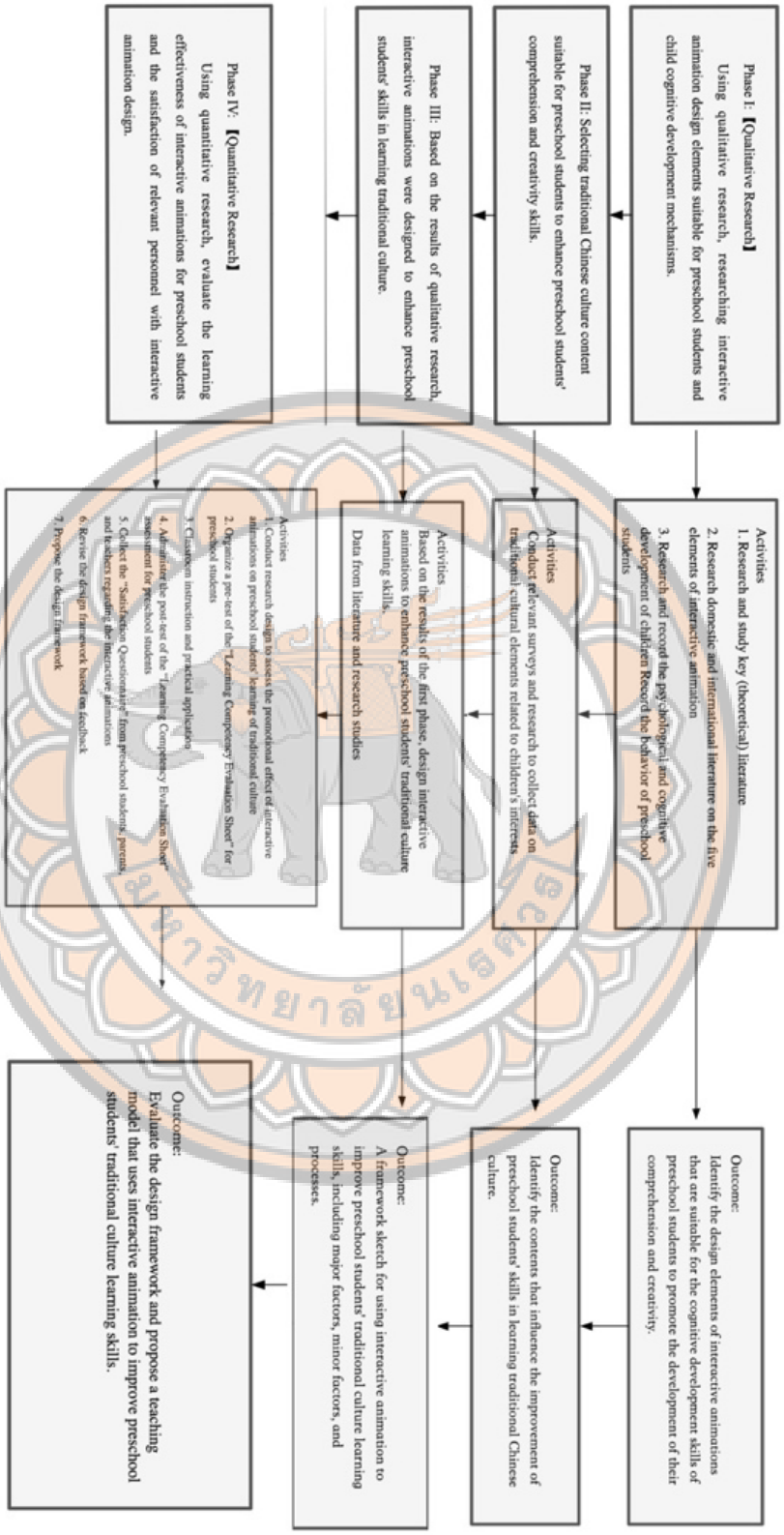



Figure 22 Research Method Flowchart

To enhance the scientific rigor and theoretical foundation of the "Phase I" and "Phase II "of the study and ensure the logical consistency and robustness of the research framework, this study employs the “Triangulation Method” (Figure 23) to conduct cross-validation and multi-dimensional validation of the findings from the "Phase I" and "Phase II "This method leverages multi-source data, diverse research strategies, and multi-perspective theoretical analysis to enhance the reliability and validity of the research.

During the framework stage, the study focused on clearly defined research objectives and questions, systematically reviewing and analyzing a large body of relevant literature to establish an initial research framework and theoretical foundation.The scope of the literature review covers Chinese preschool children's curriculum standards, theoretical foundations of children's visual cognitive development in developmental psychology, and research findings related to interactive media adaptability. Through an in-depth analysis of these documents, this study has preliminarily constructed the "Phase I" and "Phase II "of the triangular verification theoretical model, namely, a constructive analysis framework based on literature and theory.

In the validation stage, this study carried out further quantitative empirical research to explore and analyze the specific mechanisms of interactive animation in children's cognitive and cultural learning. The main research directions include, but are not limited to: analysis of the basic design elements of interactive animation, research on the relationship between interactive animation and children's visual perception development, and analysis of differences in preschool children's acceptance and preference types of traditional Chinese cultural content.Through statistical analysis of quantitative data, this study integrates and compares the principles of interactive animation design, theories of children's cognitive development, and content related to the learning of traditional Chinese culture. This process forms the validation stage of the triangular verification theory,an empirical construction based on data integration and cross-analysis.

The application stage consists of participatory observation and testing based on real educational scenarios. The research subjects include children who actually participate in the learning process, and is extended to four key stakeholder groups:

experts, teachers, parents, and children. Experts include child psychologists, kindergarten curriculum planners, and interactive animation experts.Through interviews, classroom observations of teachers and students, and other methods, feedback and suggestions from different groups on the application of interactive animation in traditional culture learning processes are collected. Combined with observation data, the applicability and effectiveness of the theoretical models established in the framework and validation stages are further verified.

After completing the three stages of triangulation and validation, the study will integrate the theoretical findings and empirical data obtained in each stage and proceed to the interactive animation design and evaluation stage. Through comprehensive analysis, a scientifically sound interactive animation design framework with cultural adaptability and cognitive compatibility for children will ultimately be constructed, providing theoretical and practical basis for improving the effectiveness of traditional culture learning among preschool children in China.

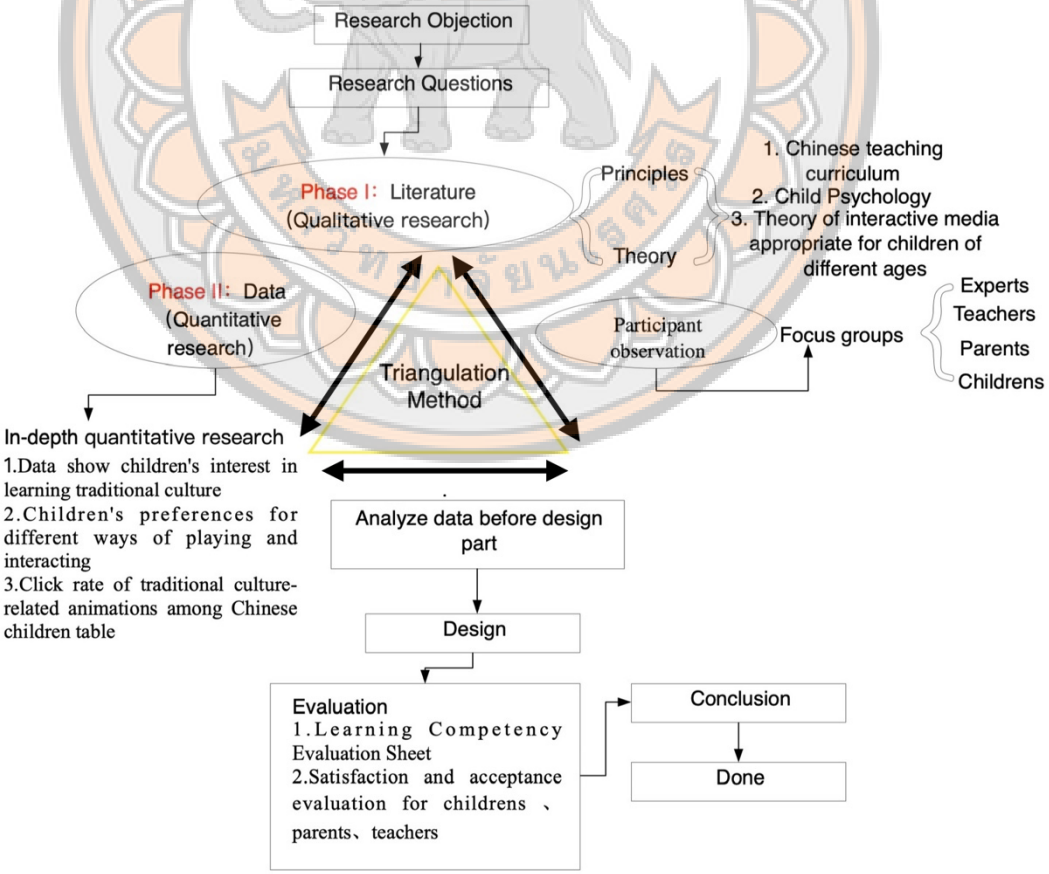



Figure 23 Triangulation Method logic diagram

**Phase I: Using qualitative research, researching interactive animation design elements suitable for preschool students and child cognitive development mechanisms.**

The Phase I employs literature research to provide a theoretical foundation and creative ideas for the subsequent interactive animation design. The research systematically reviews existing literature, analyzes and synthesizes existing research results, and extracts theoretical foundations and research perspectives. This study constructs a framework for the relationship between interactive animation design and cultural education based on existing academic achievements. In the specific implementation process, we will rely on library resources, open internet resources, and core academic databases (such as Google Scholar, CNKI, and Web of Science). We will conduct systematic searches using keywords such as "interactive animation," and "child cognitive development." We will also screen journals published between 2022 and 2025, excluding articles that are repetitive, lack empirical evidence, or are irrelevant, to ensure the authority, timeliness, and relevance of the literature. By organizing the literature, the researchers conducted horizontal and vertical comparisons of research results from different periods and fields to identify the contributions and shortcomings of interactive animation,thereby constructing the theoretical framework and design methods for this study. Therefore, this study involves three core thematic areas:

**Interactive animation design elements:** plot, character design, color, sound and music, touch elements

To systematically sort out and refine interactive animation design principles applicable to traditional culture learning scenarios for preschool students in China, we used literature research methods to analyze key elements of interactive animation design, such as plot, character design, color, sound and music, and touch elements, and constructed a preliminary design framework.

Through analyzing relevant domestic and international research results, we gain an understanding of the factors that influence children's comprehension and creativity in interactive animation, and extract interactive animation designs that are in line with the psychological development characteristics and learning needs of preschool students. Based on this theoretical foundation, we further select representative domestic and

international interactive animation works for case analysis to discover the specific manifestations of various design elements in practice and the audience's response.

This study primarily utilizes the following resources:

Chinese databases: CNKI, Wanfang Data, VIP Database;

English databases: Google Scholar, ScienceDirect, ERIC, ACM Digital Library;

Additionally, research was conducted through other channels, such as children's education design guidelines, children's interactive electronic devices, and authoritative textbooks.

Through screening Chinese and English literature published in the past decade (2015-2025) related to media design, educational technology, user experience, and other fields related to children, we clearly explored the relationship between animation design elements and children's learning or behavior. This includes empirical research, theoretical analysis, or design case studies. Because the focus of the research is on designing interactive animations suitable for Chinese preschool students, Chinese literature accounts for a relatively large proportion.

Based on the five design elements and the target audience of children, a keyword table (Table 3) was constructed:

Table 3 Comparison table of Chinese and English “keywords” in interactive animation element design

| Design elements | Chinese keywords | English keywords |
|---|---|---|
| Plot | • Children's story structure design, traditional cultural stories<br>• Language animation<br>• Folk narrative,<br>• Myth adaptation animation. | • Narrative design for children<br>• Story structure in educational media<br>• Cultural storytelling |
| Character design | • Traditional cultural characters<br>• Cartoon mythological characters<br>• Intangible cultural heritage IP<br>• Characters children's character designs | • Character design for preschool students<br>• Animated character appeal<br>• Media characters in early childhood |

| | | |
|---|---|---|
| | • Visual representations of folk legend characters | |
| Color | • Color preferences of young children<br>• traditional color applications<br>• Chinese-style color matching<br>• Color symbolism<br>• Color psychology in children's animation | • Color preference in children<br>• Color psychology in learning media<br>• Visual salience in educational design |
| Sound and music | • Children's animation voice acting<br>• Opera-style voice acting<br>• Traditional instrument sound effects<br>• Onomatopoeia instruction<br>• Cultural background sound effects | • Sound design in children's media<br>• Voiceover pacing, music and learning<br>• Auditory feedback in apps |
| Touch elements | • Early childhood touch interaction<br>• Traditional element interaction experience<br>• Cultural interactive games<br>• Interface click animation<br>• Cultural object interaction | • Touch interaction in preschool apps<br>• Child-friendly UI design<br>• Interactive learning design for tablets |

For literature searches on interactive animation elements, different keywords were used for Chinese and English. Chinese keywords mainly emphasized content related to "traditional culture," while English keywords tended to be general expressions used in international research (Table 4). This allowed for better integration of domestic and international literature.

Table 4 English and Chinese “keyword” tendencies in interactive animation element design

| Design elements | Chinese keywords | English keywords |
|---|---|---|
| Plot | Traditional cultural content (mythology, fables, folklore) incorporated into stories | The role of story structure in promoting children's understanding and learning, with little reference to specific Chinese cultural content |
| Character design | Visual reimagining of traditional images, such as cultural symbols like Nezha and Chang'e | English tends to focus on character appeal and learning motivation, as well as immersion |
| Color | Traditional Chinese color system and symbolic meanings | The influence of color on attention and emotion |
| Sound and music | The integration of music culture in animation | Speech rate, voice feedback, and multimodal learning mechanisms |
| Touch elements | Design interactive activities (such as lighting lanterns, beating drums, and turning pages) in traditional cultural settings | Ease of use, interface comprehensibility, educational application research |

Through systematic literature analysis, we have identified the key design elements of interactive animation and their connection with traditional cultural elements. Further research will combine empirical methods to validate the effectiveness of the design strategies proposed in the literature, thereby enhancing the systematic nature and reliability of the study.

**Children's Cognitive Development:** Perception, Attention, and Thinking

In order to better design interactive animations to enhance preschool students' comprehension and creativity in traditional culture, researcher will conduct in-depth studies on children's cognitive development stages. By reviewing domestic and international theoretical findings on children's cognitive development, attention mechanisms, emotional expression, symbol comprehension, and perception abilities,

researchers will systematically sort out the psychological development patterns and stage characteristics of children aged 3–6.The focus will be on Piaget's “stages of cognitive development,” Vygotsky's “zone of proximal development,” and the research of Bruner, Gagne, and other scholars on the learning process of children. Empirical research results in the field of educational psychology in China on preschool children's attention, imagination, memory, comprehension, and language skills will be summarized. This will provide a psychological basis for the plot structure, interaction complexity, language commands, color and sound elements, and other aspects of interactive animation design.

While observing preschool students at Hongyuan Kindergarten using interactive animation, we also recorded the behavioral performance and emotional responses of preschool children during traditional culture classes and the use of interactive animation. The recorded results were used to make a horizontal comparison of the responses and emotions of children aged 3-4, 4-5, and 5-6 to understand the differences in cognitive abilities between children of different ages.

**Phase II: Selecting traditional Chinese culture content suitable for preschool students to enhance preschool students' comprehension and creativity skills.**

Regarding the Phase II, the focus will be on three key areas: the current state of traditional culture learning among Chinese preschool children, field visits to kindergartens and observations of Chinese preschool children, and selection and research of traditional cultural elements.

**1. The current state of traditional culture learning among Chinese preschool children**

Understanding Chinese kindergarten language arts textbooks, with a focus on curriculum content related to traditional Chinese culture in the junior, middle, and senior classes. Analyze the presentation methods and content structure of traditional culture, folk customs, traditional arts, and classical Chinese poetry within the textbooks, emphasizing comparisons of differences in cultural content difficulty and presentation formats across textbooks for different age groups. This includes examining preschool students' cognitive levels and interest in traditional culture, assessing the suitability of teaching materials, and evaluating the effectiveness of teaching methods.

Through digital media and the internet, parents and educators can access relevant knowledge from educational websites, online digital museums, and libraries where they share their experiences and insights. Search keywords such as “children learning traditional culture” and “traditional culture education” to explore related online content, gaining insights into the importance of traditional culture education and its implementation across different families and schools. Based on the latest research data and surveys, understand their attitudes, needs, and feedback regarding traditional culture education.

In terms of literature review, this study retrieved relevant research documents from databases such as China National Knowledge Infrastructure (CNKI) over the past 10–15 years, focusing on topics including “preschool education,” “traditional culture education in kindergartens,” and “interactive animation.” Approximately 150 research outputs were initially identified. After screening and removing duplicates, around 100 representative journal articles and theses were ultimately selected as the analytical sample.

**2. Field visits to kindergartens and observations of Chinese preschool children**

First, after gaining an initial understanding of young children's learning of traditional cultural content access table (Table 5). The focus was on children's learning behaviors in authentic teaching scenarios, their interest in traditional cultural elements, and their cultural receptivity. Through systematic documentation of teaching activities, the use of teaching aids, and teacher-student interactions, a deeper understanding was gained of the actual needs and existing challenges in traditional cultural education within the current kindergarten setting.

The access table employs a 5-point Likert scale, with scores determined by researchers based on a comprehensive assessment of children's verbal responses and behavioral manifestations. Higher scores indicate greater understanding and acceptance of traditional cultural content among the children.

Table 5 Access table for children's learning of traditional culture courses

| Dimension | Inquiry questions (teacher-guided questions) | Scoring |
|---|---|---|
| Cultural understanding | Do you know what traditional culture content we learned today? | 1–5 points (Unfamiliar – Very familiar) |
| Level of interest | Did you enjoy today's traditional culture story/animation? | 1–5 points (Don't like – Enjoy) |
| Proactive participation | During class, were you willing to actively click, answer, or participate in games? | 1–5 points (Unwilling – Eager) |
| Emotional attitude | Did you find the learning process enjoyable and interesting? | 1–5 points (Unhappy – Delighted) |
| Memory and reproduction | Can you recall one thing you learned after class? | 1–5 points (Not at all – Completely) |
| Interactive acceptance | Do you enjoy learning traditional culture through animations and games? | 1–5 points (Dislike – Strongly prefer) |

Second, by integrating teacher interviews with teaching materials (Table 6), the study examines the teaching methods and strategies employed in actual kindergarten instruction. It analyzes the teaching materials used across different classes, focusing on children's cognitive levels regarding traditional cultural content, their demonstrated interest, as well as the appropriateness and effectiveness of the instructional content. Teacher instructional materials encompass specific chapters or modules within the curriculum detailing kindergarten teaching methods, such as situational teaching, game-based learning, and interactive instruction, along with their implementation and assessment approaches. These materials typically provide detailed explanations of the

theoretical foundations, practical examples, and operational steps for kindergarten teaching.

Teacher interviews employed a semi-structured format and were cross-referenced with instructional materials to evaluate the applicability and teaching effectiveness of traditional culture teaching methods.

Table 6 Interview for kindergarten teachers on traditional culture

| Dimensions | Key point | Teaching materials |
|---|---|---|
| Teaching methods | What teaching methods do you primarily use in traditional culture instruction? | Scenario-based teaching, Gamified instruction, Interactive teaching modules |
| Children's interest | How interested and engaged are the children in the traditional culture content? | Feedback and records |
| Cognitive outcomes | How well do the children understand the traditional culture content they learn? | Objectives and assessment |
| Suitability | Are the existing teaching materials appropriate for young children's cognitive level? | Structure and level explanation |
| Issues | What are the main difficulties encountered in actual teaching? | Reflection and recommendations |

Finally, through teaching activities and specialized school demonstrations, we examined preschool students' current learning status regarding traditional Chinese culture and gained deeper insights into kindergarten traditional culture education curricula. This included curriculum content selection, teaching material choices, and instructional methods such as storytelling, role-playing, crafts, music, and dance. Observe whether teaching activities are engaging and captivating, capable of holding preschoolers' attention, and assess their level of participation and response to these activities. Analyze the methods and strategies teachers employ in traditional culture education (Table 7), such as whether they utilize situational teaching or interactive teaching, and evaluate the impact of these approaches on students' learning outcomes.

Observe whether teachers emphasize cultivating students' observational skills, imagination, and creativity, and whether they encourage students to express their emotions and ideas. Observe students' performance during teaching activities, such as their level of active participation, their ability to understand and absorb traditional cultural knowledge, and their capacity to apply learned knowledge in daily life. Collect feedback from both children and teachers regarding their views, experiences, and suggestions on the application of interactive animations in kindergarten education. This helps identify the current effectiveness of interactive animations and existing challenges.

Table 7 Traditional Cultural Activities Teaching Observation and Measurement Form

| Dimensions | Observation | Method |
|---|---|---|
| Course selection | Does it include content such as classical poetry, traditional festivals, traditional arts, or historical stories? | 1–5 points |
| Method application | Does it employ methods like storytelling, role-playing, crafts, music, or dance? | 1–5 points |
| Engaging instruction | Are teaching activities engaging and interesting enough to capture young children's attention? | 1–5 points |
| Student participation and comprehension | Do children actively participate and comprehend traditional cultural content? | 1–5 points |
| Skill transfer | Does it foster observation skills, imagination, | 1–5 points |

| | | |
|---|---|---|
| | creativity, and practical application in daily life? | |

**3. Selection and research of traditional cultural elements**

Based on the aforementioned research into the current state of traditional culture learning among Chinese preschool children, researcher have screened traditional cultural content to identify elements of traditional Chinese culture suitable for enhancing children's comprehension and creativity. The screening mechanism will be based on three dimensions:

• Value: Whether traditional cultural content is representative, educational, and historically significant—such as its frequent presence in traditional Chinese cultural identity.

• Suitability: Whether it aligns with children's interests and aesthetic preferences, features adaptable storytelling, employs uplifting imagery, and fosters children's comprehension and creativity.

• Media Adaptability: Whether cultural content lends itself to interactive animation formats, incorporating visual, narrative, and interactive elements.

To ensure preschool students gain a profound cultural understanding and educational value from interactive animations, specific cultural symbols from traditional culture are systematically selected. Factors such as children's interest preferences in learning traditional culture, their preferences for interactive games and different engagement methods, and click-through rates for each animation type among Chinese children are considered. This content is presented in data format.

Data was collected through China's mainstream online platforms to gauge children's interest preferences in traditional cultural content, interactive animations, and gaming formats. By integrating publicly available backend data or industry reports from Chinese video and animation platforms (such as Tencent Video, iQIYI, and Bilibili Kids), we analyzed click-through rates and viewing durations for different types of traditional cultural animations. Concurrently, we cross-validated and analyzed the data by referencing China National Knowledge Infrastructure (CNKI), educational white papers, and children's education research reports.

**Phase III: Based on the results of qualitative research, interactive animations were designed to enhance preschool students' skills in learning traditional culture.**

Through an analysis of interactive animation elements in the Phase I, an overview of traditional Chinese cultural content, and research into various theories of children's cognitive development, interactive animations were designed. During the animation production process, we used Adobe Photoshop and Adobe Illustrator software to create the graphic design elements, including character design, costume design, prop design, scene design, button design, and component design. Adobe Premiere Pro and CapCut were used for quick editing of interactive prototypes and sound effects to meet the visual rhythm and emotional needs of preschool children. The dialogue in the interactive animations was recorded using online voice-over services. The interactive animation touchscreen components were created using Sketch, Figma, and Principle. This involved designing vector graphics, creating page layouts using editing software, adding interactive elements, and defining events to trigger animations, thereby achieving various interactive animation effects.

Sample of experts participating in teaching validation:

**1. Kindergarten curriculum planners:** They are directly involved in the education of preschool students, understand their needs and responses in the actual learning process, and can provide feedback and suggestions on the practical application of interactive animation.

**2. Child psychologists:** These experts are familiar with methods and principles of children's education and are able to judge the educational value of interactive animation and whether it is conducive to achieving specific educational goals.

**3. Interactive animation experts:** They specialize in human-computer interaction design, understanding how to design interactive interfaces and animated elements that are both engaging for students and conducive to learning.

After the interactive animation was initially completed, the researcher communicated with kindergarten curriculum planners, psychologists, and children's interaction design experts via telephone. They provided a detailed introduction to the design content and target audience of the interactive animation and sought professional opinions on the accuracy of the content, children's acceptance, the rationality of the interaction methods, and the effectiveness of cultural communication.Based on the

feedback and suggestions provided by the experts, the researcher made targeted optimizations and adjustments to the animation content, character design, interaction pacing, and presentation format, ensuring that the design scheme better aligns with the cognitive development and learning needs of preschool-aged children. The revised animation scheme entered the educational assessment phase and was tested in the classroom environment of Hongyuan Kindergarten to further validate its educational effectiveness and children's acceptance.

**Phase IV: Using quantitative research, evaluate the learning effectiveness of interactive animations for preschool students and the satisfaction of relevant personnel with interactive animation design.**

**1. Research design**

Phase III uses quantitative research methods to empirically evaluate the effectiveness of the interactive animation design framework developed in the second stage and ultimately quantify the role of interactive animation in promoting traditional culture learning among preschool students.The researcher applied the designed interactive animation in the teaching practice of Hongyuan Kindergarten and observed and measured its actual role in improving preschool students' traditional culture learning skills through real classroom teaching situations. The research identified children's points of interest in traditional culture through preliminary interviews and literature, and then identified teaching content and needs to carry out the design.

The study used several questionnaire tools to collect and analyze data in order to comprehensively evaluate the interactive animation's role in promoting traditional culture learning among preschool students. These tools included the “Learning Competency Evaluation Sheet” and a “Satisfaction Questionnaire” for preschool students, parents, and teachers to assess the interactive animation's role in promoting traditional culture learning skills among preschool students.This study project and all questionnaire materials have been approved by the Naresuan University Institutional Review Board, with approval number No.P2-0370/2567.

**2. Research objects and samples**

The study was conducted in the middle class of Hongyuan Kindergarten in Zhengzhou City, Henan Province. Through cluster sampling, a total of N=20 children were selected to participate, including 10 boys and 10 girls, aged between 4 and 5 years old. Ten teachers participated in the teaching, and 20 parents were also included in the satisfaction survey. All participants and parents signed informed consent forms, and the study was approved by the kindergarten.

**3. Research plan**

The study lasted for three weeks and organized three interactive animation teaching activities centered on the three traditional festivals of Spring Festival, The Mid-Autumn Festival, and Laba Festival. Each activity lasted 25 minutes to match the attention span and cognitive rhythm of preschool students.

All animations can be presented on tablets or touchscreen displays, offering a multi-modal interactive experience that engages visual (animation characters and scenes), auditory (voiceovers, sound effects, and dialogue), and tactile (click, drag, and other touch elements) senses. Instruction is led by teachers who guide children through the activities, ensuring they complete tasks and engage in thinking within a supportive learning environment.

The "Learning Competency Evaluation Sheet" is completed during the lesson preceding the activity and after the final session. The "Satisfaction Questionnaire" is distributed after the activity concludes, with teachers assisting children in completing the forms. Parent and teacher questionnaires are collected uniformly in paper format. Following the completion of the questionnaire survey, researcher conducted follow-up interviews with teachers, curriculum creators, and interactive animation experts to gather supplementary qualitative data.

**4. Research tools**

The "Learning Competency Evaluation Sheet" was developed by researchers in accordance with the standards outlined in the 《Guidelines for Traditional Culture Courses for Children Aged 3-6》. It includes 15 tasks, such as "festival knowledge comprehension," "custom recognition," and "idiom story recitation," and is scored using a combination of observation and questioning.

The “Satisfaction Questionnaire” (Table 8) includes satisfaction surveys of preschool students, parents, and teachers. The children's satisfaction questionnaire includes subjective feelings such as interest in animation, interactive experience, and learning gains. The parent satisfaction questionnaire includes evaluations of learning effectiveness and teaching suitability. The teacher satisfaction questionnaire includes classroom interaction, teaching technology development, and a comprehensive evaluation by all three parties. All three questionnaires use a five-point Linert scale for scoring.

Table 8 Items of dimensions in the satisfaction survey questionnaire

| Variable | Items |
|---|---|
| Students interest in animation content and interaction | 6 |
| Parents Satisfaction with Learning Effectiveness | 4 |
| Parents’ evaluation of teaching appropriateness | 3 |
| Teachers Evaluation of Teaching Technology Development | 4 |
| Teachers Satisfaction with Teaching Effectiveness | 3 |
| Satisfaction with follow-up development | 3 |

**5. Effectiveness and reliability of the tool**

The "Learning Competency Evaluation Sheet" and "Satisfaction Questionnaire" used in this study were designed to evaluate the actual effectiveness of interactive animation in enhancing preschool students' interest in and cognitive abilities regarding traditional culture. To ensure the scientific validity and reliability of the research tools, the researcher extensively referenced existing child education assessment scales and satisfaction questionnaires during the initial design stage and made adjustments to suit the local context based on the current state of preschool education in China and the characteristics of traditional culture education.

After the initial draft of the tools was completed, scholars from relevant fields such as kindergarten curriculum, child psychologists, and interactive animation were invited to conduct a preliminary review and content validity assessment of each item in the questionnaire and test form. The experts proposed a number of constructive suggestions for revision based on the degree of alignment between the project content and research objectives, the appropriateness of the language used, and the feasibility of children's

comprehension. The researcher revised and optimized the tools based on the feedback, and finally formed the official version used in the study.

**6. Research procedure**

6.1 Learning skills evaluation (pre-test design)

In order to evaluate the actual effect of interactive animation design on children's traditional culture learning skills, before the interactive animation was introduced into teaching, the researchers organized an assessment of the traditional culture learning skills of the sample (N=20) based on the “Learning Competency Evaluation Sheet” to record the initial level of traditional culture awareness of preschool students.

6.2 Research implementation

6.2.1 Lecture and guidance (15 minutes)

Teachers use multimedia teaching equipment in the classroom to play pre-designed interactive animated content.During the playback, teachers guide students to focus on key cultural information points, such as the name of the festival, related customs, and cultural symbols, based on the progression of the animation storyline. To enhance classroom engagement and understanding, teachers pose thought-provoking questions at appropriate points, encouraging students to think and express themselves. They also organize interactive discussions using physical displays (such as festival decorations, traditional clothing, or food models) to help students develop a basic understanding of traditional culture.

6.2.2 Interactive animation operation (8 minutes)

The interactive animation portion is conducted by students. Students can deepen their understanding of the lecture content by clicking, rotating, moving, and other touch controls. During this stage, teachers continue to provide necessary explanations and assistance, guiding students to pay attention to the operation steps and key points of the content to ensure that every child gains knowledge through hands-on participation.

6.2.3 Course Summary (2 minutes)

After the animation has finished playing and the interactive activities have been completed, teacher provides a concise review and summary of the lesson's content to help students organize what they have learned in a systematic manner. The summary typically includes the main points covered in the lesson, cultural meanings, representative cultural symbols, etc., and encourages students to share their feelings or

impressions of the most memorable parts of the lesson to further consolidate their learning.

6.3 Learning skills evaluation (post-test design)

Within one week after the course ended, to ensure that the teaching outcomes were accurately reflected, the researcher conducted a post-test on the original sample (N=20). The post-test continued to use the "Learning Competency Evaluation Sheet," maintaining consistency in both the content and format of the test. The test assessed the knowledge growth and understanding changes of preschool students after the instruction. By comparing the post-test results with the pre-test scores, the effectiveness of the interactive animation was confirmed.

6.4 Satisfaction and acceptance evaluation

6.4.1 Satisfaction questionnaire for children

Use simplified language, icons, and teacher guidance to help children complete the tasks, reflecting their level of acceptance and interest in the content.

6.4.2 Satisfaction questionnaire for teachers

Teachers were required to select whether each dimension was effective, appropriate, and met teaching requirements, among five detailed dimensions, and to provide suggestions for improvement.

6.4.2 Satisfaction questionnaire for parents

Parents were required to select whether they were interested, satisfied, and whether it was suitable for their children's personalized needs in five detailed dimensions, and to provide suggestions for improvement.

6.5 Interactive animation design professionalism assessment

Researcher conducted follow-up in-person interviews with teachers, curriculum creators, and interactive animation experts as supplementary qualitative data.

**7. Data collection and analysis methods**

All data were analyzed using SPSS 26.0 software. The pre- and post-test scores of the children were compared using a paired-sample t-test to determine whether the interactive animation had a significant effect on improving learning skills.

Satisfaction data were analyzed using descriptive statistics, including mean, standard deviation, and frequency distribution, to present the overall evaluation of the

interactive animation by preschool students, parents, and teachers. The significance level was set at $P<0.05$.

**8. Raw data survey design**

In the initial stage of design, researcher investigated the current status of learning traditional Chinese culture at Hongyuan Kindergarten. The purpose of this investigation was to gain an in-depth understanding of the current state of students' knowledge of traditional cultural elements, their interests and preferences, and the practical problems that exist in teaching, so as to provide data support and design basis for subsequent animation content design and teaching implementation.

Chapter 3 clearly outlines the research methods and processes involved in this study, which include theoretical analysis, case studies, and surveys using a mixed research method. Meanwhile, the assessed data is inferred and corrected. The next chapter presents the research results, which is also the most important part of this study. Based on the content of Chapter 3, Chapter 4 discusses the research and presents the research results.

# CHAPTER IV

# RESULTS AND DISCUSSION

Chapter 4 presents the results and discussion of activities carried out during Phases 1 to 4 of this study. These are presented to illustrate how the four objectives of this study were achieved.

**Results**

Research objectives 1: To investigate the design elements of interactive animation appropriate for the cognitive development of preschool children.

Objective 1 corresponds to Phase I

**Phase I: Using qualitative research, researching interactive animation design elements suitable for preschool students and child cognitive development mechanisms.**

1. Interactive animation element design research

In the design process of interactive animation, design elements constitute a crucial component. Kennedy et al. (1997) emphasize that the appropriate use of various design elements can enhance the visual appeal, interactivity, and user experience of animations, thereby improving the effectiveness of interactive animations. Design elements in interactive animations include plot, character design, color, sound and music, and touch elements. During the design process, it is essential to pay attention to these design attributes and apply the elements appropriately to maximize the effectiveness of the interactive animation design.

1.1 Strategies for setting interactive animated plot for children

Compared to traditional animation, interactive animation for children enhances multisensory experiences by engaging visual, auditory, and tactile senses, enabling children to interact in real-time with the plot during reading (Daryanes et al., 2023). Research findings indicate that well-structured story plots can increase children's attention, thereby enhancing their comprehension and engagement. Morrow (1985) found that audiovisual elements in digital animation can improve preschool students' recall and story retelling skills. However, different types of interactive animation may have varying cognitive effects on children, and when designing storylines, it is important to consider the acceptance levels of preschool students of different ages.

Research has shown that for children aged 3–5, interactive animations that clearly describe story elements are necessary to enhance story recall and plot comprehension. For higher-age children aged 6–7, interactive animations that implicitly extend beyond the story text can promote the development of creativity (Li et al. 2023). When designing interactivity, children aged 3–5 are more interested in repetitive, simple cause-and-effect story plots, while children aged 6–7 place greater emphasis on cause-and-effect relationships and can engage in simple reasoning. However, they still require sensory support, so this age group is better suited to “exploratory” or “task-based” branching stories (Figure 24). According to Erikson's psychosocial development theory (Erikson, E. H. 1950), children aged 3–5 are in the “initiative versus guilt” stage, where they may feel ashamed or guilty upon failure, thereby inhibiting their initiative. When designing branching stories for this age group, consider the changes brought about by different choices. While choices may affect the characters' emotions or the story's progression, they should not lead children to feel like they have failed.

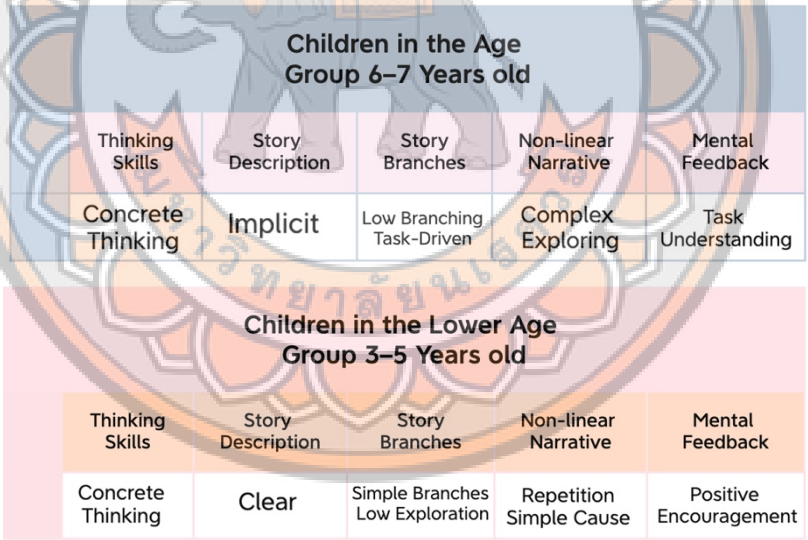



Figure 24 Interactive animation plot strategy for children aged 3-5 & 6-7

1.2 Strategies for setting interactive animated characters for children

Characters are transformed into visual figures through artistic techniques such as animation, anthropomorphism, deformation, and exaggeration, thereby endowing them with emotions. Fialho (2023) noted in their research that the different shapes of Disney cartoon characters can convey specific emotions and personality traits.Round characters are generally perceived as approachable and likable, and some studies suggest that their lack of sharp edges makes them more suitable for children's animation. In contrast,

triangular characters, as Trautmann (2021) noted, tend to convey sharpness, speed, and aggressiveness, which can evoke a sense of visual instability.

According to Sapmayada (2024), Disney animated characters tend to use oval in their designs because ovals are more flexible, easier to animate, and suitable for exaggerated movements. Squares convey stability, strength, and reliability, and are often used for powerful characters to enhance their sense of reliability. Figure 25 illustrates the common character traits corresponding to graphic designs of animated characters as compiled by the researchers. However, other studies have shown that a character's emotional impact on children is only achieved through their interaction with touchscreens, and passive video viewing does not stimulate children's learning motivation. Therefore, shapes cannot serve as the basis for children's emotional responses but should only be used as design guidelines (Zhang et al., 2023).

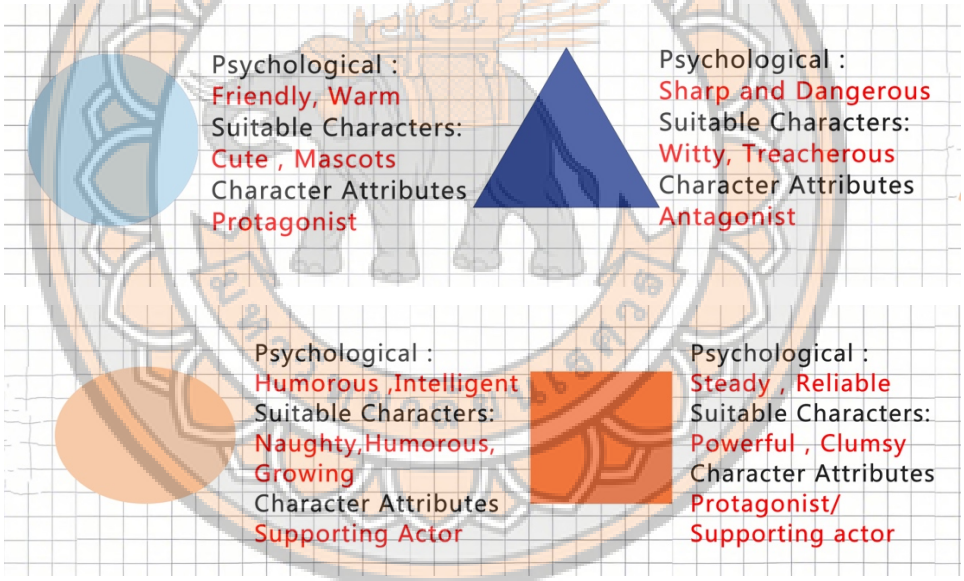



Figure 25 Different graphics used in animated character design

Costumes are an integral part of a character's visual language. Through the color, material, and style of costumes, audiences can quickly establish character recognition. In interactive animations, a character's attire can evolve with the plot, enhancing the expressiveness of their growth. In the Chinese children's dress-up app “Princess Dress-Up Adventure,” children select different outfits for virtual characters, such as Hanfu, fairy tale costumes, and modern attire. Researches has found that different clothing materials exhibit significant differences in dynamic performance during interactive presentations (Choi, 2023). For example, fairy tale princess dresses made of lightweight,

transparent fabric are more popular among girls, while metallic armor or battle attire are preferred by boys.

Through experiencing several children's educational apps on the Chinese market, we found that apps currently incorporate ethnic characteristics and traditional elements into character costumes, such as button fastenings, stand-up collars, and water sleeves (Figure 26), giving the characters cultural connotations and helping children feel and learn about traditional culture through interaction. With the development of AI technology, intelligent elements are gradually being incorporated into character costumes, enabling multi-dimensional interaction with users.

Figure 26 Application of traditional Chinese elements in costumes

Source: “XiaoHongshu” from China Application, 2023

Props are used in interactive animations to reinforce a character's personality. In children's animations, prop design can serve as unique visual memory points, and characters can use props to guide children. In “Dora the Explorer,” Dora asks children to help find a map or props in her backpack. Wartella & Jennings (2000) suggest that props designed for children in interactive animations should be as rounded and cute as possible, avoiding sharp lines and complex structures to align with children's visual cognition. Regarding color, high brightness and contrast are more likely to attract children's attention. For example, in the Japanese animation 《Doraemon》, the four-dimensional pocket and some props can change in response to children's interactions. For example, after a task is completed, props can be upgraded, which can enhance children's participation.

1.3 Strategies for setting interactive animated color for children

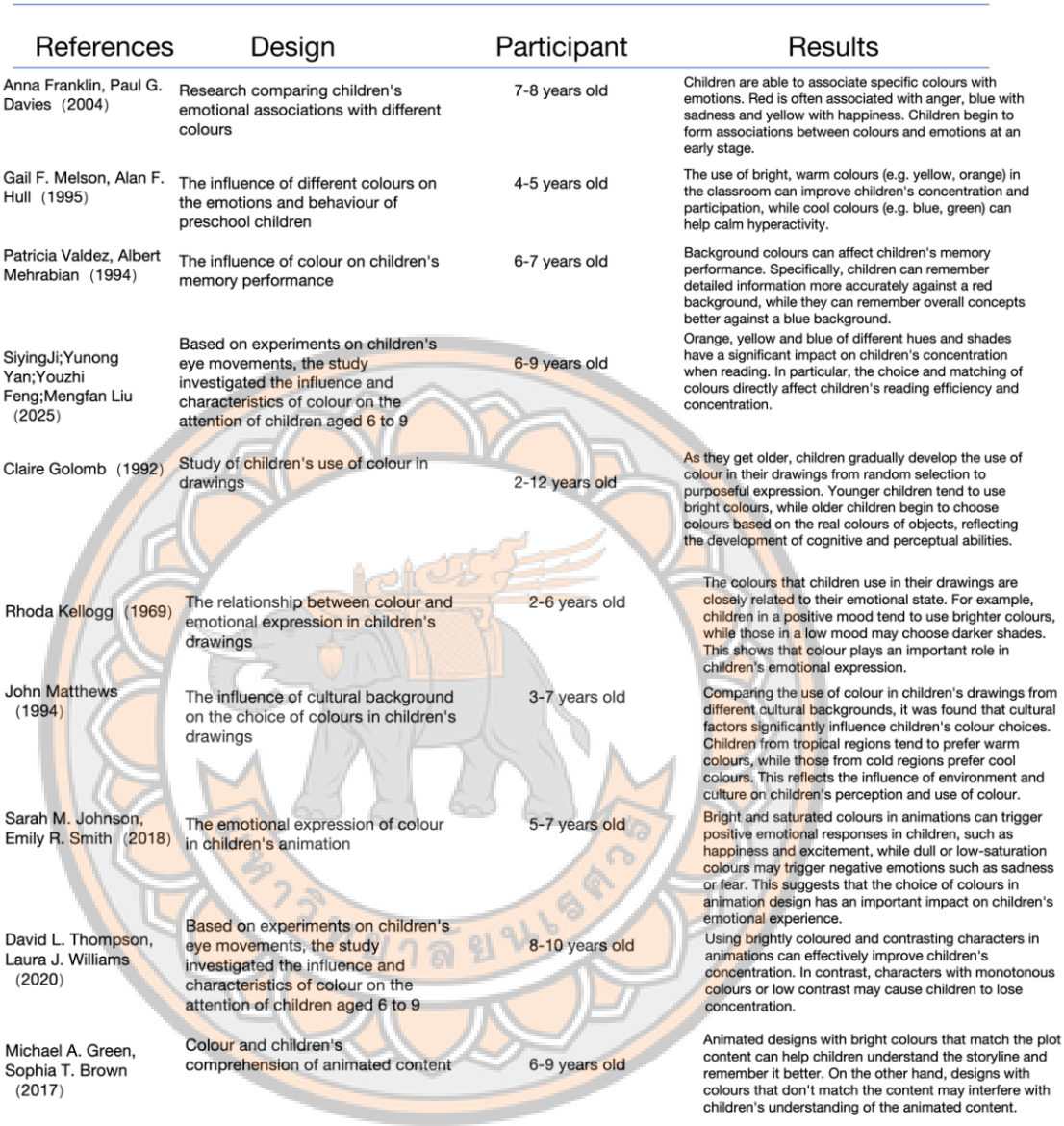
In the preschool years, different colors stimulate children's visual nerves differently and stimulate their associations. Children aged 3-4 can distinguish basic colors such as red, yellow, blue, green, orange and purple. The vision of 5-6 years old begins to approach adult vision, gradually recognising all the hues in the spectrum and distinguishing between more obvious colors in terms of brightness. Psychologist Birren (2016) showed that colors can affect children's moods. For example, some warm and harmonious colors can bring children experiences and enjoyment, and help them maintain a happy state of mind. Some dull and gloomy colors will cause children to feel anxious. Different colors also represent different emotions in psychology (Figure 27). By associating colors with emotions, children intuitively respond to colors in their paintings and in their daily lives. For example, red represents anger, blue represents sadness, and yellow represents happiness. Therefore, the appropriate use of colors can ensure children's learning effectiveness.

Figure 28 shows some representative psychological literature on children's colors. According to research, color characteristics have a significant psychological impact on children, and children also have an inherent concept of color, such as a light blue sky, dark blue sea, red sun and other established color images. The choice of colors by children can show their inner emotions, and different colors also have different emotional meanings. The choice of colors in animation design has a significant impact on children's emotional experience.

Figure 27 Emotions color

Source: Plutchik & Kellerman ,1980

Figure 28 (Cont.):



| References | Design | Participant | Results |
|---|---|---|---|
| Anna Franklin, Paul G. Davies (2004) | Research comparing children's emotional associations with different colours | 7-8 years old | Children are able to associate specific colours with emotions. Red is often associated with anger, blue with sadness and yellow with happiness. Children begin to form associations between colours and emotions at an early stage. |
| Gail F. Melson, Alan F. Hull (1995) | The influence of different colours on the emotions and behaviour of preschool children | 4-5 years old | The use of bright, warm colours (e.g. yellow, orange) in the classroom can improve children's concentration and participation, while cool colours (e.g. blue, green) can help calm hyperactivity. |
| Patricia Valdez, Albert Mehrabian (1994) | The influence of colour on children's memory performance | 6-7 years old | Background colours can affect children's memory performance. Specifically, children can remember detailed information more accurately against a red background, while they can remember overall concepts better against a blue background. |
| SiyingJi;Yunong Yan;Youzhi Feng;Mengfan Liu (2025) | Based on experiments on children's eye movements, the study investigated the influence and characteristics of colour on the attention of children aged 6 to 9 | 6-9 years old | Orange, yellow and blue of different hues and shades have a significant impact on children's concentration when reading. In particular, the choice and matching of colours directly affect children's reading efficiency and concentration. |
| Claire Golomb (1992) | Study of children's use of colour in drawings | 2-12 years old | As they get older, children gradually develop the use of colour in their drawings from random selection to purposeful expression. Younger children tend to use bright colours, while older children begin to choose colours based on the real colours of objects, reflecting the development of cognitive and perceptual abilities. |
| Rhoda Kellogg (1969) | The relationship between colour and emotional expression in children's drawings | 2-6 years old | The colours that children use in their drawings are closely related to their emotional state. For example, children in a positive mood tend to use brighter colours, while those in a low mood may choose darker shades. This shows that colour plays an important role in children's emotional expression. |
| John Matthews (1994) | The influence of cultural background on the choice of colours in children's drawings | 3-7 years old | Comparing the use of colour in children's drawings from different cultural backgrounds, it was found that cultural factors significantly influence children's colour choices. Children from tropical regions tend to prefer warm colours, while those from cold regions prefer cool colours. This reflects the influence of environment and culture on children's perception and use of colour. |
| Sarah M. Johnson, Emily R. Smith (2018) | The emotional expression of colour in children's animation | 5-7 years old | Bright and saturated colours in animations can trigger positive emotional responses in children, such as happiness and excitement, while dull or low-saturation colours may trigger negative emotions such as sadness or fear. This suggests that the choice of colours in animation design has an important impact on children's emotional experience. |
| David L. Thompson, Laura J. Williams (2020) | Based on experiments on children's eye movements, the study investigated the influence and characteristics of colour on the attention of children aged 6 to 9 | 8-10 years old | Using brightly coloured and contrasting characters in animations can effectively improve children's concentration. In contrast, characters with monotonous colours or low contrast may cause children to lose concentration. |
| Michael A. Green, Sophia T. Brown (2017) | Colour and children's comprehension of animated content | 6-9 years old | Animated designs with bright colours that match the plot content can help children understand the storyline and remember it better. On the other hand, designs with colours that don't match the content may interfere with children's understanding of the animated content. |

Figure 28 Literature on children's color psychology and emotional expression (1969-2025)

Therefore, to further understand children's perception of color, many studies have compared the color sensitivity of boys and girls, including research on animation design and interface design tailored to boys and girls. Jakovljević et al.(2021) proposed that different colors also have different effects on the comprehension and attention of boys and girls. Figure 29 summarizes the researchers' findings based on literature data regarding the preferred duration of attention to color between boys and girls.

Figure 29 (Cont.):

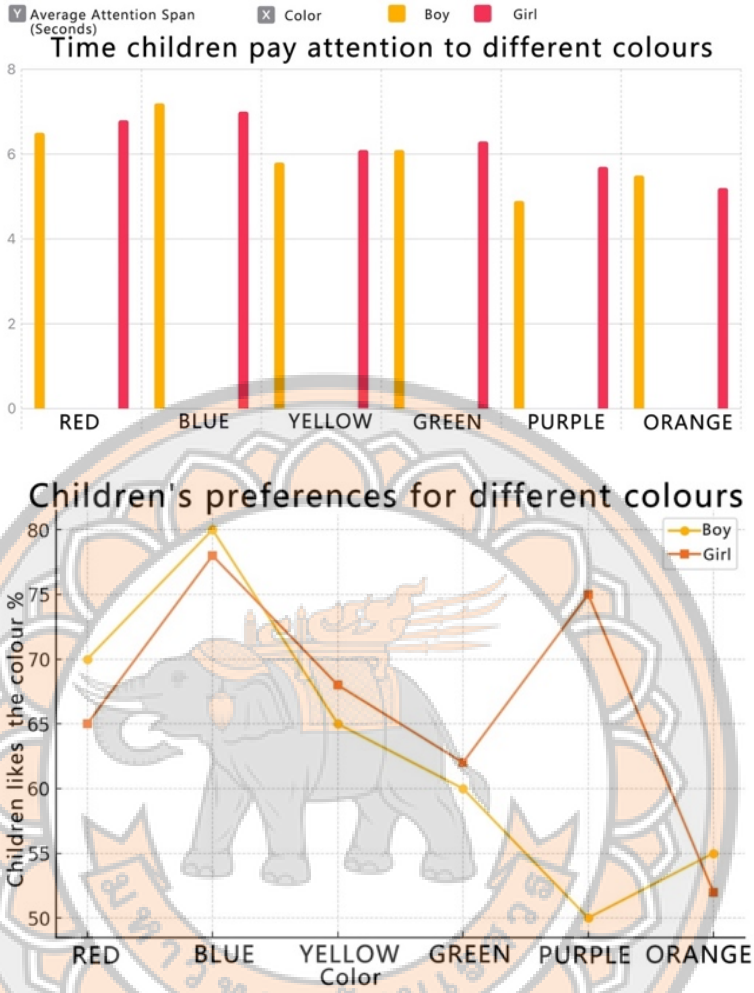



Figure 29 Children's attention span and preference for different colors

According to extensive data: Children exhibit certain differences in the duration of attention toward different colors, with an average attention span ranging from 5 to 7.5 seconds. Boys tend to prefer cool tones, such as blue, green, and dark hues, while girls prefer warm tones and bright colors, such as red and purple, which are also considered more approachable. However, some psychologists also note that it is not advisable to frame children's understanding of color based on adult perceptions, as the colors children currently prefer merely represent a stage in their developmental growth.

Brightness and luminosity are also important color factors for preschoolers.3-4 years old can distinguish basic colors such as red, yellow, blue, green and orange. 5-6 years old can begin to distinguish more obvious color luminosities (Figure 30). According to the characteristics of children’s visual development, high-luminosity

colors are the earliest and easiest for children to perceive and recognize. A light- yellow background enhances visual clarity, helping children to recognize content more quickly and increase comprehension. Child et al. (1968) proposed that colors with lower brightness are more suitable for use in a calm, focused environment, and that high-brightness colors can extend children's attention span compared to low-brightness colors. At the same time, high-brightness colors can quickly attract children's attention, and too high a brightness may cause visual fatigue, thereby reducing concentration. For puzzle-solving games, appropriate low-brightness colors can help children focus more on the core content without being distracted by overly bright elements. When making interactive choices, high-contrast buttons are easier for children to identify, but excessive brightness should be avoided.

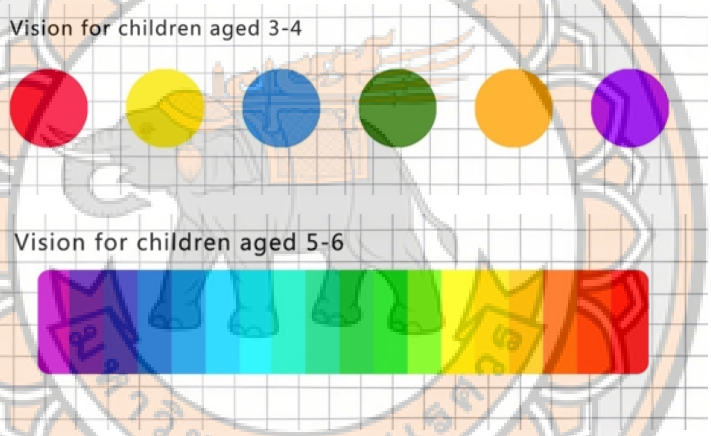



Figure 30 Color vision in children aged 3–6

Source: Wang et al ,2003

1.4 Strategies for setting interactive animated sound and music for children

The age of 3-5 is a critical period for children's initial education. Children aged 3-5 have gradually developed the ability to perceive and recognize music through their auditory senses. At the same time, children at this stage will also unconsciously hum, expressing their emotions through the frequency and amplitude of the music. For example, they will be excited by cheerful music and calm by soothing music. Li&Yu (2022) published in the journal of graphics that in an experiment, that constructing a mapping between sound and picture and an interactive platform for children's sound-picture interaction can effectively enhance children's interactive experience and increase their interest in drawing pictures.

The music in interactive animations refers to background music. Different background music can also produce different effects. Experimental research (Cassaday et al., 2002) found that in a learning environment with soft music in the background, children's emotions are more stable, and the learning time is 22% longer than in an environment without background music. Soft, looped music is also more conducive to concentration and comprehension. When soft music is played in the background, children will have a higher memory of information when learning basic concepts such as letters, shapes, and colors. Sound effects include dialogue and prompts. Dialogue is designed so that background music does not cover the voice and interactive sound effects, and for preschool students aged 3-6, there can be appropriate pauses to allow students to think independently. Interactive prompts are an important part of interactive music. Because this sound effect can guide children through interactive tasks, for example, conveying information through sound effects, a successful "ding dong" sound indicates a reward, and an incorrect "beep" sound reminds them to try again. Correct prompts can strengthen memory and make it easier for children to recall what they have learned. Bertelson & Tisseyre (1969) confirmed that prompts of different lengths have different reminder effects (Table 9). Too long an audio effect is likely to cause negative emotions in children, which will affect learning outcomes.

Table 9 The response effects of different sound effects on children

| Sound Duration | Scene | Children's Responses |
|---|---|---|
| Short (0.2–0.5 seconds) | Button clicks, swipes, feedback | Instant feedback improves concentration |
| Medium length (0.5–1 second) | Rewards, error messages, task start | Enhances interactivity and aids comprehension |
| Long sound effect (1-2 seconds) | Countdown, special animations, situational sound effects | Create a sense of immersion and guide emotions |

Source: Bertelson & Tisseyre ,1969

1.5 Strategies for setting interactive animated touch elements for children

Touch elements are a characteristic of interactive animation design, and intuitive operation allows users to interact with the machine. This interaction puts the user in the

driving seat and is designed to cater to interactive and fun learning methods. In children's interactive animations, because children are at an early stage of cognition, we have to consider the design of the touch elements of the interactive animation.

In children's interactive animations, the main touch elements are in the form of clicks, drags, swipes, pinches and rotations (Figure 31). In interactive animation learning, children's cognition is obtained through these parts of the touch method. Xie et al. (2018) have confirmed that the reasonable use of touch elements can help children understand cause and effect relationships more quickly, strengthen their understanding of logic, and thus better enhance their understanding and creativity. It has been confirmed by child experts that active touch in interactive animations can increase attention and concentration and also improve memory, compared to passive viewing of interactive animations. Therefore, touch element design can help enhance the interactive animation experience.

Figure 31 Children's touch gestures in interactive animations

According to research on interactive animation apps currently on the market, clicking and dragging are the most commonly used interactive button forms. Especially for interactive animation designed for children aged 3-4, clicking and dragging are the simplest forms of interaction, quickly helping children establish cause-and-effect relationships within the story. Interactive animations designed for children aged 5-6 can add interactive button forms such as swiping and pinching, because the cognition of 5-6 years old is gradually developing. Swiping can exercise the fine control of children's fingers and wrists, and pinching will help children observe. Swiping buttons are suitable for exploratory interactive animations, such as zooming in on a map. During the touch control process, an effective mechanism needs to be established with the child. Sluggishness and slow feedback can cause unnecessary cognitive distraction in the learning process. In addition, Lanna & Oro (2019) found in their research that children

aged 3-6 years old occasionally drag and click unnecessarily on the device due to physical limitations, so effective guidance is needed during the design process.

2. Child psychological cognitive development

Gaining an understanding of children's cognitive development is very important for interactive animation design, as children's cognitive development directly affects how they use interactive animation to improve their comprehension and creativity. Children of different ages differ in terms of perception and attention, language development, and thinking and reasoning. By studying the cognitive development of preschool children aged 3-6, researchers will learn how to use interactive animation to improve their comprehension and creativity.

2.1 Perception

Children in the pre-operational stage are in a concrete thinking mode and cannot understand abstract concepts. Children in this stage can associate real-life objects or events with representational symbols, and their internal mental representations are extremely rich（Figure 32）. They begin to use symbols to replace the real world, or express real ideas through drawings. They use simple lines and colors to replace "mum", "sun" or "animals". Children at this stage believe that some things are also conscious and alive. They often extend human consciousness and motives to inanimate things, for example, treating toys as real companions and pencils as a castle. This process is called "Animism" (Tylor, 1871).

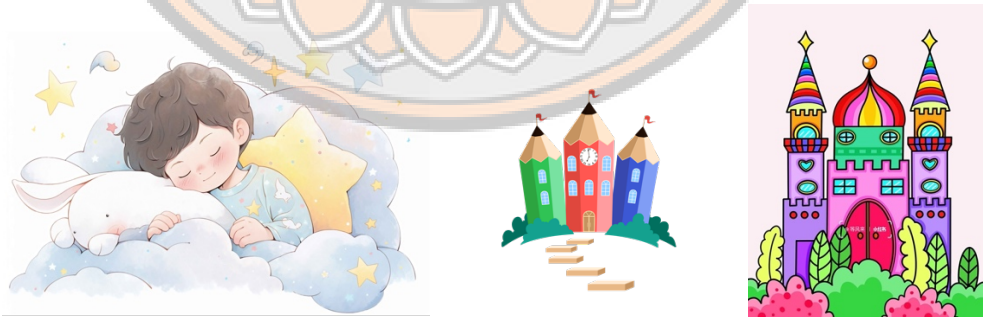


Figure 32 Example of animism theory

Source: "XiaoHongshu" from China Application, 2023

The animist perspective is widely used in character design for interactive animation. Goldman & Poulin-Dubois (2024) proposed that the anthropomorphic behaviour of characters in interactive animation can better engage children in the role, such as "speaking", jumping" and "smiling", which will promote the development of

children’s imagination and creativity. In addition, according to researchers’ studies of the literature on the design of interactive animation characters, animal characters are more popular than human characters. Compared with human characters, talking animals, animals that wear clothes or animals that can dance are more likely to stimulate children’s imagination. The reasonable use of animism theory to help children establish an emotional connection is important for interactive animation design. Interactive animation design that conforms to children’s perceptual characteristics can enhance their interest, strengthen the interactive experience, and thus promote their understanding of the learning content and the development of creativity.

2.2 Attention

Attention is the initial stage of children's thinking. The stability and concentration of attention directly affect the acquisition and processing of information. Children's attention span also increases with age.

• Children aged 3-4 years old generally have an attention span of about 5-10 minutes.

• Children aged 5-6 years old have an attention span of about 10-15 minutes.

According to Leontiev (1978), children's attention can be divided into two types:

• Inattentive attention: At the early age of 3-4 years old, children mainly have inattentive attention, which is passive and easily distracted.

• Intentional attention: As children grow older, they begin to develop a sense of purpose and goal orientation, and their attention gradually becomes autonomous and controllable.

Children with intentional attention paid more attention to details and refinement than those with unintentional attention. At the same time, there were significant differences in their attention to graphics, colors, sounds, and interactions (Figure 33). They paid more attention to changes in graphic details, shifted their focus from basic colors to recognizing more color layers, and shifted their focus from simple geometric shapes to recognizing complex shapes in interactive buttons (Figure 34).

Lin (2011) concluded in his study on the role of animation in enhancing children's attention that children should actively search for or utilize specific visual information within animations to enhance their attention. This strategy also reduces cognitive load caused by irrelevant searches, freeing up working memory capacity for more intrinsic

learning. In interactive animations, guiding children to actively search for visual content can improve their attention. However, it is important to consider the varying durations of attention among different children and design interactive animations appropriately.

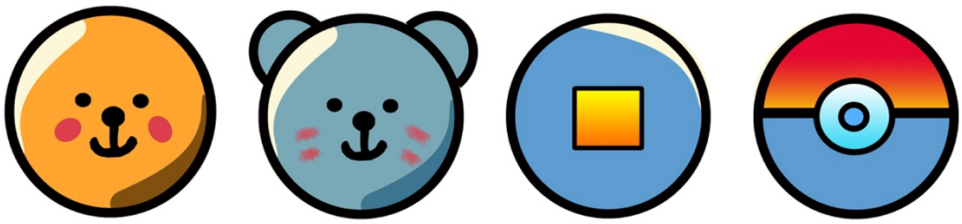


Figure 33 Comparison of attention graphics in children of different ages

Figure 34 Comparison of attention color in children of different ages

2.3 Thinking

Children in the pre-operational stage of thinking mainly use intuitive thinking, and they like stories that present exaggerated visuals, story-driven plots, and simple cause-and-effect interactions. Also, children in this stage are in an irreversible thinking mode and have difficulty thinking backwards. For example, when children pour juice from a short and fat cup into a tall and thin cup, due to their irreversible thinking, they will mistakenly believe that there is more juice in the tall and thin cup because they only focus on the height and ignore the fact that the volume remains the same（Figure 35）.

Figure 35 Demonstration of irreversible thinking

In conjunction with this research, some interactive animation designs will use demonstrations to help children demonstrate logical thinking. This will greatly help children establish cause and effect relationships, such as putting apples in a basket in sequence, or rescuing trapped animals in sequence, etc. Also, the undo and redo touch elements in the interactive animation will cause difficulties for children to understand, resulting in frustration due to incorrect operation. Voice-over animation guidance is more acceptable and easier for children to understand than pure pictures or text.

Research objectives 2: To identify elements of traditional Chinese culture that are suitable for interactive animation design, with the aim of enhancing preschool children's comprehension and creative skills.

Objective 2 corresponds to Phase II

**Phase II: Selecting traditional Chinese culture content suitable for preschool students to enhance preschool students' comprehension and creativity skills.**

1. Research on Traditional Chinese Culture

Research on traditional Chinese culture is focused on the current situation of preschool students' learning of traditional Chinese culture and the content of traditional culture. Through research on these two aspects, traditional culture suitable for interactive animation design is selected to enable preschool students to understand and creatively learn traditional culture, which is also the ultimate goal of the research.

1.1 Study on the Current Situation of Preschool Students Learning Traditional Culture in China

According to the current educational plan for kindergartens, there are obvious differences and levels in the traditional cultural teaching content and targets for preschool students aged 3-4 and 5-6.

• 3-4 years old: The teaching content mainly focuses on reading and literacy. Through the teacher's guidance, children learn to read traditional culture and recognize characters while reading. This stage emphasizes language input and knowledge absorption, and is a fundamental stage that focuses on cultivating comprehension.

• 5-6 years old: Based on reading and literacy, the teaching content adds the element of storytelling about traditional culture. Children not only master the connotations of traditional culture, but also form their own understanding and are able to narrate it creatively.

Therefore, in view of the course structure, students aged 3-4 mainly focus on understanding, while those aged 5-6 gradually transition to creative expression. The core objectives of both are to enhance preschool students' comprehension and creativity in traditional culture.

The primary methods through which preschool students learn traditional culture include art activities conducted by kindergartens, by parents, by book reading, and interactive game experiences. Figure 36 presents a survey questionnaire conducted in 2022 targeting students from a kindergarten in Jinshui District, Zhengzhou City, Henan Province, China. The questionnaire reveals the ranking of preschool students' preferences for different traditional culture learning methods.As shown in the figure, “Games & Interactive Experiences” are the most preferred learning method among children, followed by “Craftsmanship” and “Storytelling & Reading.” In contrast, “Drama” and “Learn with Parents” are less popular.

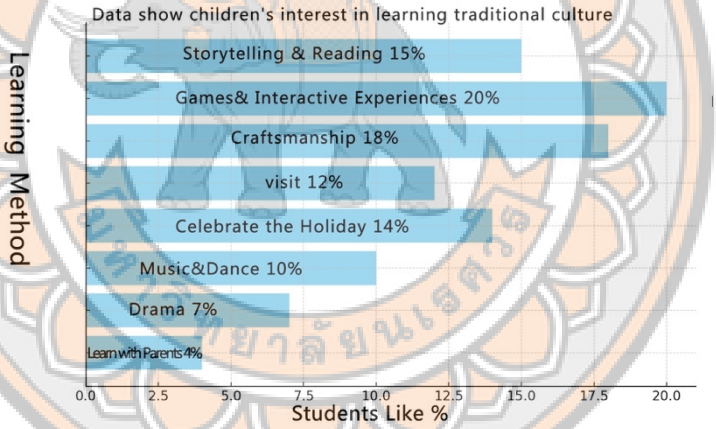



Figure 36 Data show children's interest in learning traditional culture

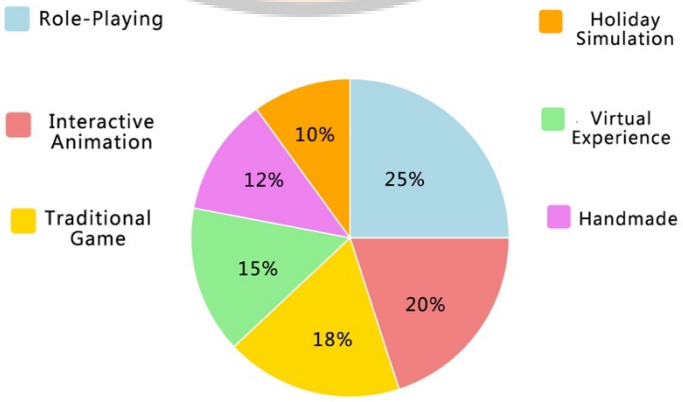



Figure 37 Children's preferences for different ways of playing and interacting

At the same time, the kindergarten also conducted a questionnaire survey on game-based and interactive learning methods (Figure 37). The results showed that "Role-Playing" was the most popular interactive method among children, followed by "Interactive Animation", "Virtual Experience" ranking fourth. This indicates that children prefer immersive and highly interactive learning methods, which can stimulate their enthusiasm for active learning.

Additionally, aesthetic theories such as “天人合一” and “中庸” hold significant research value in Chinese design. For instance, “天人合一” emphasizes harmony between humans and nature, while the Doctrine of the Mean stresses balance and moderation. These aesthetic principles are frequently applied in the background design of Chinese animation. Furthermore, certain Chinese educational theories warrant examination, such as Tao Xingzhi's theory of life-based learning, which stresses integrating education with daily existence. One could argue that the design of festival customs and traditional stories in animation draws from children's everyday experiences, enabling them to “learn through life and gain insight through experience.”

1.2 Research on Elements of Traditional Chinese Culture

Interactive animation has market potential in China. Based on the current click-through rates for traditional culture-related animations among Chinese children (as of 2022) (no data was found for interactive animation click-through rates), the top three types of animations preferred by children are "Mythology","Traditional Festival", and "Intangible Cultural Heritage" (Table 10).

Table 10 Click rate of traditional culture-related animations among Chinese children table (as of 2022) (Ten thousand calculate)

| | Animation | Click Rate (Ten Thousand) |
|---|---|---|
| 1 | Mythology | 250 |
| 2 | Traditional Festival | 230 |
| 3 | Intangible Cultural Heritage | 196 |
| 4 | Historical Allusion | 170 |
| 5 | Story of Chinese Idiom | 142 |
| 6 | Farming Culture | 127 |
| 7 | Theatrical Art | 98 |

First, Chinese mythology (such as idiom stories, myths and legends, and historical anecdotes) is highly narrative in nature and suitable for increasing participation through role-playing and interactive experiences. By setting different branches that influence the direction of the story, a single storyline can develop into multiple storylines, thereby increasing understanding of traditional culture. This interaction not only stimulates creative thinking, but also deepens understanding of traditional cultural plots and characters.

Secondly, traditional festival-related content (such as the Spring Festival, Dragon Boat Festival, and Mid-Autumn Festival) is suitable for task-based interactive experiences to engage children. As Bao (2024) pointed out, traditional festivals are well-suited for creating children's picture books, which can spark children's interest through interactive reading. In some Chinese interactive animation apps, similar interactive designs such as “making dumplings” and “making zongzi” allow children to select ingredients, operate tools, and complete festival activities.

Third, Chinese arts and crafts (such as Chinese calligraphy, shadow puppetry, and Peking opera) are more suitable for interactive animation design that emphasizes control and exploration. These arts emphasize hands-on practice and sensory feedback, allowing children to form a preliminary understanding of traditional arts and crafts.

Role design should be differentiated according to cultural categories and narrative styles. Mythological characters should adopt classic designs (such as Sun Wukong, Nezha, and Zhu Bajie) to reinforce story recognition. Festival-related content should be presented in the form of cartoon animals with cultural props, such as cats dressed in traditional costumes and zodiac animals eating dumplings, to increase cultural appeal.

Furthermore, in interactive animation, “signature action” design is equally crucial. “Signature action” refer to representative, repetitive, and easily recognizable body language that helps enhance character emotional expression and improve character recognition. As Nie (2005) noted in 《Animation Introduction》, many characters in traditional Chinese animation possess iconic and recognizable “signature action”, such as the Monkey King wielding his golden staff, Nezha standing on his Wind Fire Wheels, and Black Cat Detective saluting. These actions can serve not only as key feedback points or trigger mechanisms in interactive processes, but also as carriers of cultural memory.

In subsequent practice and research, the design of role images and “signature action” in traditional Chinese culture can be based on studies of children's cognitive and emotional receptivity to different styles of character design and action. In addition, the assessment model for whether interactive animation can promote traditional culture learning among preschool students needs to be further refined in the future.

Research objectives 3: To design interactive animations elements aimed at improving preschool children’s skills to learn traditional Chinese culture.

Objective 3 corresponds to Phase III

**Phase III: Based on the results of qualitative research, interactive animations were designed to enhance preschool students' skills in learning traditional culture.**

3.1 Plot

Figure 38 shows the structure of the interactive animation plot, which is based on the themes of Spring Festival, The Mid-Autumn Festival, and Laba Rice Porridge Festival. The main storyline focuses on clearly describing the story, with interactive elements added after each scene. For 4 - 5 years old children in middle kindergarten, the plot helps them sort out clear and concise storylines. Additionally, the extension of the storyline incorporates interactive animation elements that require a certain degree of logical reasoning.

This design demonstrates a gradual increase in difficulty as the plot progresses. For example, in the interactive animation with the “Spring Festival”, Plot 2 supplements and explains Plot 1, providing children with a deeper understanding. Plot 3 is an upgrade based on Plot 2, incorporating more challenging content to guide children to engage in more complex thinking and judgment (Figure 39), thereby stimulating their creativity. The same design logic is applied to the “The Mid-Autumn Festival” and “Laba Rice PorridgeFestival”, ensuring that the entire learning process is both coherent and multi-layered.

It is worth noting that, despite the higher difficulty level of Plot3 and similar scenarios, preschool-aged children may fail to complete tasks due to incorrect choices. However, according to Erikson's (Erikson, E. H., 1950), children at this stage are in the “initiative versus guilt” developmental period. They tend to establish autonomy and initiative through trial and error, so even when faced with challenges or failure, they do

not experience negative emotions. Instead, these experiences may motivate them to further explore and learn.

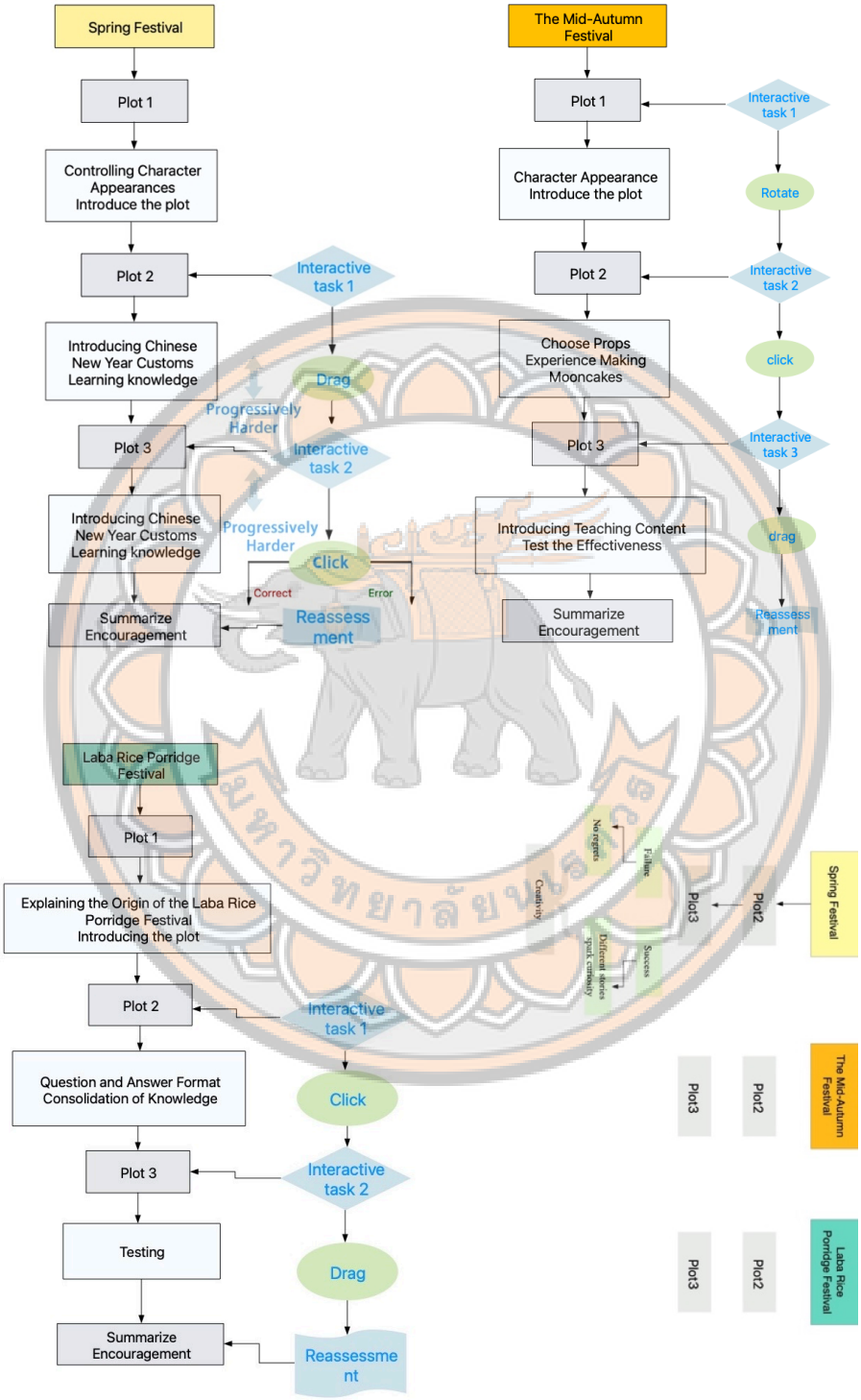



Figure 38 Interactive animation plot structure diagram

Figure 39 Interactive animation plot progression diagram

During the branching narrative selection process, interactive animations dynamically add corresponding visual elements based on children's choices, thus providing support and guidance to children at the visual sensory level (Figure 40). This design enhances the immersiveness of interactive animations and effectively stimulates children's sensory interest and motivation to participate. Even if children encounter “failure” during the selection process, they will not feel frustrated or guilty. Instead, they will experience different visual effects and story developments due to the changes in the plot path, further stimulating their curiosity to explore. This design philosophy draws inspiration from strategies used in interactive animation education in the United States, emphasizing a “task-oriented” approach to presenting branching plots, guiding children to actively think and operate, thereby enhancing their problem-solving abilities and logical reasoning skills. In this process, children gain positive participation experiences through continuous trial and error and feedback, which helps cultivate their awareness and capacity for independent learning.

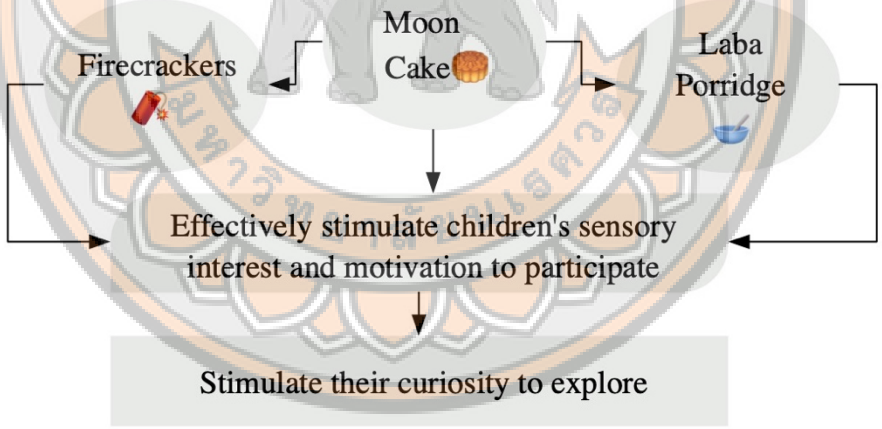



Figure 40 Visual elements of interactive animation plot

In the interactive animation studied, the story plot design combines the theoretical basis of children's cognitive development and attention mechanisms. According to the theoretical research on “attention” in Objective 1 above, based on Lin (2011), animation that guides children to actively search for or use specific visual information not only helps improve their attention span and effectively reduces irrelevant cognitive load caused by aimless searching, it also frees up more working memory resources for deeper learning and understanding.

Based on this theory, this interactive animation employs a multi-segment branching structure and visually guided cues (Figure 41) in its plot design to encourage children to independently explore key elements of the story. For example, in themes such as “Spring Festival” or “The Mid-Autumn Festival,” through character dialogue, environmental changes, or task prompts, children are guided to focus on specific clues or scene changes to complete task-based interactions. Such designs enhance children's concentration while watching and encourage them to form purposeful visual search strategies through repeated interactions.

Figure 41 Interaction design visual prompt diagram

In particular, considering the differences in attention span among children aged 4–5 years old in middle kindergarten, interactive animations were adjusted in terms of rhythm control and interaction node arrangement. The design avoids overly long single animation playback times and inserts interactive operations and feedback at appropriate times to form a “watch-operation-feedback” (Figure 42) cycle to maintain continuous participation and psychological engagement.

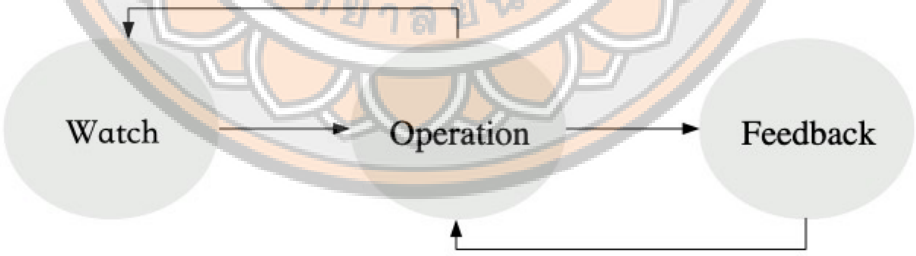



Figure 42 Interaction design operation and feedback patterns

3.2 Storyboard

• “Spring Festival”（Figure 43）

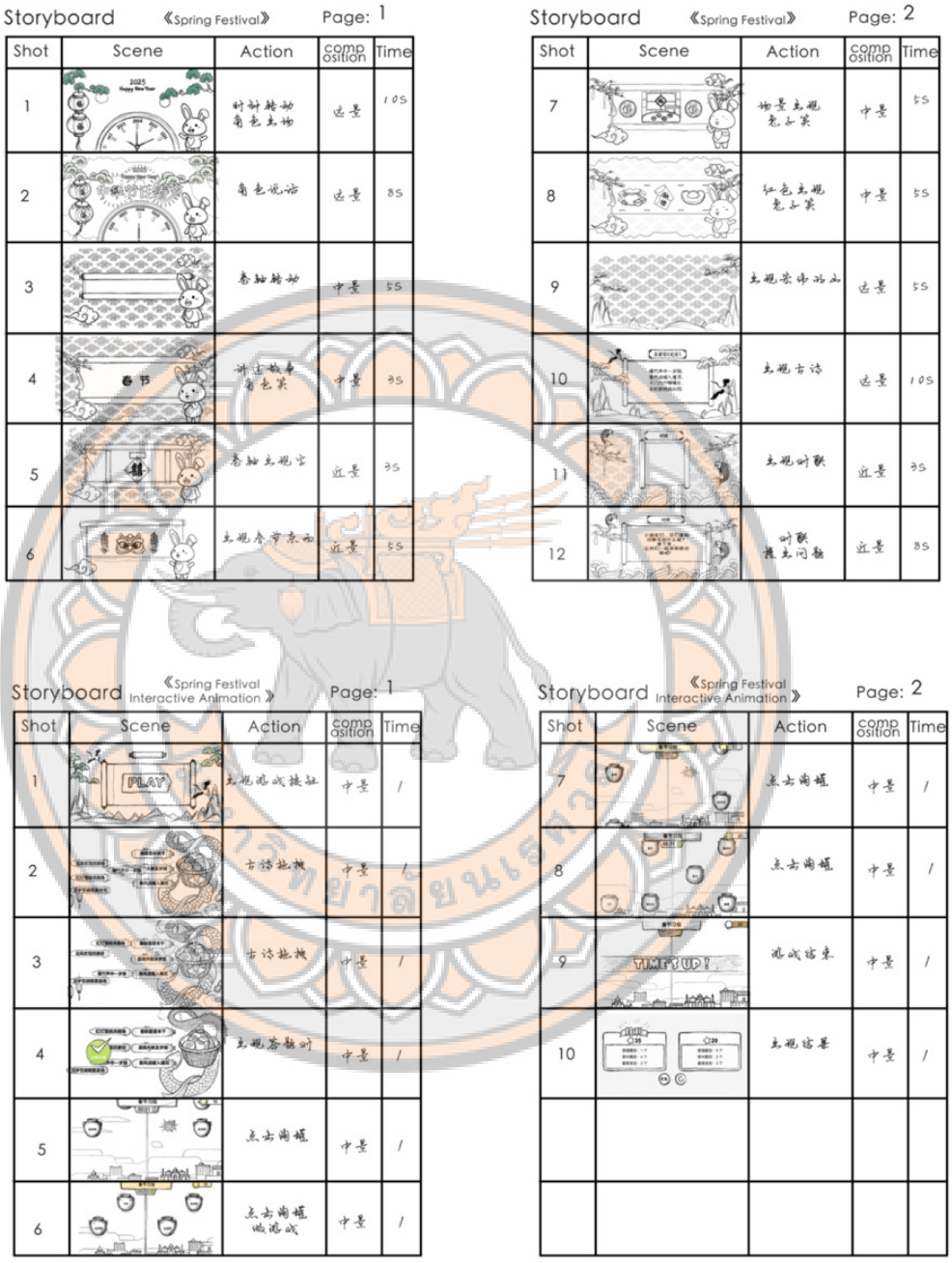



Figure 43 “Spring Festival” interactive animation storyboard

• “The Mid-Autumn Festival” （Figure 44）

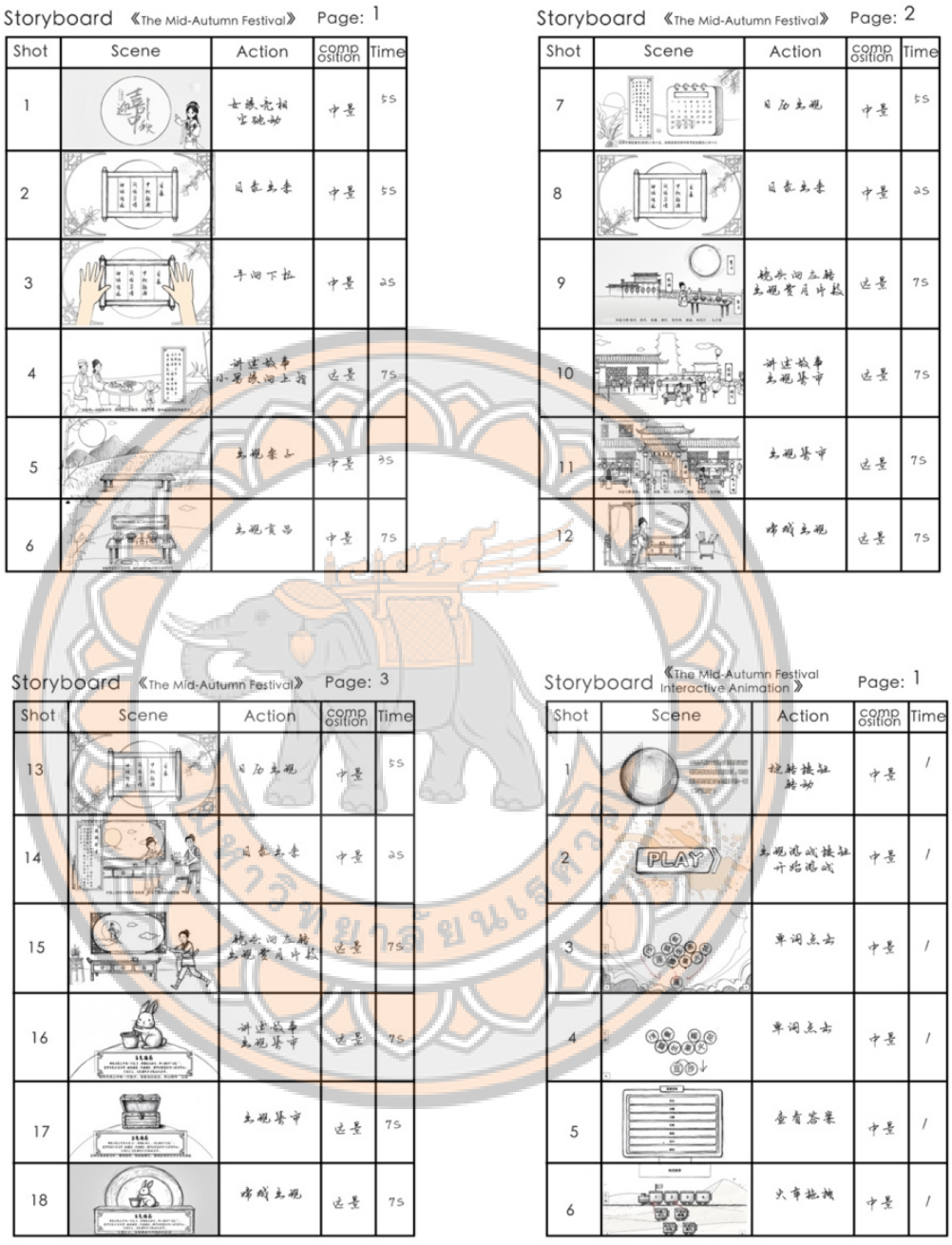



Figure 44 “The Mid-Autumn Festival” animation storyboard

• “Laba Rice Porridge Festival” （Figure 45）

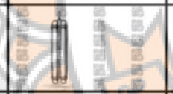
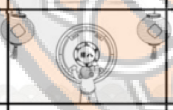
Storyboard 《Laba Rice Porridge Festival》 Page: 1

| Shot | Scene | Action | composition | Time |
|---|---|---|---|---|
| 1 | | 小老鼠 | 远景 | 5S |
| 2 | | 讲述今天 腊八由来 | 远景 | 7S |
| 3 | | 梅花摆动 下雪 | 中景 | 2S |
| 4 | | 老鼠咯咯笑，灯笼摆动 活动摆动 | 中景 | 3S |
| 5 | | 转动 变一盘色和白色 | 近景 | 2S |
| 6 | | 逐渐 变成黄色 | 近景 | 2S |

Storyboard 《Laba Rice Porridge Festival》 Page: 2

| Shot | Scene | Action | composition | Time |
|---|---|---|---|---|
| 7 | | 灯笼 慢慢出现 | 中景 | 3S |
| 8 | | 叶上逐渐放大 | 中景 | 4S |
| 9 | | 腊八粥 | 慢慢出现 | 远景 | 2S |
| 10 | | 腊八品 腊八粥 腊八豆腐 | 腊八粥和豆腐 慢慢出现 | 远景 | 5S |
| 11 | | 咯咯笑着 | 近景 | 2S |
| 12 | | 图案出现 | 近景 | 3S |

Storyboard 《Laba Rice Porridge Festival》 Page: 3

| Shot | Scene | Action | composition | Time |
|---|---|---|---|---|
| 13 |  | 卷轴打开 | 中景 | 4S |
| 14 | | 出现图案 | 远景 | 3S |
| 15 |  | 小熊滚动 | 远景 | 5S |
| | | | | |
| | | | | |
| | | | | |

Storyboard 《Laba Rice Porridge Festival Interactive Animation》 Page: 1

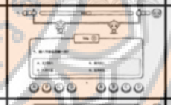
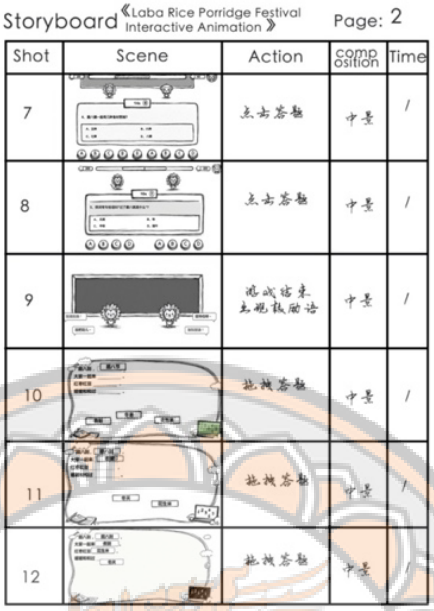
| Shot | Scene | Action | composition | Time |
|---|---|---|---|---|
| 1 | | 出现开始 游戏按钮 | 中景 | / |
| 2 |  | 点击答题 | 中景 | / |
| 3 | | 点击答题 | 中景 | / |
| 4 | | 点击答题 | 中景 | / |
| 5 | | 点击答题 | 中景 | / |
| 6 | | 点击答题 | 中景 | / |

Figure 45 (Cont.):


Storyboard 《Laba Rice Porridge Festival Interactive Animation》 Page: 2

| Shot | Scene | Action | composition | Time |
|---|---|---|---|---|
| 7 | | | | / |
| 8 | | | | / |
| 9 | | | | / |
| 10 | | | | / |
| 11 | | | | / |
| 12 | | | | |

Figure 45 “Laba Rice Porridge Festival”animation storyboard

3.3 Character Design

Researcher designed three characters for role design, named “Pudgy Rabbit” , “Sister Luna” and “Lucky Rat” (Figure 46) . Character design fully incorporates the principles of Objective 1. The adorable “Pudgy Rabbit” and “Lucky Rat” feature oval shapes to enhance their approachable and playful appeal. For these animal characters, round eyes and bodies are integrated to convey intelligence. “Sister Luna” is modeled after human figures with a square design to enhance stability and reliability.

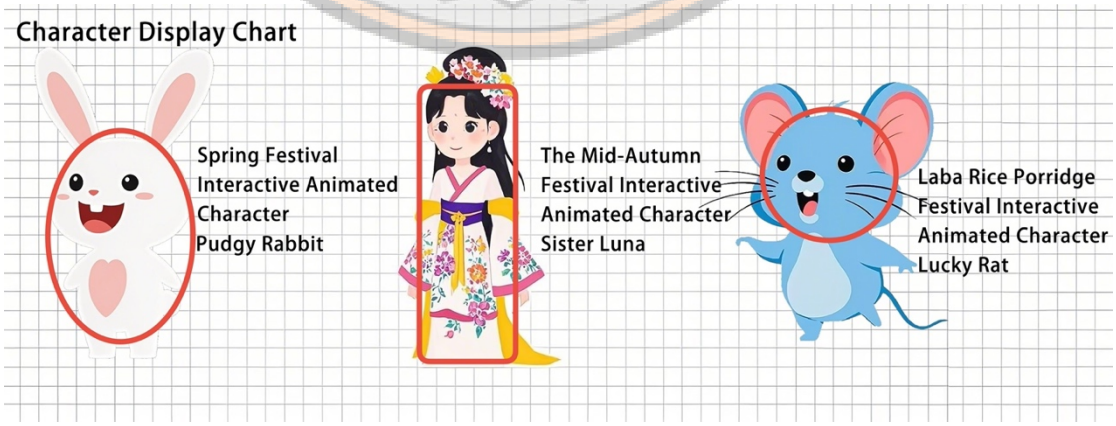



Figure 46 Interactive animation character design

• “Spring Festival”, “Pudgy Rabbit” character design (Figure 47-51)

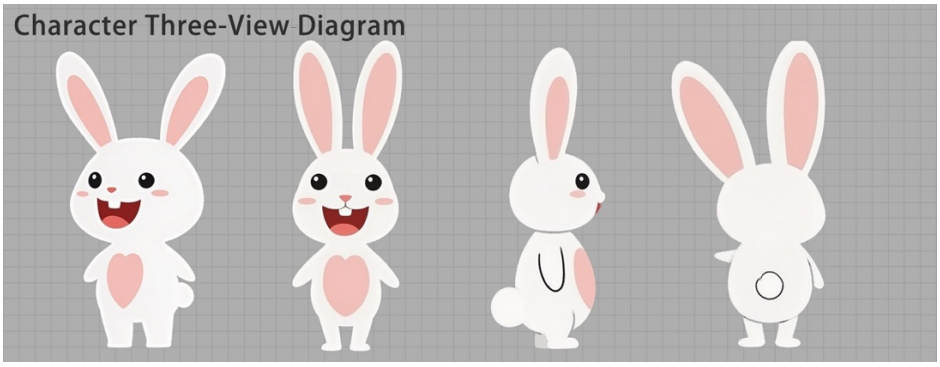



Figure 47 “Pudgy Rabbit” three-view diagram

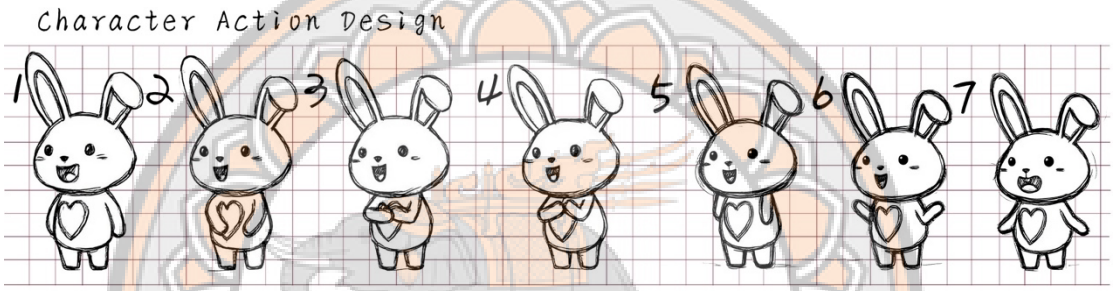



Figure 48 “Pudgy Rabbit” sketch action design

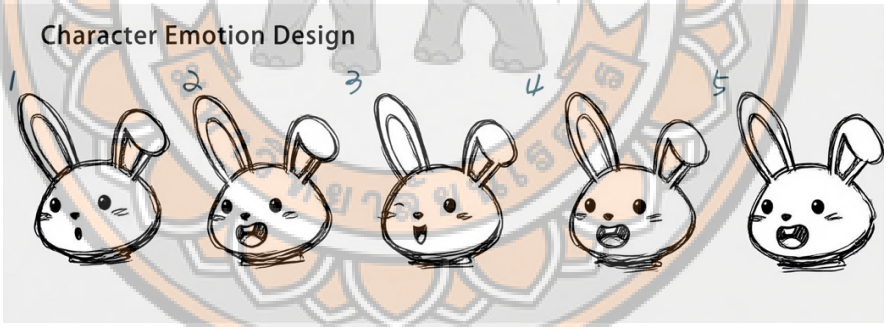



Figure 49 “Pudgy Rabbit” sketch emotion design

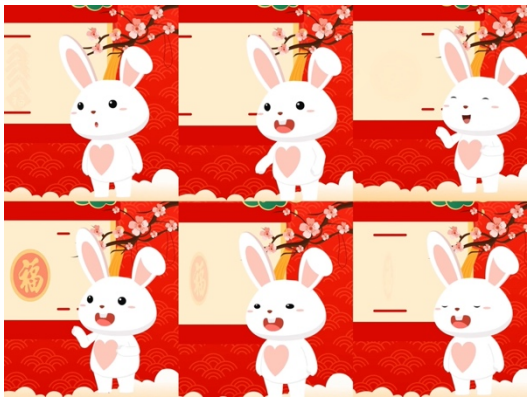


Figure 50 “Pudgy Rabbit” action design

Figure 51 “Pudgy Rabbit” emotion design

• “The Mid-Autumn Festival”, “Sister Luna” character design (Figure 52-56)

Figure 52 “Sister Luna” three-view diagram

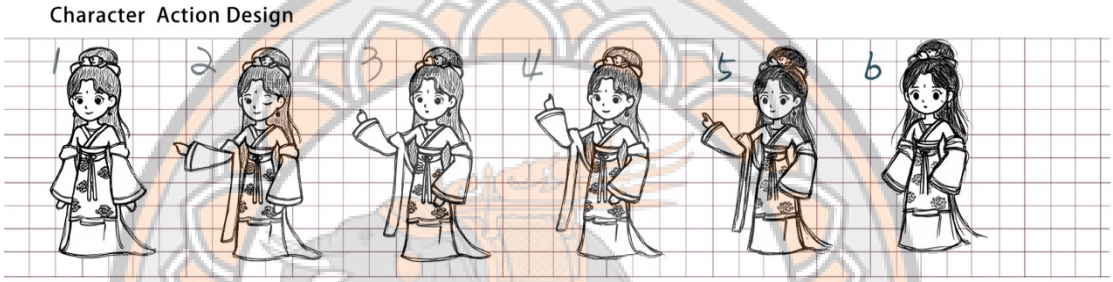



Figure 53 “Sister Luna” sketch action design

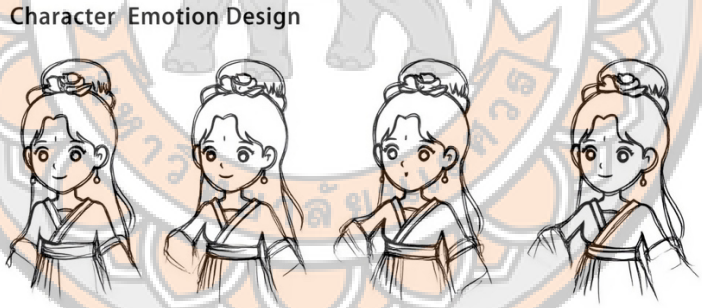



Figure 54 “Sister Luna” sketch emotion design

Figure 55 “Sister Luna” action design

Figure 56 “Sister Luna” emotion design

• “Laba Rice Porridge Festival”, “Lucky Rat”character design(Figure 57-58)

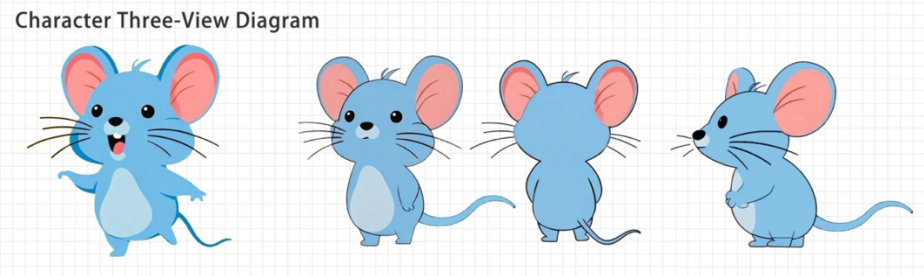



Figure 57 “Lucky Rat” three-view diagram

Figure 58 “Lucky Rat” character emotions

The character's movements are also embedded with “behavioral mimicry” from Japanese interactive animation, such as the traditional Chinese cultural actions of “paying New Year's calls,” “moon viewing,” and “greeting.”The plot incorporates positive elements, such as the character encouraging children to think and actively driving the story forward. These action designs are based on children's psychological expectations of “signature action”, such as the iconic “New Year's greetings” gesture during the Spring Festival and the “moon-gazing” gesture during the Mid-Autumn Festival. These actions provide children with psychological expectations and emotional support (Figure 59), thereby promoting their comprehension and innovation.

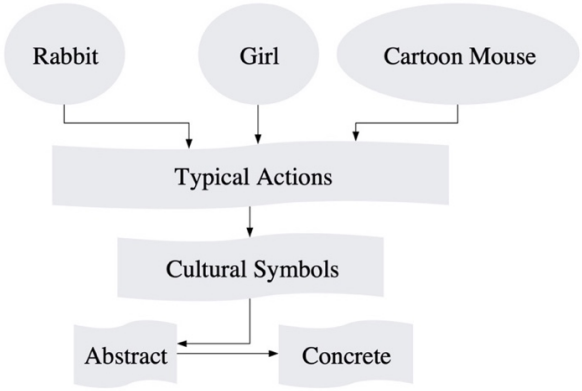



Figure 59 Cultural symbol conversion

For character costume, researcher considered cultural categories and narrative styles, and through the reasonable selection and construction of visual symbols, enhanced the cultural recognition and emotional appeal of the animation content. Specifically, for interactive animations themed around festivals, this study selected a white rabbit as the main character in the Spring Festival, aligning with the cultural tradition of the Chinese lunar zodiac. Moreover, the cartoon rabbit design resonates with children's cognitive development, effectively evoking emotional resonance among preschool children and increasing their willingness to participate.

In the Mid-Autumn Festival theme, a girl dressed in Hanfu (Sister Luna) is chosen as the main guide character. Through the cultural symbols of traditional clothing, children are guided to perceive and understand the aesthetic beauty of China's excellent traditional clothing. This enhances the cultural depth of visual expression and achieves the dual goals of plot comprehension and cultural awareness. In the interactive animation for the Laba Festival, a blue cartoon mouse is chosen as the main character, combining elements of the Chinese zodiac culture and festival food customs.Blue has strong visual recognition, helping to focus children's attention while aligning with the seasonal characteristics of the Laba Festival. This visual design endows the character with greater approachability and interactive potential. Through the use of cultural props such as the character “eating Laba porridge, the abstract becomes concrete, helping children deepen their understanding and memory of traditional festival customs through hands-on activities and observation (Figure 60).

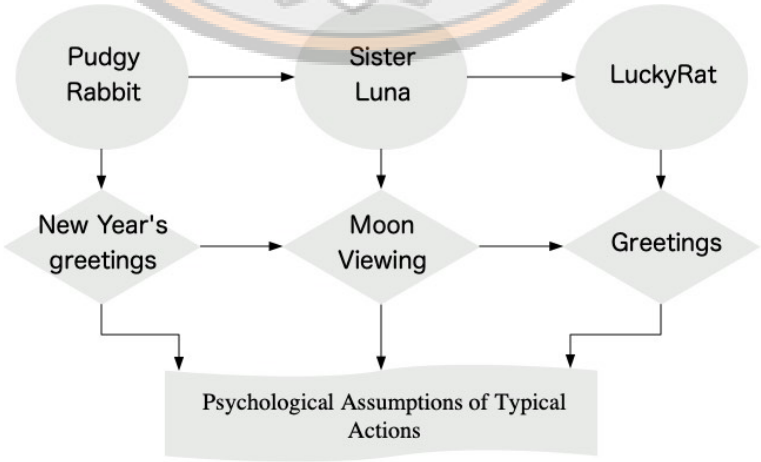



Figure 60 Symbolic gestures “signature action”

Based on the principles of interactive animation costume design outlined in Objective 1, the researcher adopted a strategy combining “Subtraction” and “Addition” for the interactive animation character costumes in this study (Figure 61) to achieve harmony and consistency between the visual presentation of the character costumes and the overall animation style.

For example, in the interactive animations themed around “Spring Festival” and “Laba Rice PorridgeFestival” considering that the background scenes already possess sufficient visual impact and cultural significance, the researchers intentionally simplified the complexity of the main characters' costumes,the “Pudgy Rabbit” and “Lucky Rat”,to avoid visual distractions caused by excessive decorative elements, thereby reducing cognitive load for children.

This simplified approach not only highlights key cultural elements in the festival scenes but also helps children focus their attention on the main plot and interactive content. This is also based on children's cognitive development of attention. According to the research in Objective 1, children aged 4–5 gradually develop intentional attention but have not yet fully developed the precision required for intentional attention. Therefore, design should take into account differences in precision.

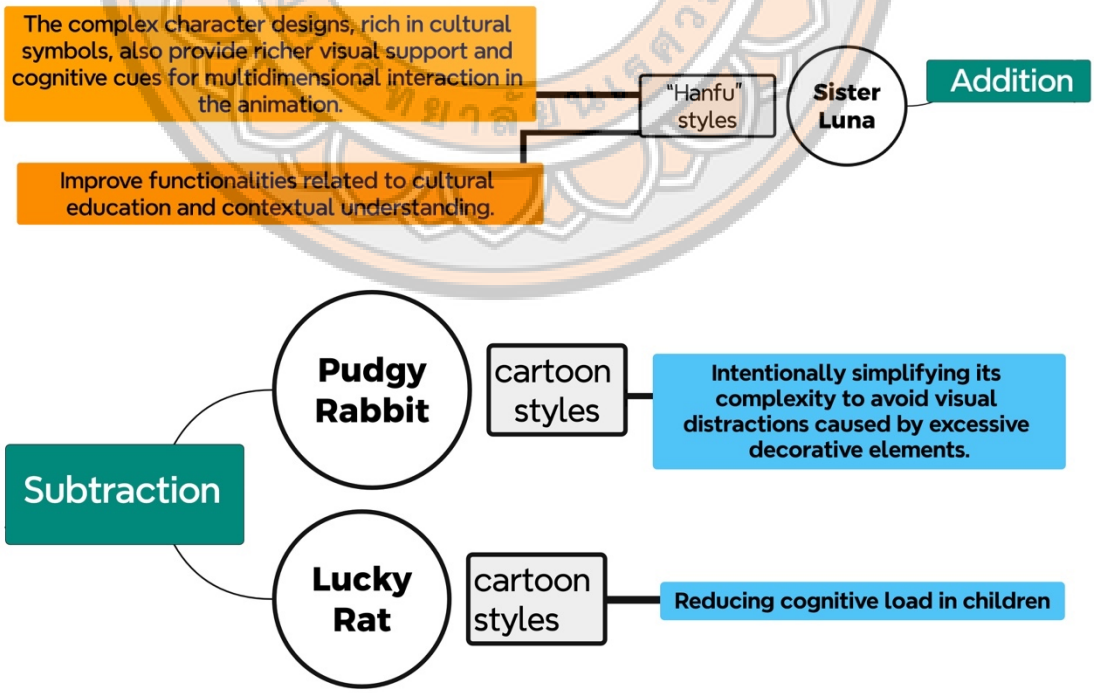



Figure 61 Interactive animation costume design principles

In contrast, in the interactive animation themed around “The Mid-Autumn Festival”, researcher adopted an “addition” strategy, incorporating more traditional ethnic elements into the design of the character “Sister Luna”, especially in her clothing, which was based on representative Hanfu styles. This visual reinforcement of culture improved the cultural recognition of the character and helped children better understand the festive atmosphere and traditional meaning of "The Mid-Autumn Festival". Additionally, the complex and culturally symbolic character design provides richer visual support and cognitive cues for multi-dimensional interactions within the animation, enhancing children's immersion and engagement during viewing and interaction. These details effectively enhance the functionality of the interactive animation in terms of cultural education and contextual understanding.

From the perspective of children's cognitive development, the visual characteristics and behavioral expressions of these characters enable children to quickly recognize the cultural associations between the characters and the festival. They can also project their emotions and extend their imagination within the symbolic system, thereby participating more actively and deeply in the animation interaction process. This helps reduce cognitive load, improve interaction efficiency, and strengthen the symbolic construction and internalization of traditional culture in children's minds.

In the three interactive animation designs, the timing of the characters' appearances and exits follows the principles of moderate presentation, reinforcement of impressions, and avoidance of cognitive overload (Figure 62). The researcher did not set the characters' appearance times too long, but instead used short, “signature action” to quickly establish the characters' images, thereby closing the psychological distance between them and the children and creating a friendly and welcoming interactive atmosphere. For example, in the opening phase of the interactive animation, characters make their debut through specific cultural actions (such as “New Year's greetings,” “waving,” and “handing over porridge”), using visual reinforcement and emotional expression to establish an initial connection. As the plot progresses to the Act II, they gradually fade out of the main visual focus, avoiding prolonged attention on the characters and redirecting children's cognitive resources toward plot development and task execution.

Figure 62 (Cont.):

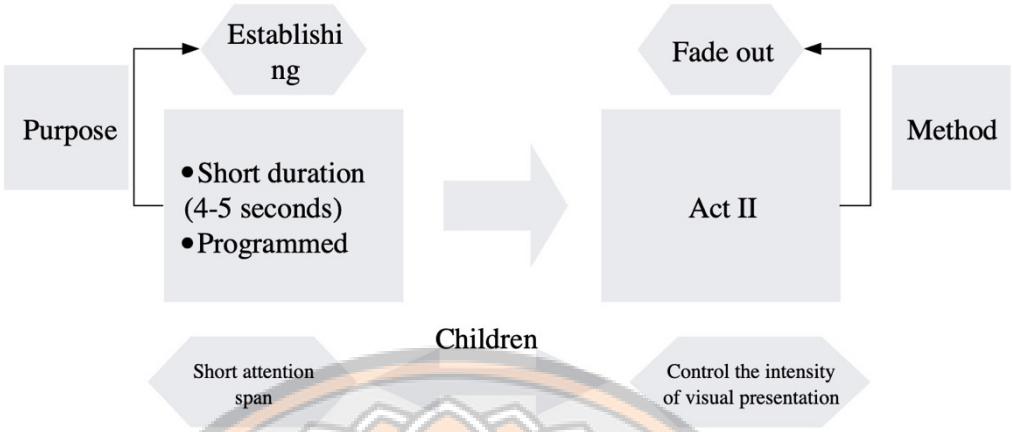



Figure 62 Structure diagram of character entrance and exit arrangements

This “phased role participation” design model fully considers the attention characteristics and social-emotional development features of 4-5 years old children in the pre-operational stage. Children at this stage have a short attention span, are easily attracted by novel or dynamic stimuli, but if exposed to the same stimulus for a long time, they are likely to lose interest. Therefore, controlling the visual presentation density of characters in the animation helps optimize information input.

Meanwhile, the characters do not completely withdraw during the animation learning tasks and interactive game stages but accompany students in completing knowledge construction through narration and emotional encouragement. This design concept is based on Vygotsky's “zone of proximal development” theory and Erikson's psychosocial development stage model.During the learning process, children need guidance and support from a “third party” to achieve a leap in their abilities, and the characters' voice prompts and encouraging words play the role of “scaffolding,” providing cognitive direction and emotional encouragement at key points.In the game experience, when children fail a task, the character's voiceover displays feedback such as “Keep going, try again.” When children succeed, they receive affirming statements based on their actions, such as “You're amazing!” This not only provides contextual support but also fulfills children's psychological need for positive evaluation, reinforcing their task motivation and willingness to participate.

Figure 63 (Cont.):

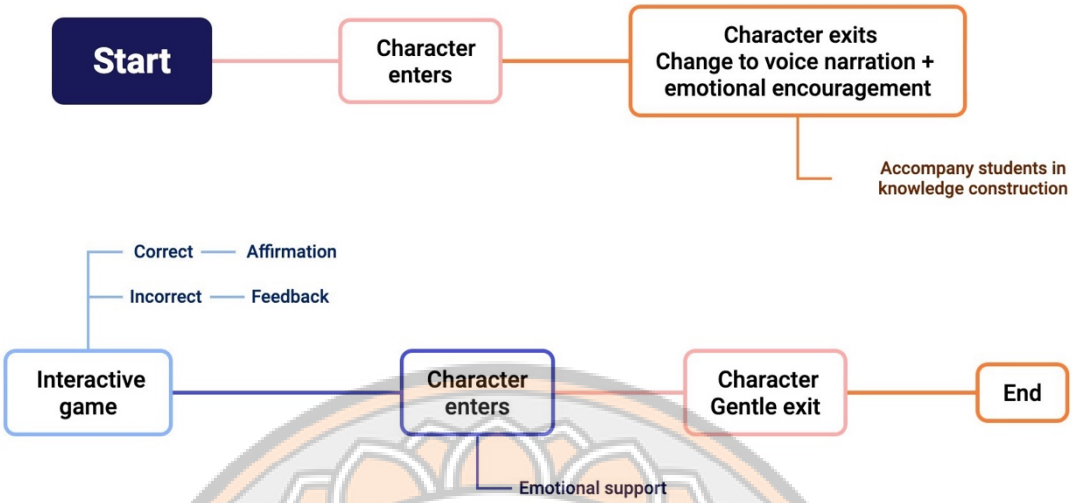



Figure 63 Character presentation strategy diagram

At the end of the animation, the characters say goodbye gently and summarize the story, which not only completes the function of information consolidation and psychological reassurance, but also helps children form a complete experience loop, which is conducive to improving memory integration and learning transfer abilities. Overall, in the character design process, researcher adopted a character presentation strategy of “brief appearance,process guidance,emotional accompaniment,gentle exit” (Figure 63). By scientifically regulating the rhythm and manner of character participation, they provided children with stable, moderate, and perceptible interactive support, thereby enhancing their acceptance of traditional cultural knowledge and learning outcomes.

3.4 Color

Regarding color selection, this study follows the stage-based laws of color cognition and emotional perception in child development psychology and combines the functional divisions of interactive animation to adopt differentiated color strategies for different content modules: high brightness and high saturation colors are mainly used in the storytelling section to enhance visual stimulation and concentration, while low brightness and low saturation tones are preferred in the interactive game section to reduce visual interference and promote task focus. Additionally, by pairing warm and harmonious auxiliary color schemes, a comfortable and friendly atmosphere is created across the entire visual composition, thereby enhancing preschool children's emotional

resonance and situational cognitive abilities (design rationale referenced in Table 1) (Figure 64).

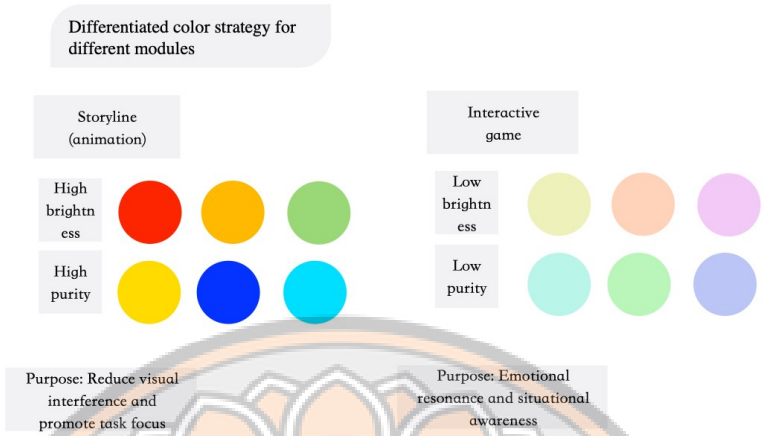



Figure 64 Differentiated color strategy for different content modules

According to the description of objective 1, children aged 4–5 in the middle class are in the stage of transition from sensory perception to rational differentiation in color cognition.They begin to recognize basic color hues in the spectrum (such as red, yellow, and blue), but their understanding of abstract color attributes such as brightness (lightness/darkness) and saturation (vibrancy/dullness) remains vague, often relying on emotional experiences or contextual cues for judgment. Therefore, in animation design, using brightness control to guide attention and employing color atmospheres to convey emotions are effective strategies aligned with the cognitive characteristics of this developmental stage.

Since children have an inherent cognitive tendency toward color (Maule et al., 2023), this study adopted targeted color strategies in the theme setting of interactive animations based on the festival context and children's perceptual characteristics to enhance the contextual relevance and cultural expression of visual performance.

• “Spring Festival”

Warm colors (Figure 65) are used to highlight the festive atmosphere, with a warm color scheme dominated by red, orange, and gold to create a warm and festive atmosphere. These high-brightness warm colors are not only visually appealing, but also match children's emotional cognitive patterns of ‘happiness’ and “bustle.”

Figure 65 (Cont.):

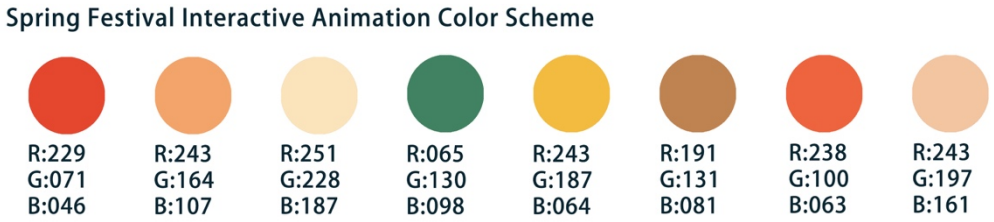



Figure 65 “Spring Festival” color card

The Spring Festival scheme interactive animation features a dominant red palette, symbolizing festive traditions and joy, comprising approximately 50% of the overall color scheme to establish a striking visual presence. Complementary colors,primarily orange-yellow and green,account for about 12%, creating both harmony and contrast with red while adding depth to the composition.

Additionally, the animation incorporates soft accent colors like beige, brown, and flesh tones, each accounting for approximately 10%, 8%, and 8% respectively. These hues serve to transition, harmonize, and soften visual tension without diminishing the primary color scheme (Figure 66).

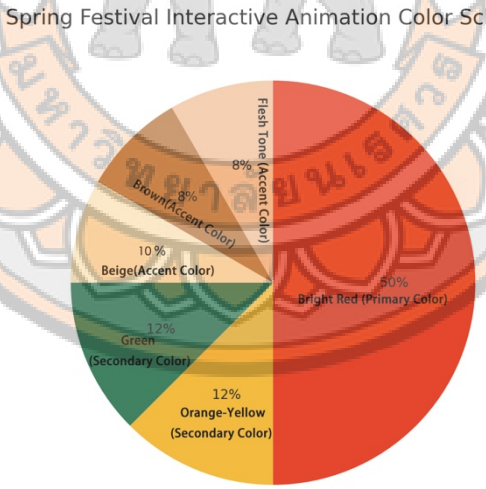



Figure 66 “Spring Festival” interactive animation color scheme

In certain scene color designs, researcher integrated elements of traditional Chinese cultural education and aesthetic theory, aligning with the cognitive development characteristics and aesthetic sensibilities of Chinese children. This approach enhances the cultural depth and local distinctiveness of the work.

In the scene color design for the “Spring Festival”, incorporating imagery such as Spring Festival couplets, lanterns, and firecrackers aligns with Chinese aesthetic characteristics, embodying the essence of “中和之美.” When teaching classical poetry knowledge points, avoiding overly crowded visuals and adopting the Chinese artistic form of “negative space” to present the content of classical poetry ensures clear information delivery and fosters an environment conducive to learning poetic imagery (Figure 67).

Figure 67 “Spring Festival” scene design

• The Mid-Autumn Festival

Choose cool colors (Figure 68) to create the mood, with a cool color scheme dominated by blue, dark orange, and light yellow. The low-saturation color combination conveys the tranquility and poetry of the festival, effectively stimulating children's perception of abstract emotions such as “reunion” and “longing.”

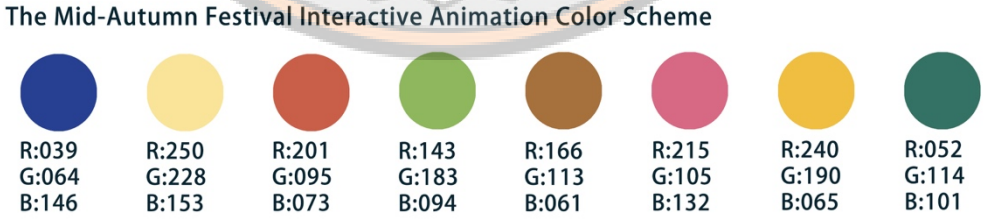



Figure 68 “The Mid-Autumn Festival” color card

In the interactive animation color design themed around the Mid-Autumn Festival, the primary color is a navy blue symbolizing the night sky and tranquility, accounting for approximately 40% of the overall color composition to establish a prominent visual dominance. Supporting colors primarily consist of light yellow, dark red, and light green,

each comprising about 12%, 10%, and 10% respectively. These create a contrast between warm and cool tones while enriching the visual depth of the composition.

Additionally, the animation incorporates soft accent colors such as brown, pink, golden yellow, and dark green, each accounting for approximately 7%. These accents serve to transition, harmonize, and soften visual tension without diminishing the primary color scheme (Figure 69).

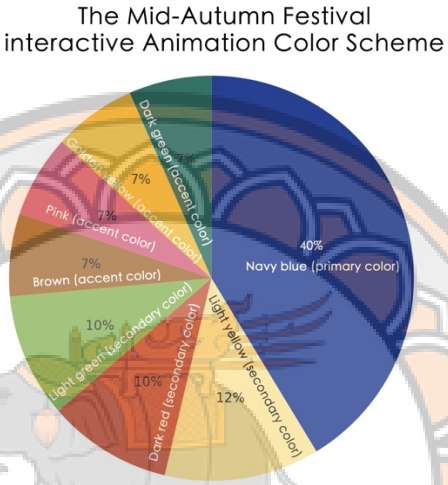



Figure 69 “The Mid-Autumn Festival” interactive animation color scheme

For “The Mid-Autumn Festival” scene design, the theory of “天人合一” was referenced. By naturally integrating symbolic elements of the festival,the moon, chrysanthemums, and courtyards,the composition achieves aesthetic harmony and creates a distinctive festive atmosphere (Figure 70).

Figure 70 “The Mid-Autumn Festival” scene design

• Laba Rice PorridgeFestival

Low-saturation colors (Figure 71) that resonate with everyday life.For example, low-saturation blues, light greens, and pale purples are used as primary colors to align with the festival's cultural imagery of “daily life, warmth, and simplicity.” Through soft color palettes, the design aims to recreate the tactile quality of winter customs and the warmth of family life. This color scheme strategy seeks to reduce cognitive stress, evoke familiarity, and help children naturally connect the animated scenes with their real-life experiences.

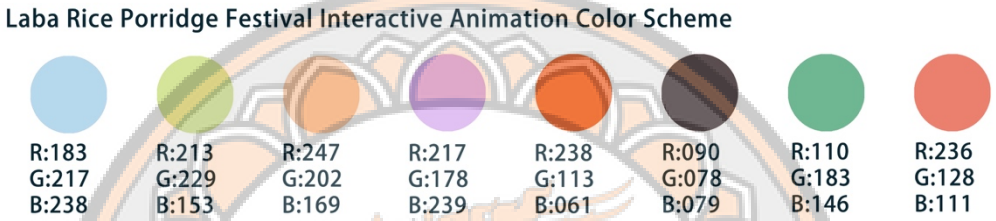



Figure 71 “Laba Rice Porridge Festival” color card

In the color design for the interactive animation themed around the Laba Festival, the primary palette centers on low-luminance light blue, light green, and light purple, collectively accounting for approximately 60% of the overall color scheme. This emphasizes the festival's “everyday, warm, and simple” atmosphere, conveying the texture of winter life and family warmth.

Complementary colors include skin orange, teal, and orange-red, each comprising about 8%, 10%, and 10% respectively. These hues inject vitality and depth into the warm palette. Additionally, brown and pink with accent colors are incorporated at roughly 6% each, serving to transition, harmonize, and enrich visual expression without overpowering the primary tones (Figure 72).

Figure 72 (Cont.):

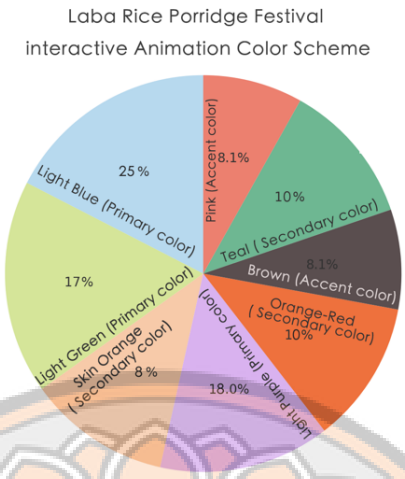



Figure 72 “Laba Rice Porridge Festival” interactive animation color scheme

In the scene color design for “Laba Rice Porridge Festival” , visual elements emphasize the depiction of grains, jujubes, and lotus seeds,traditional foods associated with the occasion. This representation extends beyond mere surface imagery to convey the joy of blessings and bountiful harvests. Drawing inspiration from the Chinese artistic technique of “托物言志,” the design deepens children's perception of the cultural significance embedded within the festive imagery (Figure 73).

Figure 73 “Laba Rice Porridge Festival” scene design

Considering the individual differences in sensitivity to different colors among children aged 4–5, the extensive use of a single cool or warm color in animation scenes may lead to visual fatigue or distraction. Therefore, in the specific scene design, researchers adopted a strategy combining color harmony and visual complementary color mixing. For example, in the "Spring Festival" scene, red lanterns are paired with

dark green pine trees to create visual contrast and balance; in "The Mid-Autumn Festival" scene, a deep blue night sky is used to highlight a bright yellow full moon, enhancing the layering and emotional tension of the scene; and in the " Laba Rice PorridgeFestival" scene, a light blue winter background is paired with dark-colored Laba Festival ingredients. This design approach, which reinforces the narrative context and maintains visual rhythm through color composition, not only helps extend children's attention span but also enhances the overall visual aesthetic experience.This highly contextually consistent color narrative function also aligns with the design philosophy emphasized in children's animation design in Nordic countries, which prioritizes the balance between content structure and visual aesthetics.

With regard to the combination of colors and children's attention, this study fully considered the stability and concentration time limits of children of different age groups (based on the conclusions of objective 1). Through the use of high-brightness, high-contrast color combinations (Figure 74), the animation quickly attracted children's unintentional attention at the beginning of the story and gradually guided them to intentional attention during the task interaction stage.For example, in character guidance and key task segments, bright primary colors (such as red, yellow, and blue) are paired with auxiliary color blocks to draw children's focus to visual focal points, thereby establishing a path dependency for information processing.In specific button designs and object feedback mechanisms, researchers varied graphic complexity and color layers to accommodate the operational needs of children with different attention levels. In interactive game segments, graphic details and color schemes are more complex, making them easier for children with developed intentional attention to identify and focus on, while also testing their sensitivity to visual detail differences.

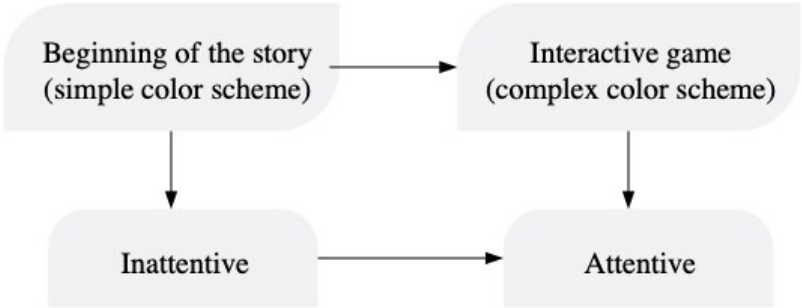



Figure 74 Color matching and children's attention cognition

In addition, the study noted individual differences in attention span, so a phased visual rhythm control strategy was adopted in the plot design and interface layout. This strategy balances the rhythm between high-stimulus content (such as character appearances and plot twists) and low-stimulus content (such as cultural explanations and command waiting), helping children to regulate their visual excitement and cognitive processing in a rhythmic manner and avoid distraction or fatigue caused by monotonous or excessive stimuli.

3.5 Sound & Music

Figure 75 shows the interactive animation music design flowchart. The overall design concept is based on children's auditory development patterns and relevant empirical research, and mainly consists of three parts: background music, narration, and interactive sound effects (Figure 75), which mainly serve to maintain the attention and learning efficiency of preschool students. During the interactive animation, researcher prioritized light background music with a steady rhythm to create a positive and stable learning atmosphere, while avoiding strong, abrupt musical stimuli that could distract children's attention. At the same time, to enhance the characters' guiding role and emotional connection with children, the narration in the animation was voiced by the main characters, using first-person or dialogue to establish an interactive relationship with children. The voice content of characters is also used to explain tasks and narrate the plot, as well as to express some of the emotions of children, helping them to project their own experiences onto the characters and thereby stimulating empathy and immersion. In terms of sound and music, researcher control the volume and frequency of background music to ensure that dialogue is clear and dominant, avoiding interference with semantic understanding. The dialogue is also designed with appropriate pauses to allow children to think and make judgments independently at key points of interaction, in line with the developmental needs of 3-6 years old.

Figure 75 (Cont.):

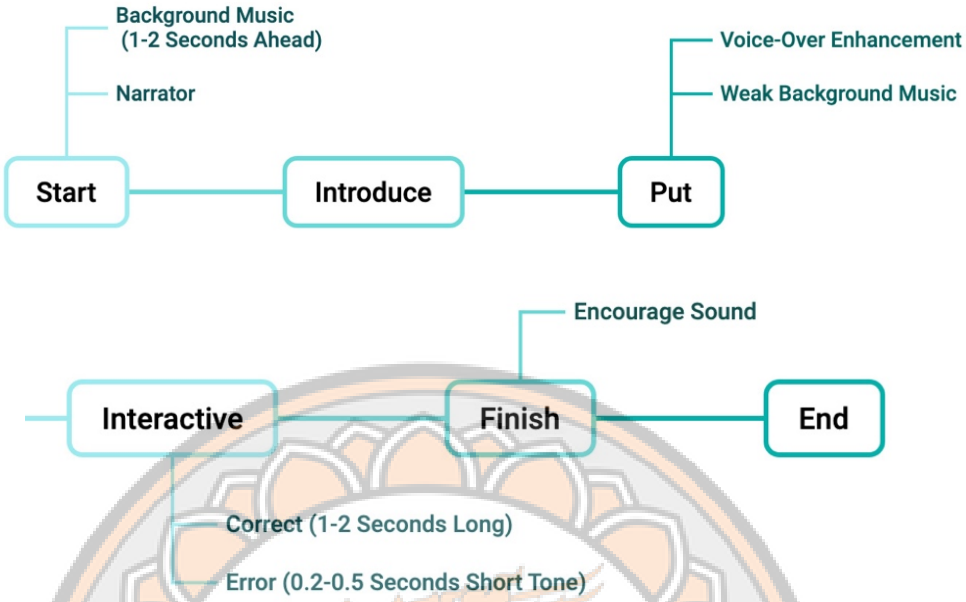



Figure 75 Interactive music flowchart

For different stages of interactive scenarios and operational behaviors, the design also incorporates highly responsive and emotion-guiding sound effects. For example, when children complete a task, a short, cheerful “ding” sound is played immediately to provide positive feedback and a sense of accomplishment. When an incorrect or mistake occurs, “try again” sound reminds children to try again. This type of auditory feedback mechanism not only provides immediacy and directionality but also effectively reinforces operational memory and enhances learning efficiency. In the study, the duration of the prompt sounds is controlled within 1.0 seconds to ensure clarity of information transmission and appropriateness of rhythm. (Figure 76)

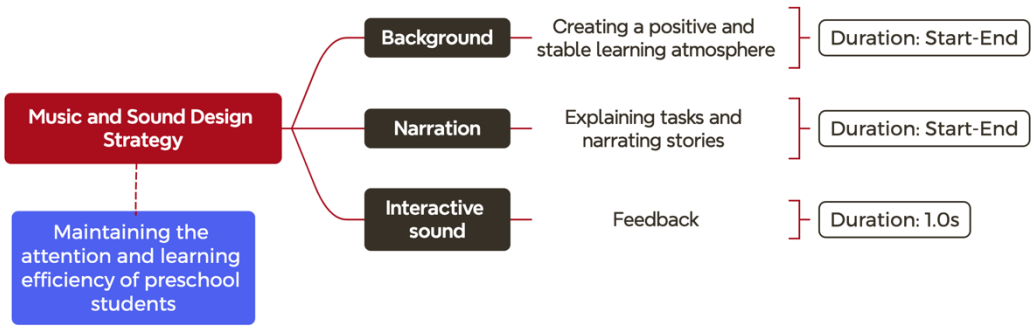



Figure 76 Music and sound design strategy

Based on the children's perceptual characteristics and interactive animation design principles proposed in Table 1, the researchers fully considered the duration, type, and functional differences of sound effects in the design of interactive sound effects to achieve more effective information transmission and emotional guidance. The sound effects corresponding to the “correct” and “incorrect” buttons are differentiated in terms of duration and pitch. The “correct” feedback typically uses a relatively longer and ascending tone, which not only creates a sense of reward but also prolongs the emotional experience for children. In contrast, the “incorrect” feedback employs a short, low-frequency tone to avoid overstimulating the child’s emotions, reduce feelings of frustration, and encourage repeated attempts (Figure 77). This sound design strategy, based on differences in duration, helps children establish an auditory association between actions and feedback, thereby strengthening memory pathways and enhancing the efficiency of interactive learning.

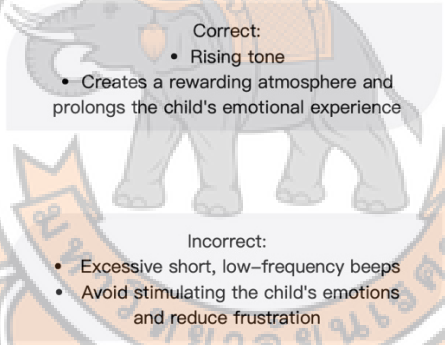



Figure 77 Sound effect duration strategy

In the background music design for interactive games, researcher did not choose to completely stop the background music, but instead adopted a dynamic adjustment method of “continuous playback + gradual volume reduction.” Specifically, when children enter the interactive thinking phase, the background music continues to play to maintain the overall continuity and immersion of the situation, while simultaneously reducing the volume and frequency of the background music to leave children with auditory space for thinking and judgment. This approach demonstrates a thorough understanding and adaptation to the characteristics of children in the preoperational stage, whose auditory sensitivity and attention allocation abilities are still underdeveloped, thereby avoiding the background sound from occupying too many cognitive resources.

Between character voices and prompts, researchers have specifically incorporated a “cognitive pause” mechanism, which involves a brief pause of 0.5–1.5 seconds after key feedback. This design is based on principles of child cognitive psychology, which suggest that brief, intentional silences reduce the pressure of information input and provide children with opportunities to construct meaning on their own. This is particularly beneficial during operational feedback, story twists, or cultural explanations, as it helps promote comprehension and memory.

3.6 Touch element

Before the interactive game officially begins, researcher set up a unified start button (Figure 78) that appears in both the story narrative and the interactive game.

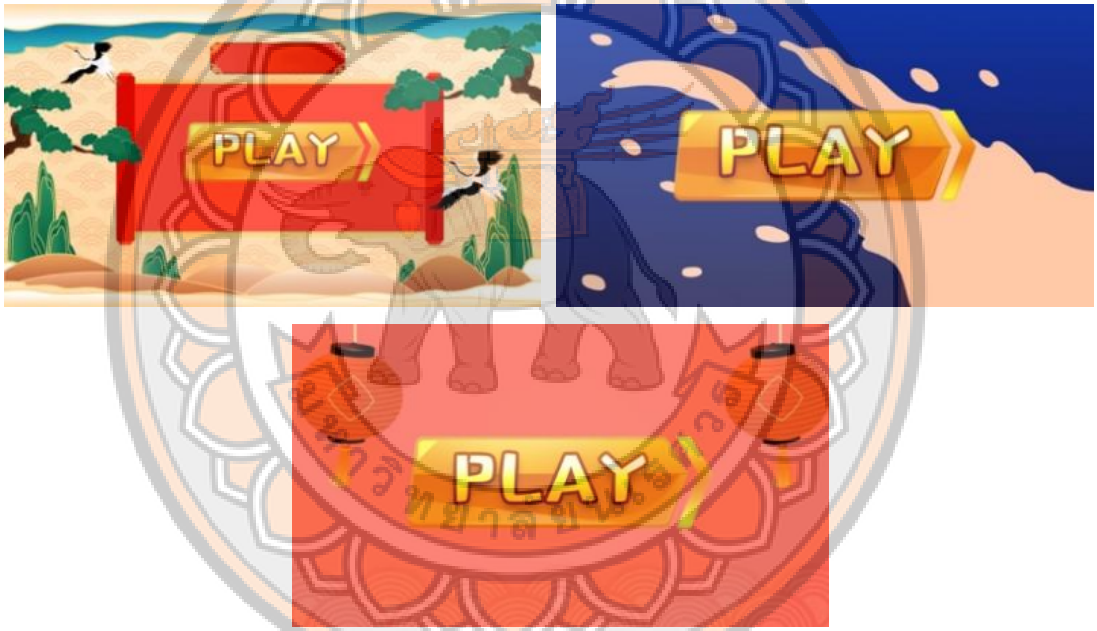



Figure 78 Interactive touch button

The button serves as a clear behavioral cue for children in terms of interface visuals, and also establishes a stable start mechanism in the operation process, which helps reinforce children's behavioral expectations and sense of task. The repeated use of this unified button across different game scenarios establishes a fixed operational pattern. Drawing on the “Pavlovian effect” described in classical conditioning theory (Pavlov, 1927), the repeated pairing of the “start button,game begins” relationship gradually leads children to anticipate feedback and develop a desire to participate upon seeing the button, thereby achieving automated responses to interactive behaviors. This conditioned reinforcement mechanism strengthens children's ability to adapt to the task

rhythm and subtly enhances their positive emotional connection to the learning content and concentration, laying a solid psychological foundation for subsequent interactive sessions.

• Background design

The background design of the interactive animations incorporates imagery such as hills, jungles, and bamboo groves to represent learning environments. To highlight the primary learning subjects, the backgrounds are simplified to avoid clutter. For the interactive animation of "Spring Festival," traditional Chinese red color schemes were selected. For "the Mid-Autumn Festival" animation, dark-toned backgrounds were chosen. The "Laba Festival" animation features color palettes reflecting everyday life.

For the "Spring Festival" theme(Figure 79), the background combines the dragon—a symbol of the Chinese spirit and ascent—with steamed buns in an auspicious basket as an interactive animated backdrop. The steamed buns in the basket represent abundance and family reunion. This background choice holds symbolic significance for the Spring Festival.

Figure 79 "Spring Festival" background design

For "the Mid-Autumn Festival"theme(Figure 80), the background features a bright moon. In Chinese culture, the moon represents reunion and embodies the festival's emotional connection to family, hometown, and kinship. The rotating interactive moon design symbolizes the festival's pursuit of reunion ideals and a better life.

Figure 80 (Cont.):

Figure 80 “the Mid-Autumn Festival” background design

For the “Laba Festival” theme(Figure 81), the background features a cartoon-style pencil and blackboard design to connect with students. The monochrome color scheme aligns with the winter setting and harvest motifs central to the Laba Festival.

Figure 81 “Laba Rice Porridge Festival”background design

• Text design

In the design of interactive animated texts, researcher fully considered the cognitive development characteristics of 5- to 6-year-old children, avoiding complex grammar and abstract vocabulary to ensure rapid comprehension (Figure 82). The text incorporates onomatopoeic sounds, personified expressions, and rhythmically structured sentences to enhance linguistic vividness and playful expression. Beyond narrating the story, characters engage children through interactive prompts and feedback, boosting immersion and operational engagement.

Figure 82 (Cont.):

Figure 82 Interactive text design

For example:

Narrator: 小朋友们，你们准备好了么？游戏开始了

Command: GO!

In the interactive animation for “the Mid-Autumn Festival,” the teacher adds the instruction, “请小朋友转一转，让月亮变的更圆吧,” allowing students to experience the changing phases of the Mid-Autumn moon.

Each interactive animation game features progressively increasing difficulty. For example, in the “Spring Festival” game, the first level involves matching ancient poems,relatively straightforward. The second level requires tapping clay pots to learn Spring Festival customs, with an added countdown timer to foster a competitive spirit among students.

In interactive animation games, to ensure students' engagement and comprehension, the text design avoids excessive use of obscure or difficult Chinese

characters. Prior to development, researchers thoroughly referenced and integrated literacy curriculum objectives and cognitive characteristics of 5-6 years old kindergarten children. The text underwent careful selection and simplification to align the interactive animation content with children's language development levels.

• Button design

In button design, researcher incorporated interactive animations into the background and selected a green color scheme for the buttons. Psychologically, green readily conveys meanings of safety, positivity, and progress, making it suitable for preschool children to operate. Considering children's operational habits, some buttons were designed to be clickable multiple times, with each click triggering different feedback. For instance, clicking buttons A, B, C, D triggers an error sound if incorrect, while correct selections advance directly to the next question. The design incorporates a “GO” button as the primary action button for initiating each game session, launching tasks, or entering learning scenarios. This is supplemented with arrow symbols to enhance intuitiveness (Figure 83).

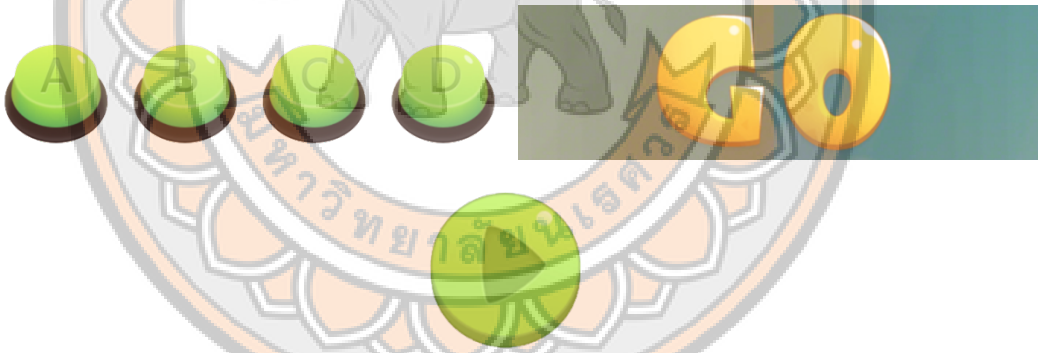



Figure 83 Interactive button design

• Color design

In the interactive animation color design for the “Spring Festival,” the first game primarily features red and gold, aligning with the festive cultural atmosphere. Supporting green and blue tones create a fresh and vibrant background layering. The second game's operation buttons uniformly adopt a brown jar shape, echoing the image of traditional pottery jars to enhance cultural affinity. The time display area uses yellow and gold to highlight its prompting function, enabling children to quickly grasp key information.

In the color design for the interactive animation “the Mid-Autumn Festival,” the moon scene of the first game features a deep blue and black cosmic backdrop, highlighting the bright yellow moon to evoke the mystical and tranquil atmosphere of Mid-Autumn Festival culture.The second game's “Knowledge Sorting” segment employs light blue and sandy yellow backgrounds paired with green carriages, ensuring a clear interface aligned with cognitive logic to help children quickly distinguish learning tasks. The vocabulary practice section utilizes high-saturation red, orange, yellow, and purple circular elements for striking contrast.

In the color design for the “Laba Rice Porridge Festival”interactive animations, the first game features a brown background to highlight the two characters,the little lion and the little monkey,whose designs also incorporate golden hues. The second game, “Classic Poetry Matching,” uses a light green background paired with orange story elements. The low saturation helps regulate students' overall interest and meets their visual cognitive needs.

• Shape design

The shape design of interactive animations primarily employs geometric and flat forms to reduce children's recognition burden. Most objects and interface elements feature rounded corners and curved shapes. Forms are kept close to children's everyday experiences to facilitate their association and comprehension. For example: earthenware pots, lanterns, white clouds, and flowers,these elements are both intuitive and connected to traditional culture. In “the Mid-Autumn Festival” theme, a game features a small locomotive assembling classical poetry. While the train's shape is inherently angular, the overall design employs rounded corners, carefully avoiding sharp edges (Figure 84).

Figure 84 Interactive shape design

• Touch form design

In the interactive game system designed in this study, researcher reasonably integrated three main touch elements,click, drag, and rotate,based on the stage

characteristics of cognitive and motor development in the sample age group (4-5 years old middle kindergarten students). These touch operations improved the interactivity and operability of the interactive animation, strengthened children's active participation awareness, and promoted their cognitive development and logical thinking.

In the three interactive games designed in this study, the interaction operation methods were deliberately distributed according to a ratio of click 50%, drag 40%, and rotate 10% (Figure 85). This weighting of operations was based on a comprehensive consideration of preschool children's cognitive development levels, fine motor skills, and task difficulty suitability.

Click operations, as the most basic and intuitive form of interaction, account for 50% of the total. This operation aligns with the motor development stage of most children aged 3–6, enabling them to quickly establish a basic understanding of the interactive system and build operational confidence, thereby enhancing engagement and fluency in learning. Click operations can be used to trigger animation responses, activate voice prompts, or complete simple selection tasks, making them a key means of achieving high-frequency information feedback and immediate interaction.

Drag operations account for 40% of the tasks and are relatively complex and precise movements. Therefore, drag is used in the interactive animation settings to reorganize patterns, categorize and match items, and simulate production in game scenarios, which helps improve children's logical thinking and operational expression.

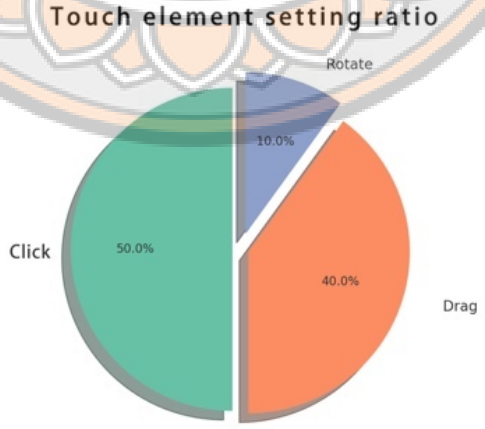



Figure 85 Touch element setting ratio

Rotate operations are set to only 10%, mainly considering that this operation requires high levels of fine motor control in children. Although the frequency of this operation is low, as a supplementary form of interaction, rotational tasks can enhance

the diversity and challenge of the game, stimulate children's interest in exploration while completing tasks, and avoid monotony and repetition in the game process.

• In the early stages of touch-based applications, the interface design is intuitive and simple. In interactive animations, touch gestures can be used to trigger character dialogue, switch scenes, activate item responses, and other actions, helping children understand cause-and-effect relationships and event logic through active interaction. For example, in an interactive game with a “Spring Festival” (Figure 86), the interface features multiple clay pots. Children must click on the pots to match them with the correct Spring Festival customs, such as “eating dumplings” or “going on a spring outing.” Upon selecting the correct option, the interface plays cheerful sound effects and provides visual feedback to reinforce memory of the customs.

Additionally, the clay pot serves as an interactive animation element. In ancient China, clay pots were essential vessels for storing grain and liquor, symbolizing “full granaries and bountiful harvests” and embodying the prosperity and well-being associated with the Spring Festival. Within traditional Chinese customs, clay pots are often linked to ‘sealing’ and “guarding,” signifying the preservation of blessings and good fortune within the home to prevent their dissipation. Children can use this element to develop an understanding of clay pots and connect them to the Spring Festival.

Figure 86 “Spring Festival” “click” interactive game interface

In the interactive game with "The Mid-Autumn Festival" (Figure 87), click on colorful Chinese character buttons scattered across the interface, such as “bean,” “flower,” and “fruit,” allows players to combine ingredients to make moon cakes. By clicking on different ingredients, the system provides feedback on whether the combination is successful, forming a loop of exploration and cognition.

The use of small balls in a match-three puzzle format as props for this interactive animation game stems from the circular shape of mooncakes themselves. By associating mooncakes with matching balls—labeled with ingredients like lotus seed paste, red bean paste, and nuts—it symbolizes the diversity and continuity of traditional Chinese culinary culture. This allows children to discover the cultural significance behind mooncake making through interactive play. As a festival celebrating harvest, Mid-Autumn itself honors the bounty of grains and fruits. The appearance and disappearance of the balls symbolize "harvest, sharing, and auspiciousness," reflecting Chinese culture's emphasis on harmony between humanity and nature.

Figure 87 "The Mid-Autumn Festival" "click" interactive game interface

In the animated segment "Laba Rice PorridgeFestival" (Figure 88), a single-choice question interface is set up. Children click on the green circular button to select an answer option. Upon clicking, the system evaluates the answer and immediately provides feedback indicating whether it is correct or incorrect. This is combined with character voiceovers and a countdown mechanism to guide children in focusing on completing the answering task.

The lion and monkey were chosen as companions for this interactive game segment because in Chinese culture, the lion represents courage and strength, symbolizing how knowledge brings confidence and bravery. The monkey embodies agility and wisdom, signifying flexible thinking and clever responses in learning. Together as characters in this quiz game, they embody the cultural essence of "Laba Enlightenment."

Figure 88 (Cont.):

Figure 88 “Laba Rice PorridgeFestival” “click” interactive game interface

• Drag is an intuitive and vivid interaction method that suits the operational habits and cognitive characteristics of preschool children. In interactive animation games with traditional festival, the drag mechanism is cleverly used to enhance learning fun and participation. Students complete the reorganization of a festive scene by dragging and matching Spring Festival-related couplets such as “爆竹声中一岁除”, “红灯笼挑亮橘角”, “北风吹雪四更初”, and “旧岁在硝烟里退场” to corresponding visual elements. Through this interactive matching of classical poetry and imagery, they not only gain an understanding of the cultural symbols and customs associated with the Spring Festival, but also enhance their abilities in text-image association and festive imagination (Figure 89).

The rocket was chosen as the interactive animation element for the Spring Festival-themed game. Symbolizing speed and soaring skyward, the rocket's arrow guides children to swiftly locate correct answers in the poetry matching game. The arrow itself serves as a “direction indicator,” assisting children in completing the poetry pairings.

Figure 89 “Spring Festival” “drag” interactive game interface

In “The Mid-Autumn Festival" game (Figure 90), The researcher designed an activity in which students are asked to drag lines from the poem 《水调歌头·明月几时有》, such as “明月几时有”, “把酒问青天”, “但愿人长久” and “千里共婵娟” into the compartments of a small train in the correct order. By rearranging the positions of the poem lines through drag interaction, the activity stimulates children’s interest in classical poetry and helps cultivate their linguistic sense and memory related to traditional festival culture.

In this section, the train was chosen as the vehicle connecting ancient poems because preschoolers are familiar with the image of a “train," making it easy for them to understand the sequence of carriages → facilitating their manipulation and memorization during sorting tasks. During the interaction, children push and pull verses into carriages to arrange them, symbolizing knowledge being systematically carried and passed forward, embodying a “cultural journey.”

Figure 90 “The Mid-Autumn Festival” “drag” interactive game interface

In the interactive game with “Laba Rice Porridge Festival” (Figure 91), students drag words such as “煮粥,” “冬天” and “花生米” and place them correctly in the Laba Festival nursery rhyme, thereby reviewing the customs of the festival and improving their language expression skills.

Figure 91 (Cont.):

Figure 91 “Laba Rice Porridge Festival” “drag” interactive game interface

• Rotate is a relatively complex form of touch interaction for children, typically appearing in interactive tasks that require exploration, observation, or spatial cognition. Incorporating rotation buttons into interactive animations enriches the user experience and motivates children to actively explore.

In this interactive animation content, rotate touch elements have been integrated into “The Mid-Autumn Festival”. Researcher have designed an interactive function where children can rotate the moon using a single finger (Figure 92). As the rotate angle changes, the moon image gradually transitions from the "crescent moon" to the "waxing moon", and finally to the "full moon", ultimately reaching a state of perfection.This visual transformation vividly recreates the natural phenomenon of the moon's waxing and waning during The Mid-Autumn Festival. This design seamlessly combines the dynamic process of natural phenomena with the cultural significance of traditional festivals, encouraging children to observe, compare, and develop understanding through hands-on interaction. Compared to static images or verbal explanations, the rotate interactive feature provides children with an active opportunity to construct knowledge, allowing them to experience the changes in the moon's phases through hands-on participation.

Figure 92 (Cont.):

Figure 92 “The Mid-Autumn Festival” “rotate” interactive game interface

3.7 Link to the design video

•“Spring Festival”

https://drive.google.com/file/d/1U42cPEyTF3DP6baahfHW9mIBBXjsGVte/view?usp=sharing

•“The Mid-Autumn Festival”

https://drive.google.com/file/d/1l6GGWU_5pkf_oYIia2kGtRxq3AHGADsH/view?usp=sharing

•“Laba Rice Porridge Festival”

https://drive.google.com/file/d/1FMnDEmaLz_mKjUGuqKgjh3M2WKMPp3Sb/view?usp=sharing

For Scan:

“Spring Festival” “The Mid-Autumn Festival” “Laba Rice Porridge Festival”

Research objectives 4: To evaluate the effectiveness of the designed interactive animations in enhancing preschool children's learning of traditional Chinese culture.

Objective 4 corresponds to Phase IV

**Phase IV: Using quantitative research, evaluate the learning effectiveness of interactive animations for preschool students and the satisfaction of relevant personnel with interactive animation design.**

1. Pre- and post-test data by Learning Competency Evaluation Sheet(Appendix B)

Pre-test and post-test numerical measurements were analyzed using a paired-samples T-test, which included:festival knowledge comprehension (e.g.,"Can you name a festival custom?"), custom recognition (e.g.,"Can you correctly match festivals with traditional items?"), idiom story recitation (e.g.,"Can you explain the meaning of an idiom story?") and an open-ended questions assessing imaginative thinking (e.g.,"Which cartoon plot impressed you the most?"). Composite scores were calculated for all indicators before and after the intervention.

According to the scatter plot comparison of pre- and post-test results (Figure 93), the pre-test mean score was M=27.14 [SD: 4.8], and the post-test mean score was M=31.35 [SD: 5.1], with a significant overall improvement in mean scores [MD=+4.21, SE=1.11]. The difference was statistically significant [T=6.47], indicating that students demonstrated improved learning outcomes in traditional cultural knowledge through the use of interactive animation [p: $3.35 \times 10^{-6}$, significant at $p<0.05$].

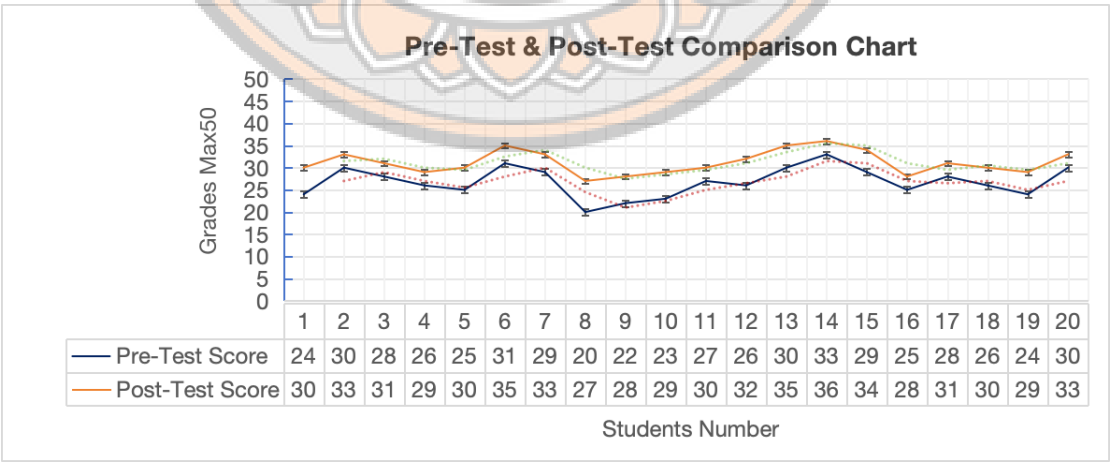



Figure 93 Comparison of Pre- test and Post-test Scores

2. Data on preschool students' preferences for visual elements

According to the preference ratings for visual elements of among students in the experimental group, children showed a significantly higher preference for cartoon characters in high-saturation warm colors compared to low-saturation cool colors [High-saturation: M: 4.35, SD: 0.58; Low-saturation: 3.60, SD: 0.72; $t(19) = 3.42$, $p < 0.0028$, $d = 0.77$].

Character preference statistics across three interactive animation clips revealed that students generally favored animal-type characters with round eyes and oval shapes, whereas human-type characters received lower preference scores. Among all, the animal character “Pudgy Rabbit” was the most favored, with children even mimicking its exaggerated actions and dialogue after class.

• Pudgy Rabbit: Prop.%=50，Pref.n=10,M:4.45, SD:0.52

• Sister Luna: Prop.%=20，Pref.n=4，M:3.70, SD:0.65

• Lucky Rat: Prop.%=30，Pref.n=6，M:4.10，SD:0.60

Children also demonstrated differentiated preferences for rhythmic, informational/scientific, and experiential. Results showed a significantly higher preference for rhythmic sound effects [Prop.%=55, Pref.n=11, M:4.50, SD:0.56].

Lastly, the effectiveness of various touch interactions-click, drag, and rotate-in sustaining children's engagement was evaluated based on four dimensions: attractiveness, attention, sustained participation, and exploratory motivation.

•Click: received the highest engagement score [EI = 4.45], indicating strong interest and sustained involvement.

• Drag: scored slightly lower [EI = 4.10], but showed high levels of attention and exploratory behavior.

• Rotate: [EI = 3.50], triggered curiosity but was observed to reduce focus over time due to complexity.

3. Post- evaluation satisfaction survey questionnaire data

A questionnaire survey was conducted among preschool students(Appendix C), parents(Appendix D), and teachers(Appendix E) to evaluate satisfaction level with the experimental outcomes. According to the results, in the parental assessment dimension (Table 11), the item "Interest Stimulation" received a relatively high score [$\bar{x}$=4.30,

SD=0.47], This indicates that most parents recognize the positive role of interactive animation in stimulating preschool children's learning of traditional culture.

While "Family Interaction" scored lower [$\bar{x}$=3.90, SD=0.62], indicating that interactive animations still have room for improvement in promoting parent-child collaborative learning. These results indicate that although interactive animation has significant advantages in attracting children's attention and stimulating active participation, there is still room for improvement in promoting co-learning and co-creation behaviors and interactions between parents and children. Parents believe tha, this difference in scores may be due to the need for optimization of interactive animation design in family application scenarios. Some parents also noted that while the animation content is engaging, it lacks clear guidance strategies to encourage parents and children to engage in deeper discussions or extended activities around the animation, resulting in “joint viewing” failing to naturally transition into “joint learning.”

Student satisfaction (Table 12) was generally high, particularly in “Interesting” [$\bar{x}$=4.45, SD=0.45] and Liked” [$\bar{x}$=4.40, SD=0.48], The two numerical values indicate that this interactive animation has a significant advantage in attracting children's attention and stimulating positive experiences. In particular, the high evaluation in terms of “interestingness” indicates that the animation design has successfully triggered children's emotional involvement and immersion, demonstrating good entertainment value and appeal.Based on multimedia learning theory, emotional motivation is a key driver of learning for preschool children (Darmawati & Setiawan, 2024), and “interesting” is often a prerequisite for children to maintain attention and engage in interaction.

In contrast, the “Learning Benefits” dimension scored relatively low [$\bar{x}$=4.15, SD=0.58], with a slightly larger standard deviation, indicating that children remain cautious about whether they gain substantive knowledge or cultural understanding from the interactive animation. This result suggests that while the interactive animation is highly engaging, there is room for improvement in terms of content depth, the completeness of the knowledge structure, or learning outcomes.Future designs should maintain the element of fun while further enhancing the perceptibility and transferability of knowledge transmission and cultural connotations, ensuring that

learning outcomes go beyond superficial memory and instead foster a deep understanding of traditional culture and the ability to express it actively.

In the teacher evaluation dimension (Table 13), “Applicability of Educational Content” was rated positively [$\bar{x}$=4.20, SD=0.44], suggesting that teachers recognize the educational value of the interactive animation， The findings indicate that teachers generally recognize the suitability of the interactive animations designed by this research institute for use in course instruction.Teachers noted that the animation content effectively aligns with the cognitive level and learning needs of preschool children, demonstrating educational specificity and effectiveness in terms of knowledge point selection, cultural element presentation, and expression methods. This evaluation affirms the functional value of interactive animations as teaching auxiliary resources from a professional instructional perspective, particularly in the field of traditional cultural literacy education, where animation formats effectively address the limitations of text-based or narrative-based instruction in terms of visual clarity and engagement.

However, “Integration and Utilization of Resources” received a relatively lower score [$\bar{x}$=3.95, SD=0.55], indicating that optimization is needed in this area. On the one hand, current animation resources may not yet be well integrated with existing teaching activities, curriculum frameworks, or instructional pacing, and lack systematic instructional support materials such as lesson plan templates, teaching guidelines, or activity extension plans.On the other hand, while interactive animations possess independent educational potential, their role as instructional tools has not yet been fully integrated into teachers' daily teaching processes. Some teachers have reported that although animation content is appealing, further guidance and support are still needed when organizing instruction or conducting interdisciplinary integration. Therefore, in order to improve resource integration efficiency, it is necessary to focus not only on content development, but also on the design of teaching environments and the construction of resource support systems.

Table 11 Parents Satisfaction Questionnaire Results

**Results of parent's satisfaction questionnaire analysis (N=20)**

| Evaluation Dimensions | $\bar{x}$ | SD |
|---|---|---|
| Learning Effect | 4.12 | 0.53 |
| Interest Stimulation | 4.30 | 0.47 |
| Family Interaction | 3.90 | 0.62 |
| Educational Resources | 4.05 | 0.49 |
| Personalized Learning | 4.00 | 0.55 |
| Subsequent Use | 4.22 | 0.41 |

Table 12 Preschool Students Satisfaction Questionnaire Results

**Results of preschool student's satisfaction questionnaire analysis (N=20)**

| Evaluation Dimensions | $\bar{x}$ | SD |
|---|---|---|
| Liked | 4.40 | 0.48 |
| Interesting | 4.45 | 0.45 |
| Learning Benefits | 4.15 | 0.58 |
| Characters and Stories | 4.28 | 0.51 |
| Interactive experience | 4.32 | 0.46 |
| Subsequent Use | 4.35 | 0.43 |

Table 13 Teachers Satisfaction Questionnaire Results

**Results of teacher's satisfaction questionnaire analysis (N=10)**

| Evaluation Dimensions | $\bar{x}$ | SD |
|---|---|---|
| Teaching Effectiveness | 4.10 | 0.49 |
| Learning Interest Stimulation | 4.05 | 0.52 |
| Interactivity | 4.12 | 0.50 |
| Applicability of Educational Content | 4.20 | 0.44 |
| Achievement of Educational Goals | 4.00 | 0.51 |
| Effectiveness of Technology-Assisted Teaching | 4.18 | 0.47 |
| Integration and Utilization of Resources | 3.95 | 0.55 |
| Subsequent Use | 4.08 | 0.46 |

Based on all quantitative evaluation data (Figure 94), interactive animations are generally satisfactory in promoting traditional culture course learning among preschool students.In the three-party evaluations, whether it was the children's "Interesting" ($\bar{x}$=4.45), parents' high recognition of "Interest Stimulation" ($\bar{x}$=4.30), or teachers' affirmation of "Applicability of Educational Content" ($\bar{x}$=4.20), all reflect that the animation performs well in terms of motivating learning, capturing attention, and aligning with the cognitive development of preschool children.This result indicates that interactive animation has already laid a solid foundation and demonstrated significant

potential to become a viable medium for traditional culture education in early childhood education.

However, the relatively low scores in certain dimensions indicate that there is still room for improvement in interactive animation design.For example, the score for the “Family Interaction” dimension in the parent satisfaction survey was relatively low ($\bar{x}$=3.90). From the perspective of family education theory, the family is an important setting for the initial formation of children's cultural cognition and values (Elsayed, 2024). Therefore, if interactive animation is to further expand its application potential in traditional cultural education, it should strengthen support for family co-learning scenarios at the content and interaction strategy levels.Teachers' scores in the “Integration and Utilization of Resources” dimension ($\bar{x}$ = 3.95) indicate that the systematic and convenient application of animation in teaching environments still needs to be strengthened. Additionally, the evaluation in the “Learning Benefits” dimension of the student satisfaction survey questionnaire ($\bar{x}$ = 4.15) is slightly lower than other emotional or experiential indicators, further indicating that content design requires more refined adjustments to enhance educational effectiveness and the expression of knowledge structures.

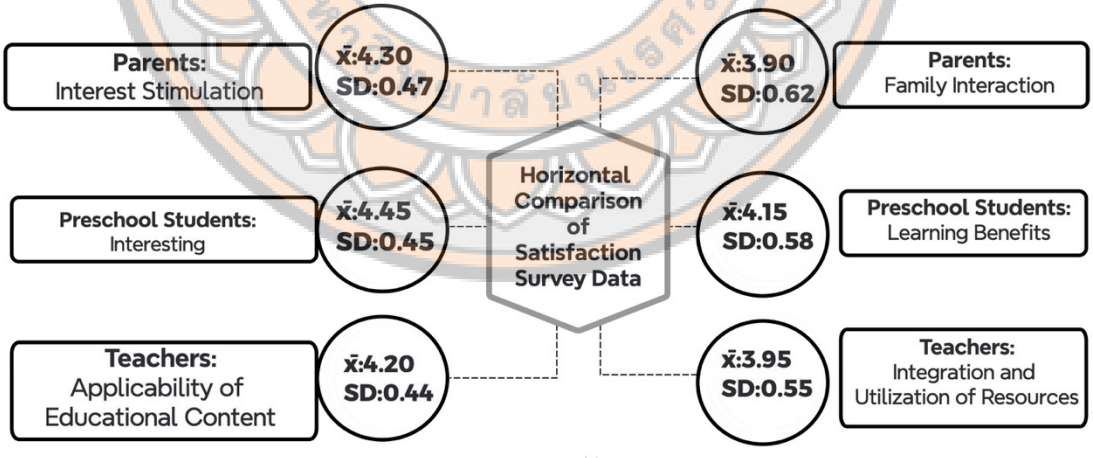



Figure 94 Horizontal comparison of satisfaction survey data

In the evaluation results from parents, children, and teachers, “Subsequent Use” [Parents: $\bar{x}$=4.22, SD=0.41; Preschool Students: $\bar{x}$=4.35, SD=0.43; Teachers: $\bar{x}$=4.08, SD=0.46] all showed a strong positive trend, indicating that interactive animations can stimulate sustained use by multiple parties in actual use. This not only indirectly

validates the appeal of interactive animation content design and the potential of its educational functions but also reflects users' high expectations for further deepening and expanding the application of such products in traditional cultural education scenarios.

Following the completion of the questionnaire survey, researcher conducted follow-up interviews with teachers, curriculum creators, and interactive animation experts to gather supplementary qualitative data.

In interviews with teachers who participated in the questionnaire survey, 75% of teachers believed that the introduction of the designed interactive animations could effectively enhance young children's focus and engagement in the classroom. Teachers pointed out that traditional oral instruction often struggles to sustain children's interest for extended periods, whereas animations combined with touch-based interactions make knowledge transfer more vivid and intuitive. For instance, when learning about traditional festivals, children could engage deeply and ask questions spontaneously by tapping characters on the screen to advance the animation's storyline. Some teachers also mentioned that using interactive animations in the classroom provided new teaching aids, making the classroom atmosphere more lively. However, it also required teachers to familiarize themselves with the operation process in advance to ensure the smooth flow of the class.

During interviews with kindergarten curriculum creators, it was emphasized that interactive animations, as part of the curriculum content, play a positive role in integrating traditional cultural education. The principal pointed out that the current proportion of traditional cultural content in preschool education curricula remains relatively limited. Interactive animations can transform abstract and difficult-to-grasp cultural knowledge into intuitive and concrete experiences, lowering the comprehension threshold for young children. Simultaneously, the director believes interactive animation design must balance educational value with engagement, avoiding excessive pursuit of visual effects at the expense of accurate knowledge delivery. the director also proposed that broader future implementation of such resources requires consideration of integration with the kindergarten's overall curriculum framework. This ensures interactive animations can be genuinely embedded within teaching activities rather than used in isolation.

In discussions with experts in interactive animation, specialists generally agreed that this work effectively reflects the cognitive characteristics of preschool children in its interface design and interaction methods. Design experts noted that the use of touch-based elements aligns with young children's intuitive operational habits, enabling them to achieve learning objectives through simple actions. Additionally, the integration of traditional Chinese cultural elements,such as pottery jars, lanterns, and the full moon,enhances the educational depth with cultural richness. However, experts also suggested that future refinements could incorporate a “tiered design” approach. This would involve providing different levels of interaction and content depth tailored to children of varying ages, thereby accommodating individual differences.

**Discussion**

This study discusses interactive animation factors and processes related to improving children's learning skills in traditional culture, with the aim of enhancing children's comprehension of traditional culture and creativity.

Research has found that the rational design of interactive animation elements can promote the development of preschool students' comprhension and creativity. Through the design of open-ended storylines, dynamic visual guidance, musical rhythm control, and cause-and-effect operations, it is possible to stimulate their motivation to learn. This finding is consistent with previous research results, as noted by Li et al. (2024) and Agustina et al. (2023) pointed out that highly interactive technologies can effectively enhance children's learning interest and initiative through timely feedback, dynamic participation, and personalized path design, thereby promoting the development of multiple skills such as language comprehension, logical reasoning, and creative expression.In this study, children of different age groups were classified and discussed in the design and analysis of interactive animation elements. This layered design approach aligns with Vygotsky's “Zone of Proximal Development” (Vygotsky, L. 1978) theory, which suggests that through appropriate guidance and support from interactive animation elements, students can gradually move from their current actual abilities to higher cognitive levels. This theory has been validated in the studies by Eun (2019),Daneshfar & Moharami (2018), and Herodotou (2018), and helps improve preschool students' comprhension and problem-solving abilities.

The cognitive development of preschool students is characterized by animism,

attention focused on single features, and irreversible thinking. Based on this information, interactive animations utilize visualization, contextualization, and operationalization to support the cognitive construction of preschool students, thereby aligning with children's understanding patterns.This finding aligns with the conclusions of Vedechkina (2021), who found that dynamic presentation and interactive mechanisms can guide children's attention, enhance the depth and breadth of understanding, and thereby promote the development of cognitive flexibility and creativity.

The layered planning of traditional cultural elements facilitates gradual learning. Combining the standardized movements found in traditional Chinese culture enhances children's cultural familiarity. Designing with cultural context not only optimizes teaching but also serves as an important pathway for children to transition from imitation to creation. This finding is consistent with Blumberg's (2019) conclusion that incorporating specific cultural behavioral elements into interactive scenarios facilitates children's cognitive transfer from cultural learning to contextual and active creation.

The study also found that visual symbols of traditional culture are presented through contextualized content, guiding students to acquire knowledge within specific cultural scenarios. This approach enhances children's culture perception and memory by transforming abstract knowledge into concrete imagery, thereby improving the effectiveness of cultural knowledge expression. Those finding are consistent with those of McRae et al. (2018), who concluded that contextualized visual representations can assist young children in better understanding abstract concepts.

In the study, the “scaffolding” support theory (Vygotsky, 1978) was used to set up design “problem-based”. Techniques such as “character prompts”, “voice guidance”, and “feedback mechanisms” were employed to provide timely support to children during the learning process. This theory has been confirmed in studies by Raslan (2024), Ismail et al. (2023), and Stern&Hertel (2022), all of which demonstrate that scaffolding supports the internalize learning strategies and improve children's problem-solving skills.

Based on the experimental results, it has been confirmed that interactive animations play a positive role in enhancing preschool students' interest and initiative in learning traditional culture. By optimizing the design of interactive elements and presenting traditional cultural content in an interactive format, their learning motivation

can be stimulated. As pointed out by Li et al. (2024) and Agustina et al. (2023), interactive digital technologies can enhance children's engagement and emotional investment, thereby strengthening the immersiveness and sustainability of the learning experience.

Furthermore, the findings of this study align with those of Arifin et al. (2023), who used interactive devices to improve children's object recognition skills. Their experimental results indicated that interactive technology had a positive effect on children's knowledge construction in early childhood education, and children were satisfied with their experience using such interactive tools.

The study references and integrates interactive animation design principles for young children from other countries, such as game exploration mechanisms, character behavior imitation strategies, and aesthetic-oriented content construction, to ensure that interactive animations are both consistent with children's cognitive development levels and educationally adaptable in a cross-cultural context.

Chapter 4 comprehensively evaluated the effectiveness of the designed interactive animation in enhancing preschool students' traditional culture learning skills through a combination of qualitative and quantitative research methods. The research subjects were 20 preschool children in kindergartens. A “pre-test-intervention-post-test” experimental design was adopted, supplemented by teacher interviews, classroom observations, and parent questionnaire feedback.This chapter integrates the elements of interactive animations with theories of children's cognitive development, and provides a detailed explanation of how these design elements, when combined with traditional Chinese cultural content, align with the perceptual and cognitive developmental stages of preschool children, thereby enhancing the comprehensibility and absorption efficiency of the cultural content and to discuss the results of the study. The next chapter presents conclusion and future directions of this thesis.

# CHAPTER V

# CONCLUSIONS，RECOMMENDATIONS AND LIMITATIONS

## Conclusions

The study shows that, in order to achieve the objectives, activities carried out at various stages indicate that, through the rational design of interactive animations, children's comprehension and creativity in traditional culture can be effectively improved, thereby promoting the learning skills of preschool students in traditional culture. Given the current situation of preschool students' learning of traditional culture, it is increasingly important to improve children's comprehension and creativity in traditional culture.

The cultivation of these skills is not only conducive to the formation of creative thinking skills in preschool students, but also enhances their interest and initiative in learning traditional culture courses to a certain extent. Through interaction with interactive animations, students cannot only gain an intuitive and vivid understanding of traditional culture, but also subtly promote the development of their thinking skills, aesthetic abilities, and sense of cultural identity.The research results show that teachers who make full use of interactive animation, an expressive and participatory medium, in the teaching process can effectively convey course content, and scientifically design teaching activities based on the characteristics of children's cognitive development stages to guide students to actively participate in the learning process. This teaching method helps students construct a knowledge system based on an understanding of traditional culture, improves their overall understanding and internalization of the course, and thereby realizes a shift from “passive acceptance” to “active construction” in learning.

Research has found that interactive animation elements suitable for children's cognitive characteristics, such as clearly structured plots, graphic character designs, effective guidance through color and music elements, and reasonable touch feedback mechanisms, can effectively enhance preschool students' interest in learning and cultural comprhension. At the same time, children's perception, attention, and thinking skills also directly affect the teaching effectiveness of interactive animation, strengthening their understanding of story development and imaginative thinking.

The research findings demonstrate that interactive animation, when integrated with visually distinctive and signature action from traditional Chinese culture, such as mythological legends, traditional crafts, and Chinese traditional art, is suitable for the re-creation of interactive animation design. This facilitates cognitive transfer from imitation to creation in children. Additionally, by incorporating layered design principles, it provides an effective pathway for children's cultural learning.

Reasonable interactive animation design is essential for improving preschool students' comprhension and creativity. In order to ensure the deep application of interactive animation in educational practice, designers need to fully consider the differences in cognitive levels, attention span, language development, and emotional expression among students of different age groups. In specific implementation, the adaptability of different age groups (junior, middle, and senior classes) in the same kindergarten needs to be taken into consideration.

For example, for students aged 3-4 in the junior class, interactive content should focus on intuitive, vivid, and repetitive operations, while students aged 5-6 in the middle class can be given tasks with increased challenge and complexity to guide the further development of their thinking.For seniors aged 6-7, the design of interactive animations should fully consider their upcoming transition to first grade, especially the differences in curriculum content and teaching priorities across regions. To ensure a seamless transition, interactive animations should gradually introduce basic knowledge related to first grade while maintaining fun and interactivity.This personalized design tailored to individual needs ensures that the learning content is age-appropriate and suitable, and also ensures that the educational value of interactive animation is widely applicable to students of different age groups. Through differentiated content presentation and interactive mechanisms, interactive animation can more effectively support the comprehensive development of students in terms of cognition, emotion, and creativity, truly achieving the teaching goal of education through entertainment.

Researcher designed interactive animations to enhance the learning skills of Chinese preschool students in traditional culture courses and conducted a satisfaction assessment of the interactive animations. The results showed that the interactive animations had significant educational effects in enhancing preschool students' understanding and interest in traditional culture, and also demonstrated good cross-

cultural education transferability and adaptability.Specifically, the symbolic images, narrative structures, interactive methods, and cultural imagery employed in the animations possess a certain degree of cultural universality and educational universality. They can respect local cultural characteristics while providing valuable references and insights for early education in other cultural contexts.

Besides, based on the satisfaction survey results, interactive animation has been well received and recognized by preschool students. Most students showed great interest and willingness to participate during the use process, indicating that this teaching method has significant advantages in stimulating learning motivation and enhancing classroom interaction. The satisfaction data further verifies the effectiveness and age appropriateness of interactive animation in terms of content design, operational experience, and cultural expression. More importantly, this research finding indicates that this type of interactive animation is applicable not only to the local preschool education environment but also has the potential to be promoted and applied in other countries or regions. Its design concept, which integrates traditional cultural elements with interactive media technology, provides a practical example for constructing an open, diverse, and inclusive preschool education content system, and also provides theoretical support and methodological reference for promoting the integration and dissemination of cross-cultural educational resources.

**Recommendation for the pratical**

This study proposes the following recommendations to promote effective learning in traditional culture courses for preschool students.

First, in designing interactive animated content, emphasis should be placed on presenting traditional cultural elements in a deep and diverse manner. For instance, building upon festival customs and folk tales, content such as traditional Chinese mythology, folk crafts, intangible cultural heritage skills, and etiquette norms can be progressively introduced to establish a stepwise learning system. Simultaneously, excessive complexity should be avoided. Storytelling and contextualized approaches enable preschool students to gradually deepen their understanding of traditional culture within a relaxed and enjoyable atmosphere.

Second, interactive games should emphasize simplicity and fun in operation, aligning with preschool students' cognitive levels and motor coordination skills.

Integrating learning content with interactive experiences through intuitive gestures like click, drag, and rotate enhances students' engagement and immersion. Simultaneously, role-playing and interactive scenarios can help children better perceive and understand cultural connotations within virtual experiences.

For interface and visual design, vibrant colors are recommended for animated sections, while less saturated hues suit interactive game elements. Character designs should be anthropomorphic and approachable, with animal-inspired motifs particularly effective for building rapport with students. Additionally, incorporating traditional Chinese aesthetic elements,such as calligraphy, patterns, and ink painting styles,can foster a culturally immersive learning environment.

Furthermore, in sound and music design, prioritize the integration of music, narration, and sound effects. Enhance the appeal and memorability of cultural content through children's songs, folk music, and conversational explanations. Moderately incorporate tactile or dynamic feedback to make the learning process more immersive and multisensory.

Finally, regarding subsequent upgrades and evaluations of interactive animation software, an effective mechanism can be established based on feedback from preschool children's usage. This approach focuses on their points of interest, challenges encountered, and acceptance levels during interactions. Through continuous refinement and improvement, a dynamic balance between entertainment value and educational content can be achieved, thereby enhancing the effectiveness and applicability of interactive animations in traditional cultural education.

**Recommendations for the future research**

For the future, we recommend that, once interactive animation technology matures, cutting-edge technologies such as augmented reality (AR) and virtual reality (VR) be organically integrated into course content to achieve an immersive learning experience that combines the virtual and the real. This integration will not only help expand the expressive boundaries of interactive animation, but also provide new possibilities for the deep integration of cross-cultural education, educational technology, and learning psychology.

Combining AR and VR technologies with traditional culture learning can significantly improve children's sensory engagement and independent exploration

abilities in virtual environments. For example, by recreating traditional festivals, cultural customs, or historical figures in virtual scenes, children can not only observe and interact, but also express their understanding and imagination of cultural content through creative means, thereby achieving both knowledge construction and cultural identity in an immersive experience.

In addition, interactive animation can also be applied to interactive animation design strategies for children with special educational needs (such as language development delays and children with autism spectrum disorders) aged 3-4 and 5-6. More targeted interactive animation design strategies can be developed for children with special educational needs. Through careful adjustments to content, interaction methods, and rhythm control to suit their attention characteristics, perception abilities, and social interaction needs, the accessibility and inclusiveness of learning can be improved.

Finally, the acceptance and adaptability of interactive animations can be systematically tested in a multicultural context to evaluate their dissemination effects and learning feedback in different countries, regions, and cultural contexts. By collecting cross-cultural user data and evaluations, an adaptive validation mechanism and cultural expression paradigm can be gradually formed to provide theoretical basis and design references for the future development of interactive educational products with greater universality, compatibility, and cultural sensitivity.

**Limitations of the study**

This study has some limitations that should be noted. First, in the interactive animation design of this study, constrained by the functional limitations of the software used, the typographic presentation remained relatively monotonous, failing to achieve more engaging and diverse textual designs.One another limitation of this study is that there was the limited number of participants, due to its experimental nature that requires close control of many factors that affect the generalizability of the results to a wider population. However, the data obtained are valuable as preliminary data for future research that may use a larger sample size. In addition, this study was conducted in only one kindergarten in Zhengzhou, and the sample is limited in terms of regional and representative characteristics. When the results of this study are applied to kindergartens in other regions, there may be differences in effectiveness due to cultural background, educational resources, learning habits, and other factors.

# REFERENCES

# REFERENCES


Abdul Malik, M. (2024). Exploring metacognitive strategies through storytelling for preschoolers' listening comprehension skills. *In Artificial Intelligence for Supp orting Human Cognition and Exploratory Learning in the Digital Age ,2024(9), 221-238*.https://doi.org/10.1007/978-3-031-66462-5_12

Agustina, I., Siregar, L. A., Husain, D. L., Asfahani, A., & Pahmi, P. (2023). Utilization of digital technology in children's education to enhance creative and interactive learning. *Journal Pendidikan, Social Dan Kebudayaan, 10(2), 276-283.* https://doi.org/10.32505/tarbawi.v10i2.6970

Alam, A. (2022). Social robots in education for long-term human-robot interaction: socially supportive behavior of robotic tutor for creating robo-tangible learning environment in a guided discovery learning interaction. *ECS Transactions, 107(1), 12389.* DO1:10.1149/10701.12389ecst

Ale, M., Sturdee, M., & Rubegni, E. (2022). A systematic survey on embodied cognition: 11 years of research in child–computer interaction. *International Journal of Child-Computer Interaction, (2022) 33, 100478.*

Akwukwuma, V. V. N., Chete, F. O., Okpako, A. E., & Irabor, F. E. (2024). Improving User Interface Design and Efficiency Using Graphic Design and Animation Techniques. *NIPES-Journal of Science and Technology Research, 6(3).* https://doi.org/10.5281/zenodo.13765451

Anggrasari, L. A., & Dayu, D. P. K. (2022). The effectiveness of Pop-Up-based animation book to improve reading comprehension skills of elementary school students. *Journal Pendidikan Guru MI, 9*(2), 265-279. *10.24235/al.ibtida.snj.v9i2.9129*

Angong, C. (2015). A Brief Discussion on Literacy Teaching for Preschool Children. *Curriculum Education Research (28), 16.* doi:CNKI:SUN:KCJY.0.2015-28-016.

Aslan, S., Agrawal, A., Alyuz, N., Chierichetti, R., Durham, L. M., Manuvinakurike, R., Okur, E., Sahay, S., Sharma, S., Sherry, J., Raffa, G., & Nachman, L. (2022). Exploring Kid Space in the Wild: A Preliminary Study of Multimodal and Immersive Collaborative Play-Based Learning Experiences. *Educational Technology Research and Development, 70(1), 205–230*. https://doi.org/10.1007/s11423-021-10043-0

Arifin., Mohan,T., Nana,C., Erwinsyah,S., & Rizki,D.（2023）.Application of ln teractive earning Games Stimulating About Object Recognition in Early Child hood. Educator: *Journal lmiah Pendidikan,2(1),1-6.* https ://doi.org/10.55904/ed ucenter.v1i7

Aydoğdu, F. (2022). Augmented reality for preschool children: An experience with educational contents. *British Journal of Educational Technology, 53(2), 326-3 48*.https://doi.org/10.1111/bjet.13168

Aylett, R. (2022). Interactive narrative and story-telling. In The Handbook on Socially Interactive Agents: 20 years of Research on Embodied Conversational Agents, *Intelligent Virtual Agents, and Social Robotics , 2022 ( 2 ) , 463-492*.https://doi.org/10.1145/3563659.3563674

Bai, L. (2023). Interactive study of narrative animation in children and health education (Master's thesis, Luxun Academy of Fine Arts). M.A. https://link.cnki.net/doi/10.27217/d.cnki.glxmc.2023.000006doi:10.27217/d.cnki.gl xmc.2023.000006.

Bai, S., Liu, Y., Song, Y., & Cross, J. S. (2023). Exploring the Effects of Digital Storytelling-Enhanced Scenario-Based Learning on Students' Learning Outcomes. *In 2023 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE), 1-7.* 10.1109/TALE56641.2023.10398298

Barut Tugtekin, E., & Dursun, O. O. (2022). Effect of animated and interactive video variations on learners' motivation in distance education. *Education and Information Technologies, 27(3), 3247-3276.* https://doi.org/10.1007/s10639-021-10735-5

Bangert-Drowns, R. L., Kulik, C.-L. C., Kulik, J. A., & Morgan, M. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research, 61(2), 213–238*.https://doi.org/10.1080/00461520.2022.2108426

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2020). The effective components of creativity in digital game-based learning among young children: A case study. *Children and Youth Services Review, 116, 105227*.https://doi.org/10.1016/j.childyouth.2020.105227

Beran, T. N., Ramirez-Serrano, A., Kuzyk, R., Fior, M., & Nugent, S. (2011). Understanding how children understand robots: Perceived animism in child–robot

interaction. *International Journal of Human-Computer Studies, 69(7-8), 539-550*.https://doi.org/10.1016/j.ijhcs.2011.04.003

Bertelson, P., & Tisseyre, F. (1969). The time course of preparation: confirmatory results with visual and auditory warning signals. *Journal of Acta Psychological*, *(9)30, 145–154.* https://doi.org/10.1016/0001-6918(69)90047-X

Beyer, H., & Holtzblatt, K. (1998). Contextual design: Defining customer-centered systems. Morgan Kaufmann.

Birren, F. (2016). *Color psychology and color therapy: A factual study of the influence of color on human life.* Pickle Partners Publishing.

Blumberg, F. C., Deater-Deckard, K., Calvert, S. L., Flynn, R. M., Green, C. S., Arnold, D., & Brooks, P. J. (2019). Digital games as a context for children's cognitive development: Research recommendations and policy considerations. *Social Policy Report, 32(1), 1-33.* https://doi.org/10.1002/sop2.3

Bredeweg, B., Kragten, M., Holt, J., Kruit, P., van Eijck, T., Pijls, M., ... & de Boer, M. (2023). Learning with interactive knowledge representations. *Applied Sciences, 13(9), 5256.*https://doi.org/10.3390/app13095256

Briggs, R. (2004). The Language of Animation (H. K. Huimei, Trans.). China Youth Press. (Original work published in English)

Brouse, C. H., & Chow, T. H. (2009). Exploring pre-operational and concrete operational children's thinking on nutrition: A case study. *Health Education Journal, 68(3), 219-231.*https://doi.org/10.1177/0017896909346099

Bodrova, E., & Leong, D. (2024). Tools of the mind: The Vygotskian approach to early childhood education. Taylor & Francis.

Bornstein, M. H., Hahn, C. S., & Haynes, O. M. (2010). Social competence, externalizing, and internalizing behavioral adjustment from early childhood through early adolescence: Developmental cascades. *Development and psychopathology, 22(4), 717-735.*doi:10.1017/S0954579410000416

Cain, K., & Oakhill, J. (Eds.). (2013). Reading comprehension difficulties: Processes and intervention. Routledge.

Cai，Y & Shen，A. (2024). Practical difficulties and policy optimization in preschool education for children with special needs: The case of intervention for children with

autism. *Journal of Nanjing Xiaozhuang University (02), 46-52.* doi:CNKI:SUN:SFZK.0.2024-02-008.

Callaghan, T., & Corbit, J. (2015). The development of symbolic representation. *Handbook of child psychology and developmental science, 7,1-46.* https://doi.org/10.1002/9781118963418.childpsy207

Calvert, S. L. (2020). Young children's mathematical learning from intelligent c haracters. *Child Development, 91(4), 1171–1186.* https://doi.org/10.1111/cdev.13341

Cartwright, K. (2024). Interpreting young children's multiplicative strategies through their drawn representations. *Mathematics Education Research Journal, 36(2), 367-397.* https://doi.org/10.1007/s13394-023-00450-4

Cassaday, H. J., Bloomfield, R. E., & Hayward, N. (2002). Relaxed conditions can provide memory. cues in both undergraduates and primary school children. *British Journal of Educational Psychology, 72(4), 531–547.* https://doi.org/10.1348/00070990260377488

Chaiklin, S. (2003). The zone of proximal development in Vygotsky's analysis of learning and instruction. *Vygotsky's educational theory in cultural context, 1(2), 39-64.*

Chen, C. M. (2008). Intelligent web-based learning system with personalized learning path guidance. *Computers & Education, 51(2), 787-814.*https://doi.org/10.1016/j.compedu.2007.08.004

Chen, G. (2011). Preschool Education (3rd edition). Beijing: Higher Education Press.

Cheng, A., Ma, D., Qian, H., & Pan, Y. (2024). The effects of mobile applications' passive and interactive loading screen types on waiting experience. *Behaviour & Information Technology, 43(8), 1652-1663.* https://doi.org/10.1080/0144929X.2023.2224901

Cheng, S. (2025). The relationship between preschool education and children's cognitive development. *New Curriculum Teaching (Electronic Edition) (04), 141-143.* doi:CNKI:SUN:XKJX.0.2025-04-048.

Cheng, T. (2013). A brief discussion on methods for improving young children's literacy skills. *New Curriculum (Part II) (03), 118.* doi:CNKI:SUN:XKCS.0.2013-03-130.

Chen，H. (2021). Empirical research on the professional competence of kindergarten teachers. *Taste and Classics (22), 147-150.* doi:CNKI:SUN:PWJD.0.2021-22-042.

Chen, L. (2024). Research on the integration of kindergarten and family education. *Gansu Education (01), 47-51.* doi:CNKI:SUN:GSJY.0.2024-01-015.

Chen, K. (2022). An interactive design framework for children's apps for enhancing emotional experience. *Interacting with computers, 34(3), 85-98.* https://doi.org/10.1093/iwc/iwac042

Chen，P. (2024). "Cultural Understanding" in Core Art Literacy and Its Teaching Research (Doctoral Dissertation, Central China Normal University). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CDFDLAST2025&filename=1024857379.nh

Chen, X., & Ibrahim, Z. (2023). A comprehensive study of emotional responses in AI-enhanced interactive installation art. *Sustainability, 15(22), 15830.*https: //doi.org/10.3390/su152215830

Chen, Y., & Li, H. (2021). Early childhood creativity: The role of problem-solving and self-expression. *Early Child Development and Care, 191(5), 767–780.* https://doi.org/10.1080/03004430.2019.1641473

China Education Development Strategy Society. (2024). *2024 China Education Development Repor.* https://www.canedu.org.cn/site/content/7881.html

Choi, K. H. (2022). 3D dynamic fashion design development using digital technology and its potential in online platforms. *Fashion and Textiles, 9(1), 9. https://doi.org/10.1186/s40691-021-00286-1*

Chuang, C., & Jamiat, N. (2023). A systematic review on the effectiveness of children's interactive reading applications for promoting their emergent literacy in the multimedia context. *Contemporary Educational Technology, 15(2), ep412.* https://doi.org/10.30935/cedtech/12941

Clemente-Suárez, V. J., Beltrán-Velasco, A. I., Herrero-Roldán, S., Rodriguez-Besteiro, S., Martínez-Guardado, I., Martín-Rodríguez, A., & Tornero-Aguilera, J. F. (2024). *Digital device usage and childhood cognitive development: Exploring effects on cognitive abilities. Children, 11(11), 1299.* https://doi.org/10.3390/children11111299

Connor, C. M. (Ed.). (2016). The cognitive development of reading and reading comprehension. Routledge. https://doi.org/10.4324/9781315694429

Cornoldi, C. (2013). Origins of intentional strategic memory in the child. *In Piaget Today (Psychology Revivals) (pp. 183-201).* Psychology Press.

Dahlan, M. M., Halim, N. S. A., Kamarudin, N. S., & Ahmad, F. S. Z. (2023). Exploring interactive video learning: Techniques, applications, and pedagogical insights. *International Journal of Advanced and Applied Sciences, 10(12), 220-230. ttps://doi.org/10.21833/ijaas.2023.12.024*

Danby, S., Theobald, M., Davidson, C., & Thorpe, K. (2020). How talk and interaction unfold in a digitally enabled preschool classroom. *Learning, Culture and Social Interaction, 24, 100330.* https://doi.org/10.1016/j.lcsi.2020.100330

Daneshfar, S., & Moharami, M. (2018). Dynamic assessment in Vygotsky's sociocultural theory: Origins and main concepts. *Journal of Language Teaching and Research, 9(3), 600-607.*http://dx.doi.org/10.17507/jltr.0903.20

Darmawati, I., & Setiawan, D. (2024). Cognitive development and its impact on learning motivation among preschoolers. International Journal of Education and Training (InjET), 10(2), 1-7.http://eprints.iab.edu.my/v2/id/eprint/1587

Daryanes, F., Darmadi, D., Fikri, K., Sayuti, l., Rusandi, M.A., & Situmorang, D.D.B. (2023). The development of articulate storyline interactive learning media based on case methods to train students' problem-solving ability. *Journal of Heliyon, 9(4), e15082.* 10.1016/j.heliyon.2023.e15082

Deng, L., (2023). An interactive design study of children's picture books under multisensory experience. *Journal of Knowledge Window,2023(4),69-71*

Deng, L., & Wang, J. (2025). The Current Status and Breakthrough Strategies for Integrating Excellent Traditional Chinese Culture into Kindergarten Curricula. *Early Education (20), 43-47.* doi:CNKI:SUN:ZQJY.0.2025-20-009.

Denham, S. A. (2007). Dealing with feelings: how children negotiate the worlds of emotions and social relationships. *Cognitie, Creier, Comportament/Cognition, Brain, Behavior, 11(1).1-48*

Denham, S. A. (2006). Social-emotional competence as support for school readiness: What is it and how do we assess it?. *Early education and development, 17(1), 57-89.* https://doi.org/10.1207/s15566935eed17014

Drigas, A., Kokkalia, G., & Lytras, M. D. (2015). Mobile and multimedia learning in preschool education. *Journal of Mobile Multimedia, 11 ( 1-2 ) , 119-133.*https://journals.riverpublishers.com/index.php/JMM/article/view/4547

Dritsas, E., Trigka, M., Troussas, C., & Mylonas, P. (2025). Multimodal interaction, interfaces, and communication: a survey. *Multimodal Technologies and Interaction*, *9*(1), 6. *https* ://doi.org/10.3390/mti9010006

Dudley, J. J., & Kristensson, P. O. (2018). A review of user interface design for interactive machine learning. *ACM Transactions on Interactive Intelligent Systems (TiiS), 8(2), 1-37.*https://doi.org/10.1145/3185517

Du，J & Liu，L. (2012). Violent content in animated films and its impact on children's mental health. (eds.) *Proceedings of the 15th National Psychology Academic Conference (pp.147).*

Du, M. (2022). User experience and interactive animation design. Publishing House of Electronics Industry.

Du，X. (2024). Exploration of interactive narrative design in VR animation. *Toy World (09), 54-56.* doi:CNKI:SUN:TOYZ.0.2024-09-018.

Eckhoff, A., & Urbach, J. (2008). Understanding imaginative thinking during childhood: Sociocultural conceptions of creativity and imaginative thought. *Early Childhood Education Journal, 36(2), 179-185.*https://doi.org/10.1007/s10643-008-0261-4

Elsayed, W. (2024). Building a better society: The Vital role of Family's social values in creating a culture of giving in young Children's minds. *Heliyon*, *10*(7). e29208-29226. 10.1016/j.heliyon.2024.e29208 External Link

Erikson, E. H. (1950). *Childhood and society.* W. W. Norton & Company Academic

Eun, B. (2019). The zone of proximal development as an overarching concept: A framework for synthesizing Vygotsky's theories. *Educational philosophy and theory, 51 (1), 18-30.* https://doi.org/10.1080/00131857.2017.1421941

Evanick, J. (2023). The importance of feedback in personalized learning. eLearning Industry.

Fan, L., Lu, M., Qi, X., & Xin, J. (2022). Do animations impair executive function in young children? Effects of animation types on the executive function of children aged

four to seven years. *International Journal of Environmental Research and Public Health, 19(15), 8962. https* : //doi.org/10.3390/ijerph19158962

Fan, L., Zhan, M., Qing, W., Gao, T., & Wang, M. (2021). The short-term impact of animation on the executive function of children aged 4 to 7. *International Journal of Environmental Research and Public Health, 18(16), 8616.* https://doi.org/10.3390/ijerph18168616

Fernández Herrero, J., Gómez Donoso, F., & Roig Vila, R. (2023). The first steps for adapting an artificial intelligence emotion expression recognition software for emotional management in the educational context. *British Journal of Educational Technology, 54(6), 1939-1963.* https://doi.org/10.1111/bjet.13326

Fialho, A. (2023). Animated shapes: The movement drawn in cartoon animation. *Diálogo com a Economia Criativa, 8(24). 64-78.* https://doi.org/10.22398/2525-2828.82464-78

Fikriyah, M., Zaenuri, Z., & Cahyono, A. N. (2021). Problem Solving Ability Reviewed from Independent Learning at social media based Blended Learning. *Unnes Journal of Mathematics Education Research, 10(A).164-170*

Fuhs, M. W., Farran, D. C., & Nesbitt, K. T. (2020). The relationship of work ing memory and inhibition with different number knowledge skills in prescho ol children. *Journal of Experimental Child Psychology, 200, 104899.* https://d oi.org/10.1016/j.jecp.2020.104899

Gao, Z. (2018). Analysis of the Pathways for Cultivating Scientific Literacy in Preschool Education Majors. *Modern Vocational Education (07), 213.* doi:CNKI:SUN:XDZJ.0.2018-07-157.

Gathercole, S. E., & Pickering, S. J. (2000). Assessment of working memory in six-and seven-year-old children. *Journal of educational psychology, 92(2), 377*.https://doi.org/10.1037/0022-0663.92.2.377

Gieryic, P. D. (2024). *Interactive Visual Rhythmscapes.* State University of New York: http://hdl.handle.net/20.500.12648/15138

Gilakjani, A. P. (2012). The significant role of multimedia in motivating EFL learners' interest in English language learning. International *Journal of Modern Education and Computer Science, 4(4), 57*.DOI: 10.5815/ijmecs.2012.04.08

Gm, D., Goudar, R. H., Kulkarni, A. A., Rathod, V. N., & Hukkeri, G. S. (2024). A digital recommendation system for personalized learning to enhance online education: A review. *IEEE Access, 12, 34019-34041.*10.1109/ACCESS.2024.3369901

Goldman, E. J., & Poulin-Dubois, D. (2024). Children's anthropomorphism of inanimate agents. Journal of Wiley Interdis

Gopnik, A. (2012). Scientific thinking in young children: Theoretical advances, empirical research, and policy implications. *Science, 337(6102), 1623-1627.*DOI: 10.1126/science.1223416

Guilford, J. P. (1950). Creativity. *American Psychologist, 5(9), 444–454.* https://doi.org/10.1037/h0063487

Guo, X (2025). Innovation and integration of excellent traditional Chinese culture in kindergarten curriculum development. Shandong Education (15), 25-26. doi:CNKI:SUN:SDJY.0.2025-15-010.

Guo, Y. (2022). Research on the Childcare Concepts of Kindergarten Teachers in Southwest China (Master's thesis, Southwest University). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202202&filename=1022670246.nh

Gupta, J., Ahuja, M., & Garg, N. (2022). A review on human-computer interaction (HCI). *In 2022 2nd International Conference on Innovative Sustainable Computational Technologies (CISCT),2022(1), 1-6.* DOl:10.1109/CISCT55310.2022.10046656

Halford, G. S. (2014). Children's understanding: The development of mental models. Psychology Press.https://doi.org/10.4324/9781315801803

Han, C & Yu, X. (2024). Diverse expressions of China's excellent traditional culture in animated film and television works. *Film Review (04), 90-95.* doi:10.16583/j.cnki.52-1014/j.2024.04.016.

Hao, H. (2024).On the Concept of Children's Animation and the Absence of Relevant Research in China. *Contemporary animation,2023(4),109-114.*

Hao, J. (2015). A brief discussion on the use of traditional cultural elements in interactive media design. *Drama Home (24), 266.* doi:CNKI:SUN:XJZT.0.2015-24-219.

Hassan, A., Dutta, P. K., Gupta, S., Mattar, E., & Singh, S. (Eds.). (2024). Human-centered approaches in industry 5.0: Human-machine interaction, virtual reality training, and customer sentiment analysis: Human-machine interaction, virtual reality training, and customer sentiment analysis. IGI Global.

Hatira, A., & Sarac, M. (2024). Touch to Learn: A Review of Haptic Technology's Impact on Skill Development and Enhancing Learning Abilities for Children. *Advanced Intelligent Systems*, *6*(6), 2300731. https://doi.org/10.1002/aisy.202300731

He, C., Dai, X., & Fan,M. (2015). Internet Animation Culture and Communication. *Media (05), 61-63.* doi:CNKI:SUN:CMEI.0.2015-05-032.

He,Q. (2025). Strategies for integrating “appropriate” culture building with kindergarten education. *Parents, (09), 56-58.*

Herodotou, C. (2018). Young children and tablets: A systematic review of effects on learning and development. *Journal of Computer Assisted Learning, 34(1), 1-9.* https://doi.org/10.1111/jcal.12220

Hikmah, H., Wongsonadi, S. K., Hartati, S., & Jahja, Y. (2024). Enhancing early childhood social-emotional skills through innovative interactive learning media. *Asian Journal of Social and Humanities, 3(3), 526-544.* https://doi.org/10.59888/ajosh.v3i3.460

Hoberman, J. (1982). Disney animation: The illusion of life. *Film Comment*, *18*(1), 67.

Hojnor, A., Sito, R., Migo, P., Jarczak, J., & Jaszczur, W. (2024). The influence of artistic techniques on the development of manual skills in a six years old child. *Scientific Journal of Bielsko-Biala School of Finance and Law, 28(1), 118-123*.https://doi.org/10.19192.wsfip.sj1.2024.17

Hourcade, J. P. (2008). Interaction design and children. *Foundations and Trends ® in Human–Computer Interaction*, *1*(4), 277-392. http://dx.doi.org/10.1561/1100000006

Hou, Y, & Huang, X. (2017). Research on children's digital picture books based on the psychology of color cognition. *Technology and Publishing, 36(4), 71-74.* https://kjycb.tsinghuajournals.com/article/2017/1005-0590/113209G-2017-4-120.shtml

Hu, L. (2021). Analysis of the value of the application of interactive animation technology in animation teaching to enhance students' learning efficiency." *Journal of Beijing Institute of Printing 29(11),121-123.* doi:10.19461/j.cnki.1004-8626.2021.11.034.

Huang, B. (2024). Research on the evaluation and improvement of the efficiency of special funds for private kindergartens. *Sales and Marketing (27), 103-105.* doi:CNKI:SUN:XSYS.0.2024-27-034.

Huang, X. (2023). Applied research on digital animation in children and art education (Master's thesis, Luxun Academy of Fine Arts). Master https://link.cnki.net/doi/10.27217/d.cnki.glxmc.2023.000130doi:10.27217/d.cnki.glxmc.2023.000130.

Huang, Z. (2024). Research on Interactive Animation Creation with Spinal Animal Themes (Master's Thesis, Nanjing University of Information Science and Technology). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202501&filename=1024618478.nh

Hyson, M. (2004). The emotional development of young children: Building an emotion-centered curriculum. Teachers College Press.

Ireland, J., & Mouthaan, M. (2020). Perspectives on curriculum design: comparing the spiral and the network models. https://doi.org/10.17863/CAM.100405

iResearch. (2022). 2022 China Children's Healthy Growth White Paper. The Paper. https://www.thepaper.cn/newsDetail_forward_18071862

iResearch.(2021).White Paper on Digital Content for Children in China.https://www.thepaper.cn/newsDetail_forward_16735902

Ismail, N., Juhari, R., Madon, Z., Arshat, Z., Daud, M. N., & Azam, M. N. D. (2023). The use of scaffolding technique to improve children's problem-solving skills. *Journal for Re Attach Therapy and Developmental Diversities, 6, 476-586.*

Itczak, M. (2022). Child development and artistic development in art therapy. In Foundations of Art Therapy (pp. 291-334). Academic Press.https://doi.org/10.1016/B978-0-12-824308-4.00003-X

Jakovljević, T., Janković, M. M., Savić, A. M., Soldatović, I., Mačužić, I., Jakulin, T. J., & Ković, V. (2021). The effect of color on reading performance in children,

measured by a sensor hub: From the perspective of gender. *Plos one, 16(6), e0252622.* https://doi.org/10.1371/journal.pone.0252622

Janson, G. R., & King, M. A. (2006). Emotional security in the classroom: What works for young children. *Journal of family and consumer sciences, 98(2), 70-74.*https://www.proquest.com/scholarly-journals/emotional-security-classroom-what-works-young/docview/218178476/se-2

Johannsen, G. (2009). Human-machine interaction. *Control Systems, Robotics and Automation, 21, 132-62.*

Jirout, J. J., Evans, N. S., & Son, L. K. (2024). Curiosity in children across ages and contexts. *Nature Reviews Psychology, 3(9), 622-635.*https://doi.org/10.1038/s44159-024-00346-5

Ji S, Yan Y, Feng Y, et al. (2025). The effects of color on children's attention and its characteristics from 6 to 9 years old - based on an eye movement experiment. *Psychology Monthly, 20(1), 20-24.* https://doi.org/10.19738/j.cnki.psy.2025.01.005

Kabir, Z. (2013). Exploring the Second Screen with Dora.

Kalina, C., & Powell, K. C. (2009). Cognitive and social constructivism: Developing tools for an effective classroom. *Education, 130(2), 241-250.*

Kampylis, P., & Berki, E. (2014). Nurturing creative thinking . *International Academy of Education (IAE). 1-28*

Kartika, Y., Wahyuni, R., Sinaga, B., & Rajagukguk, J. (2019). Improving math creative thinking ability by using math adventure educational game as an interactive media. *Journal of Physics: Conference Series,1179(1), 012078.* 10.1088/1742-6596/1179/1/012078

Kavak, Ş., Gül, E. D., & Sarıay, M. (2024). The Relationship Between the Use of Digital Tools and Creativity in Preschool. *Kahramanmaraş Sütçü İmam Üniversitesi Sosyal Bilimler Dergisi, 21(2), 464-475.*

Kennedy, D. M., & McNaught, C. (1997). Design elements for interactive multimedia. *Journal of Educational Technology, 13(1), 1-22*. https://doi.org/10.14742/ajet.1916

Kikas, E., Silinskas, G., Jogi, A. L., & Soodla, P. (2016). Effects of teacher's individualized support on children's reading skills and interest in classrooms with different teaching styles. *Learning and Individual Differences, 49, 270-277.*https://doi.org/10.1016/j.lindif.2016.05.015

Korat, O., Segal-Drori, O., & Klien, P. S. (2016). Benefits of motion in animated storybooks for children's visual attention and story comprehension: An eye-tracking study. *Frontiers in Psychology, 7, 1641.* https://doi.org/10.3389/fpsyg.2016.01641

Lamrani, R., & Abdelwahed, E. H. (2020). Game-based learning and gamification to improve skills in early years education. *Computer Science and Information Systems, 17(1), 339-356.*https://doi.org/10.2298/CSIS190511043L

Lanna, L. C., & Oro, M. G. (2019). Touch gesture performed by children under 3 years old when drawing and coloring on a tablet. *International Journal of Human-Computer Studies, 124, 1-12.* https://doi.org/10.1016/j.ijhcs.2018.11.008

Lebowitz, J., & Klug, C. (2011). Interactive storytelling for video games: A player-centered approach to creating memorable characters and stories. Focal Press.

Lee, L. (2010). Music therapy enhances attention span and promotes language a bility in young special needs children. In *Proceeding of the ISME commission seminar on Music in Special Education, Music Therapy, and Music Medicin e*, 34-45. https://www.isme.org/sites/default/files/documents/2006 2008+Special Ed+Proceedings.pdf#page=41

Levy, D. B. (2021). *Your career in animation: How to survive and thrive*. Simon and Schuster.

Lewis, S. C., Guzman, A. L., & Schmidt, T. R. (2019). Automation, journalism, and human–machine communication: Rethinking roles and relationships of humans and machines in news. *Digital journalism, 7(4), 409-427.*https://doi.org/10.1080/21670811.2019.1577147

Li, H., Zhang, T., Woolley, J. D., An, J., & Wang, F. (2023) Exploring factors influencing young children's learning from story books: Interactive and multimedia features. *Journal of Experimental Child Psychology, 233(10), 10-15*. https://doi.org/10.1016/j.jecp.2023.105680

Li, J. (2023). A Study of Middle Class Children's Responses and Preferences to Traditional Chinese Culture Picture Books from a Child's Perspective (Master's Thesis, East China Normal University). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202501&filename=1024331979.nh

Li， J. (2024). Practical research on the effective integration and development of preschool education and special education. *New Education (22), 77-79.* doi:CNKI:SUN:LXJY.0.2024-22-031.

Li， J. (2024). Research on the inheritance and innovative design of excellent traditional culture in picture books for children aged 3-6. *Footwear Craftsmanship and Design (16), 126-128.* doi:CNKI:SUN:ZWXE.0.2024-16-042.

Li， J. (2020). The integration of Chinese traditional culture and educational theater. *Chinese Teachers (11), 86-88.* doi:CNKI:SUN:ZGJT.0.2020-11-026.

Li, L. (2025). A study on the impact of color usage in children's animation on cognitive development. *Color (01), 43-45.* doi:CNKI:SUN:LXSE.0.2025-01-012.、

Lillard, A. S., Drell, M. B., Richey, E. M., Boguszewski, K., & Smith, E. D. (2015). The immediate impact of different types of television on young children’s executive function. *Pediatrics, 136(4), 664–669.* https://doi.org/10.1542/peds.2015-1912

Li, N, Zhang Z, Yang Y, Sha S, & Weng Z. (2022). An eye movement study of preschool children using tangible and multi-touch interfaces. *Packaging Engineering, 43(16), 101-108.* https://d.wanfangdata.com.cn/periodical/bzgc202216013

Li, Q., Wang, J., & Luo, T. (2024). Evaluating interactive digital exhibit characteristics in science museums and their effects on child engagement. *International Journal of Human–Computer Interaction, 40(3), 838-849.* https://doi.org/10.1080/10447318.2022.2126584

Li， X. (2024). Principles of expression animation and case studies of its specific applications in computer animation. *Toy World (09), 69-71.* doi:CNKI:SUN:TOYZ.0.2024-09-023.

Li, X., & Yu, Y. (2022). Research on the interactive design of children’s audio-visual products based on. multi-modal sensory experiences. Journal of Gra

Li, X., Zhang, C., & Wu, Y. (2022). Deconstruction of Immersive Animation Image Interaction Design under Virtual Reality Technology. *Wireless Communications and Mobile Computing, 2022(1), 2104633.* https://ir.uitm.edu.my/id/eprint/112948

Li， Y & Han， Y. (2019). Exploring innovations in preschool English courses. *English Square (02), 126-127+156.* doi:10.16723/j.cnki.yygc.2019.02.062.

Li, Y, & Wang, J. (2015). Interaction Design and New Media Art. Beijing: Tsinghua University Press.

Lin, C. (2009). Developmental Psychology (2nd ed.). Beijing: People's Education Press.

Lin,L. Research on user experience design of interactive animation based on audiovisual language . Hubei: Hubei University of Technology,2020.

Liu, D., & Zhang, Y. (2016). Research on the expression of interactive animation. *Journal of Chifeng College (Natural Science Edition), 32(21), 136-137.* http://.10.13398/j.cnki.issn1673-260x.2016.21.059.

Liu, X., & Pan, H. (2022). The path of film and television animation creation using virtual reality technology under the artificial intelligence. *Scientific Programming, 2022(1), 1712929.* https://doi.org/10.1155/2022/1712929

Luo, J., & Lin H. (2024). Opening a new world of picture books: a study of augmented reality technology in children's cognitive development. *Journal Textile Reports,43(11) ,63-65.*

Mao，Y. (2023). Research on the Development of Adult Animation in China in a Pan-Animation Environment (Master's Thesis, Nanjing University of the Arts). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202501&filename=1024381655.nh

Martzoukou, K. (2022). “Maddie is online”: an educational video cartoon series on digital literacy and resilience for children. *Journal of Research in Innovative Teaching & Learning, 15(1), 64-82.* https://doi.org/10.1108/JRIT-06-2020-0031

Marougkas, A., Troussas, C., Krouska, A., & Sgouropoulou, C. (2023). Virtual reality in education: a review of learning theories, approaches and methodologies for the last decade. *Electronics, 12(13), 2832.* https : //doi.org/10.3390/electronics12132832

Masood, M., & Thigambaram, M. (2015). The usability of mobile applications for pre-schoolers. *Procedia-Social and Behavioral Sciences*, *197*, 1818-1826. https://doi.org/10.1016/j.sbspro.2015.07.241

Maule, J., Skelton, A. E., & Franklin, A. (2023). The development of color perception and cognition. *Annual Review of Psychology, 74(1), 87-111.*https://doi.org/10.1146/annurev-psych-032720-040512

Mayer, R. E. (2009). Multimedia learning (2nd ed.). Cambridge University Press.

McLelland, J. (2024). Connecting Piaget's cognitive development theory to technology in the early years. *He Kupu, 8(1)*.https://doi.org/10.32672/pice.v2i1.1381

McRae, K., Khalkhali, S., & Hare, M. (2018). Representational visuals of abstract financial concepts: A means to foster financial literacy. *Journal of Visual Literacy, 37(2), 123–135.* https://doi.org/10.1177/14788047241277768

Mermelshtine, R. (2017). Parent–child learning interactions: A review of the literature on scaffolding. *British Journal of Educational Psychology, 87(2), 241-254.* https://doi.org/10.1111/bjep.12147

Merritt, E. G., Wanless, S. B., Rimm-Kaufman, S. E., Cameron, C., & Peugh, J. L. (2012). The contribution of teachers' emotional support to children's social behaviors and self-regulatory skills in first grade. *School psychology review, 41(2), 141-159.*https://doi.org/10.1080/02796015.2012.12087517

Ministry of Education. (July 2023). 2022 National Education Development Statistics Bulletin. Official website of the Ministry of Education of the People's Republic of China. https://www.moe.gov.cn/jyb_sjzl/s5990/202307/t20230711_1075096.html

Morrow, L.M. (1985). Retelling stories: A strategy for improving young children's comprehension, concept of story structure, and oral language complexity. *The Elementary School Journal, 85(5), 647-661.* https://doi.org/10.1086/461427

Mou, T. Y., Jeng, T. S., & Chen, C. H. (2013). From storyboard to story: Animation content development. *Educational Research and Reviews*, *8*(13), 1032. https://academicjournals.org/article/article1379770481_Mou%20et%20al.pdf

Muis, K. R., Ranellucci, J., Trevors, G., & Duffy, M. C. (2015). The effects o f technology-mediated immediate feedback on kindergarten students' attitudes, emotions, engagement and learning outcomes during literacy skills developme nt. *Learning and Instruction*, *38*, 1-13.https://doi.org/10.1016/j.learninstruc.2015.02.001

Mustoip, S., Al Ghozali, M. I., As, U. S., & Sanhaji, S. Y. (2023). Implementation of Character Education through Children's Language Development in Elementary Schools. *IJECA (International Journal of Education and Curriculum Application), 6(2), 91-100.*https://doi.org/10.31764/ijeca.v6i2.14192

Nansen, B. (2020). *Young children and mobile media.* Springer International Academic.

National Association for the Education of Young Children (NAEYC) & Fred Rogers Center for Early Learning and Children's Media. (2012). Technology and interactive media as tools in early childhood programs serving children from birth through age 8. NAEYC. https://www.naeyc.org/content/technology-and-young-children

Nelson, K. E. (2014). Children's Language: Volume 4. Psychology Press.

Neumann, M. M., & Neumann, D. L. (2014). Touch screen tablets and emergent literacy. *Early Childhood Education Journal, 42(4), 231–239.* https://doi.org/10.1007/s10643-013-0608-3

Niu, Y. (2025). Strategies for kindergartens to enhance young children's cultural identity by relying on tea culture. *Fujian Tea,47(04),136-138.*

Olaz, X., Garcia, R., Ortiz, A., Marichal, S., Villadangos, J., Ardaiz, O., & Marzo, A. (2022). An interdisciplinary design of an interactive cultural heritage visit for in-situ, mixed reality and affective experiences. *Multimodal Technologies and Interaction, 6(7), 59.* https ://doi.org/10.3390/mti6070059

Ouyang, S. (2016). Analysis of the visuality and interactivity of digital interactive animation. *Popular Literature and Art (10), 130.* doi:CNKI:SUN:DZLU.0.2016-10-124.

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2021). Teaching mathematics with mobile devices and the Realistic Mathematical Education (RME) approach in kindergarten. *Advances in Mobile Learning Educational Research, 1(1), 5-18.* 10.25082/AMLER.2021.01.002

Parmar, D., Olafsson, S., Utami, D., Murali, P., & Bickmore, T. (2022). Designing empathic virtual agents: manipulating animation, voice, rendering, and empathy to create persuasive agents. *Autonomous agents and multi-agent systems, 36*(1), 17. https://doi.org/10.1007/s10458-021-09539-1

Parry, J. (2024). The Phenomenology of Animation. *Animation*, *19*(2-3), 83-100. https://doi.org/10.1177/17468477241281307

Pasarín-Lavín, T., Abín, A., García, T., & Rodríguez, C. (2023). Relationship between Executive Functions and Creativity in Children and Adolescents: A Systematic Review. *Children (Basel, Switzerland), 10(6), 1002.* https://doi.org/10.3390/children10061002

Paul, R. W. (2013). Critical and reflective thinking: A philosophical perspective. In Dimensions of thinking and cognitive instruction (pp. 445-494). Routledge.

Pavlov, I. P. (1927). Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex (G. V. Anrep, Trans.). Oxford University Press. (Original work published in Russian 1903)

Pérez-Ferra, M., Quijano-López, R., & García-Martínez, I. (2020). Impact of educational habits on the learning of 3–6 years old children from the perspective of early childhood education teachers. *Sustainability, 12(11), 4388*.https: //doi.org/10.3390/su12114388

Piaget, J. (1952). The origins of intelligence in children. International Universities Academic

Plucker, J., Beghetto, R., & Dow, G. (2004). Why creativity matters: A definition and key issues. *Creativity Research Journal, 16(1), 87–98.* https://doi.org/10.3389/fpsyg.2018.02095

Plutchik, R., & Kellerman, H. (1980). *Emotion: Theory, research, and experience.* Academic Press. https://doi.org/10.1080/0144929X.2023.2224901

Popovska Nalevska, G., & Kuzmanovska, M. (2020). TEACHING METHODS AS A FACTOR OF STUDENTS'LEARNING MOTIVATION. *Education, 2(3-4), 40-50.*

Preece, J., Rogers, Y., & Sharp, H. (2015). Interaction design: Beyond human-computer interaction (4th ed.). Wiley.

Prins, J., van der Wilt, F., van Santen, S., van der Veen, C., & Hovinga, D. (2023). The importance of play in natural environments for children's language development: an explorative study in early childhood education. *International Journal of Early Years Education, 31(2), 450-466.*https://doi.org/10.1080/09669760.2022.2144147

Qian，J. (2019). Research on the application of electronic tools in kindergartens in the context of "Internet+". *Test Questions and Research (13), 99.* doi:CNKI:SUN:STYJ.0.2019-13-078.

Rachmavita, F. P. (2020). Interactive media-based video animation and student learning motivation in mathematics. *Journal of Physics: Conference Series, 1663(1), 012040.* https://doi.org/10.1088/1742-6596/1663/1/012040

Rahmi, W. (2024). Analytical study of experiential learning: Experiential learning theory in learning activities. EDUKASIA *Journal Pendidikan dan Pembelajaran, 5(2), 115-126.*https://doi.org/10.62775/edukasia.v5i2.1113

Raslan, G. (2024, March). The Impact of the zone of proximal development concept (scaffolding) on the students problem solving skills and learning outcomes. I*n BUiD Doctoral Research Conference 2023: Multidisciplinary Studies (pp. 59-66)*. Cham: Springer Nature Switzerland.

Reddy, P. J. K., & Revathy, K. (2024). Contextual learning. In Digital Skill Development for Industry 4.0 (pp. 83-104). Auerbach Publications.

Ren, Y. (2022). The application of spatial computing technology in digital interactive animation creation in the era of artificial intelligence. *Journal of Beauty and The Times,2022(9), 104-107.* http://doi.org/10.16129/j.cnki.mysds.2022.09.025

Research and Markets. (2021). Interactive Children's Education Market Forecast 2021–2026. https://www.researchandmarkets.com

Research on the Creation of Three-dimensional Picture Books and Animations f or Children under New Media Technology Conditions (Master's Thesis, Jilin Academy of Fine Arts). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202402&filename=1023940372.nh

Revenko, I., Hlianenko, K., Sosnova, M., Vlasenko, R., & Kolodina, L. (2024). The exploration of pedagogical approaches and methods that are designed to stimulate the creative thinking of students. *Cadernos de Educação Tecnologia e Sociedade, 17(se1), 137-146.*https://doi.org/10.14571/brajets.v17.nse1.137-146

Rezeki, A. S., & Utami, R. D. (2025). The Implementation of Animated Videos In Enhancing Positive Discipline In Early Childhood. Riwayat: *Educational Journal of History and Humanities, 8(1), 423-436*.https://doi.org/10.24815/jr.v8i1.44011

Robson, S. (2012). Developing thinking and understanding in young children: an introduction for students. Routledge. https://doi.org/10.4324/9780203133354

Rohlfing, K. J., Altvater-Mackensen, N., Caruana, N., Van den Berghe, R., Bruno, B., Tolksdorf, N. F., & Hanulíková, A. (2022). Social/dialogical roles of social robotsin supporting children's learning of language and literacy,A review and analysis of innovative roles. *Frontiers in Robotics and AI, (2022)9,971749.* doi.org/10.3389/frobt.2022.971749

Runco, M. A. (2007). Creativity: Theories and themes,Research, development, and practice. Elsevier.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology, 25(1), 54-67.* https://doi.org/10.1006/ceps.1999.1020

Salmons, J., & Wilson, L. A. (2023). Learning to collaborate, collaborating to learn: Engaging students in the classroom and online. Routledge.

Sapmayada, A. (2024). Membangun narasi visual melaluidesain karakter: Studi kasus karakter ikonik. VisArt. *Journal Seni Rupa dan Design, 2(2), 491-501.* https://doi.org/10.61930/visart.v2i2.819

Satybaldiyeva, F. A., Zh, Y. G., Zhumangaliyeva, N. K., Altekova, I. S., & Sarybay, M. A. (2024). EDUCATION OF CHILDREN WITH THE USE OF GAMIFICATION IN COGNITIVE PEDAGOGY. *Endless light in science, (31 октябрь 06), 61-69.*

Sawyer, R. K. (Ed.). (2014). The Cambridge handbook of the learning sciences (2nd ed.). Cambridge University Press.

Shaaban, T. S., & Mohamed, A. M. (2024). Exploring the effectiveness of augmented reality technology on reading comprehension skills among early childhood pupils with learning disabilities. *Journal of Computers in Education, 11(2), 423-444*.https://doi.org/10.1007/s40692-023-00269-9

Shen J. (2025). Interactive light design for children's sensory training, lighting up the hearts of children. *Industrial Design (06), 16.* doi:10.26920/j.cnki.231516cn.2025.06.021.

Sheng, N. (2015). Narratology of Images. Peking University Press.

Siegler, R. S., DeLoache, J. S., Eisenberg, N., & Saffran, J. R. (2017). How children develop (5th ed.). Worth Publishers.

Sihotang, R. A., Cendana, W., & Kristidhika, D. C. (2020). The use of video in improving students' attention in learning process of kindergarten students. *International Journal of Elementary Education, 4(4), 496-502*.https://doi.org/10.23887/ijee.v4i4.28430

So, J., An,S, Guang-Lea,L & Amy,B.,(2018).Using Animated Folktales to Teach Cultural Values: A Case Study With Korean-American Bilingual Kindergartners.

*Journal of Research in Childhood Education,32(3),295-309.*https://doi.org/10.1080/02568543.2018.1464528

Song, F. (2025). Exploring the application and practical effects of gamified teaching in preschool education. *Basic Education Forum (S1), 197-198.* doi:CNKI:SUN:JCLT.0.2025-S1-096.

Son, S. H. C., & Butcher, K. R. (2024). Effects of varied multimedia animations in digital storybooks: A randomised controlled trial with preschoolers. *Journal of Research in Reading, 47(3), 249-268.* https://doi.org/10.1111/1467-9817.1245223-00450-4

Stålberg, A., Sandberg, A., Söderbäck, M., & Larsson, T. (2016). The child's perspective as a guiding principle: Young children as co-designers in the design of an interactive application meant to facilitate participation in healthcare situations. *Journal of biomedical informatics*, *61*, 149-158. https://doi.org/10.1016/j.jbi.2016.03.024

Stern, M., & Hertel, S. (2022). Relationship between maternal scaffolding and preschooler's metacognitive strategies in a problem-solving situation. *Learning and Instruction, 80, 101631.*https://doi.org/10.1016/j.learninstruc.2022.1016317

Sovia, S. I. P., & Silvio, S. W. (2024). Analysis of digital media usage in promoting communication skills in early childhood. *International Journal of Communication, 1(1), 61-69.* https ://doi.org/10.62569/fijc.v1i1.12

Suk, H. J., & Irtel, H. (2010). Emotional response to color across media. *Color Research & Application: Endorsed by Inter-Society Color Council, The Colour Group (Great Britain), Canadian Society for Color, Color Science Association of Japan, Dutch Society for the Study of Color, The Swedish Colour Centre Foundation, Colour Society of Australia, Centre Français de la Couleur*, *35(1), 64-77.* https://doi.org/10.1002/col.20554

Sun, J. (2025). A Practical Exploration of the Integration of Chinese Excellent Traditional Culture into Kindergarten Painting Teaching. *China Ethnic Expo, (03), 226-228.*

Sun，M. (2009). Research on Character Design in Children's Animation (Master 's Thesis, Jiangnan University). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD2010&filename=2009250859.nh

Sun， Q. (2024). An exploration of the aesthetic characteristics of stop-motion animation and its contemporary forms of expression. *Film and Television Production (09), 113-115.* doi:CNKI:SUN:DSZM.0.2024-09-026.

Sun, Q., Wang, C., Dai, D. Y., & Li, X. (2025). Developmental effects of digi tally contextualized reading on preschooler's creative thinking: A quasi-experi mental study. *Journal of Experimental Child Psychology, 259, 106307.*https:// doi.org/10.1016/j.jecp.2025.106307

Sun, X., Pei, Z., Zhang, C., Li, G., & Tao, J. (2019). Design and analysis of a human–machine interaction system for researching human's dynamic emotion. *IEEE Transactions on Systems, Man, and Cybernetics: Systems, 51(10), 6111-6121*.10.1109/TSMC.2019.2958094

Sun, Y. (2025). Strategies and Practices of Integrating Chinese Excellent Traditional Culture into Early Childhood Education. *Chinese loose-leaf anthology (traditional culture teaching and research), (03), 166-168.*

Su， S., Fu, C., & Xuanzhuang,Zihao. (2025). Application research on experiential teaching in preschool science education. *Shanxi Youth (08), 172-174.* doi:CNKI:SUN:SXQS.0.2025-08-057.

Taizhou Investigation Team of the National Bureau of Statistics. (2021). Survey Finds Multiple Factors Affecting Mental Health of Primary and Secondary School Students Requires Society-Wide Attention. National Bureau of Statistics. https://zjzd.stats.gov.cn/tz/dcfx/dcfx1/202107/t20210729_103009.shtml

Tang, L., Yuan, P., & Zhang, D. (2024). Emotional experience during human-computer interaction: a survey. *International Journal of Human–Computer Interaction, 40(8), 1845-1855.*https://doi.org/10.1080/10447318.2023.2259710

Tang， Y. (2024). Research on the balanced development path of coordinated urban and rural preschool education resource allocation in the new era. *Journal of Qiannan Normal University for Nationalities (06), 66-72.* doi:CNKI:SUN:QNNS.0.2024-06-010.

Tan, J., Tang, M., & Zeng, Z. (2025). Focusing on urban-rural integration: A study on the efficiency of rural preschool education resource allocation from the perspective

of high-quality and balanced development. *Education Exploration (04), 27-32.* doi:CNKI:SUN:SEEK.0.2025-04-005.

Tao, P.(2025). The implementation path of kindergarten traditional culture programmer the perspective of core literacy. *Oriental Dolls-Picture Book and Education, (03), 49-51.*

Tarigan, W. P. L., Sipahutar, H., & Harahap, F. (2023). The impact of an interactive digital learning module on students' academic performance and memory retention. Comput. *Child, 2(2).* https://doi.org/10.29333/cac/13654

Tidwell, J. (2020). Designing interfaces: Animation, motion, and meaning (3rd ed.). O'Reilly Media.

Torrance, E. P. (1972). Teaching for creativity. *Journal of Creative Behavior, 6(2), 114–143.* https://doi.org/10.1002/j.2162-6057.1972.tb00923.x

Trautmann, L. (2021). Emotions evoked by geometric patterns. *J,Multidisciplinary Scientific Journal, 4(3), 376-393.* https: //doi.org/10.3390/j4030029

Truong, K. N., Hayes, G. R., & Abowd, G. D. (2006). Storyboarding: an empi rical determination of best practices and effective guidelines. In *Proceedings o f the 6th conference on Designing Interactive systems* (pp. 12-21). https://doi.o rg/10.1145/1142405.1142410

Tylor, E. (1871). Primitive culture: Researches into the development of mythology, philosophy, religion, art, and custom. John Murray Academic

Uhrig, M. (Ed.). (2019). Emotion in animated films. London: Routledge.

Van Kuyk, J. J. (2011). Scaffolding–how to increase development? *European Early Childhood Education Research Journal, 19(1), 133-146.*https://doi.org/10.1080/1350293X.2011.548965

Van Mechelen, M., Willems, B., Zaman, B., Vanden Abeele, V., & Laenen, A. (2016). Designing technologies for and with children: Theoretical reflections and a practical inquiry towards a co-design toolkit. https://kuleuven.limo.libis.be/discovery/fulldisplay?docid=lirias1674366&context=SearchWebhook&vid=32KUL_KUL:Lirias&lang=en&search_scope=lirias_profile&adaptor=SearchWebhook&tab=LIRIAS&query=any,contains,LIRIAS1674366&offset=0%3Flimo%3D0

Vedechkina, M., & Borgonovi, F. (2021). A review of evidence on the role of digital technology in shaping attention and cognitive control in children. *Frontiers in psychology,* https://doi.org/10.3389/fpsyg.2021.611155

Verenikina, I. (2003). Understanding scaffolding and the ZPD in educational research.

Vygotsky, L. S. (1978). Mind in society: The development of higher psycholog ical processes. Massachusetts: Harvard University Press. https://doi.org/10.1155 /2022/9130643

Wang, C. S., Lin, C. D., & Sun, D. W. (2003). Child developmental psychology (2nd ed.). Beijing Normal University Press Academic

Wang，J. (2024). Research on the development strategy of preschool children's picture books based on excellent traditional culture. *Chinese Loose-leaf Anthology (Traditional Culture Teaching and Research) (02), 181-183.* doi:CNKI:SUN:JXYU.0.2024-02-060.

Wang, J., & Wang, Z. (2023). Research status, existing problems, and optimization paths for the joint construction and sharing of digital educational resources in kindergartens. *Education Observation (21), 98-100.* doi:10.16070/j.cnki.cn45-1388/g4s.2023.21.005.

Wang, L. (2018). The effect of animated movie music on children's cognitive skills. *Contemporary Cinema, (9), 139-142.*

Wang, S. (2019). Research on Children's Programming Teaching Model for Design Thinking Cultivation (Master's thesis). Yangzhou University.

Wang, S. (2024). Research on interactive narrative design of immersive image f rom AI perspective. *In International Conference on Human-Computer Interacti on ,13(2),345-359* .https : //doi.org/10.3390/electronics13020269

Wang，S. (2016). Research on Interactive Teaching in Kindergartens Using Interactive Whiteboards (Master's Thesis, Northwest Normal University). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201701&filename=10 16238617.nh

Wang, S., & Hu, F. (2025). Development and case analysis of interactive digital teaching resources for kindergartens. *Primary and Secondary School Audio-Visual Education (05), 12-15.* doi:CNKI:SUN:ZXDJ.0.2025-05-003.

Wang, W. (2019). Interactive animation special effects production techniques in visual communication design. *Art Education Research (12), 60-61.* doi:CNKI: SUN:MSJY.0.2019-12-031.

Wartella, E., & Jennings, N. (2000). Children and computers: New technology,Old concerns. *The Future of Children, 10(2), 31–43.* https://doi.org/10.2307/1602688

Wells, P. (1998). Understanding Animation. Routledge.

Williams, W. R. (2019). Attending to the visual aspects of visual storytelling: using art and design concepts to interpret and compose narratives with images. *Journal of Visual Literacy*, *38*(1-2), 66-82.

Wirahandayani, M., Rakhmawati, W., & Rukmasari, E. A. (2023). The effect o f role playing methods on social-emotional development in preschool childre n. *Journal Obsesi: Journal Pendidikan Anak Usia Dini, 7(1), 1156-1168*.https:/ /doi.org/10.31004/obsesi.v7i1.3626

Wu, L. (2013). Children's play and symbolic representation. *Review of Global Management and Service Science, 3(8).7-14*

Xiao, Q., & Han，S. (2021). Research on the content and characteristics of professional competence of rural preschool teachers. *Early Education (43), 28-31.* doi:CNKI:SUN:ZQJY.0.2021-43-007.

Xiao, W. (2018). How to guide children to use electronic devices correctly. *Jiangsu Health Care (12), 39.* doi:CNKI:SUN:JSWB.0.2018-12-039.

Xiao, Y. (2023). Research on the Design and Implementation of Folk Games in Kindergartens Based on Project-based Learning (Master's Thesis, Southwest University).https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202402&f ilename=1024361400.nh

Xie，H. (2025). The integration of excellent traditional Chinese culture into preschool education. *Jia Ying Literature (08), 185-187.* doi:CNKI:SUN:JYWX.0.2025-08-035.

Xie, H., Peng, J., Qin, M., Huang, X., & Tian, F. (2018). Can touchscreen dev ices be used to. facilitate young children’s learning? A meta-analysis of touc hscreen learning effect. *Frontiers in Psychology, (10)*9, 2580. https://doi.org/1 0.3389/fpsyg.2018.02580

Xing，Y. (2023). Teaching practice of film and television animation based on new media. *Electronic Technology (06), 186-187.* doi:CNKI:SUN:DZJS.0.2023-06-074.

Xue, R. (2021). Research on the cognitive reboot of interactive storytelling in virtual reality animation in the new media era. *Journal of Bengbu College (01), 19-22+54.* doi:10.13900/j.cnki.jbc.2021.01.005.

Xu，G & Yan，J. (2022). The application of interactive whiteboards in storytelling teaching in rural kindergartens. *Anhui Education Research (28), 113-115.* doi:CNKI:SUN:AHJY.0.2022-28-039.

Xu，X. (2023). In the Name of "Experiment": The Concept and Paradigm of Experimental Animation. *Art Hundred (06), 107-113.* doi:CNKI:SUN:YSBJ.0.2023-06-015.

Xu，Z.(2025).The Integration of Virtual Reality and Artificial Intelligence in Immersive Media Creation. *Journal of Innovation and Development(2).* doi:10.54097/NQJEG567.

Xu, Zemin. (2021). Preschool education: Education support based on the child's perspective. *Shanghai Curriculum and Teaching Research (05), 77-80.* doi:CNKI:SUN:HKCJ.0.2021-05-018.

Yang，S. (2019). A Comparative Study of the Impact of American, Japanese, a nd Chinese Animation on Children's Socialization (Master's Thesis, Shanghai Academy of Social Sciences). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201902&filename=1019051142.nh

Yang, S. (2024). Application of multimodal interaction technology in digital experience design. *Integrated Circuit Application (12), 32-33.* doi:10.19339/j.issn.1674-2583.2024.12.013.

Yang, X. (2016). Analysis of the influence of Piaget's cognitive development theory on preschool education. *Asia-Pacific Education, 23, 128.* doi:10.16550/j.cnki.2095-9214.2016.23.100.

Yan, L., Echeverria, V., Jin, Y., Fernandez-Nieto, G., Zhao, L., Li, X., ... & Martinez-Maldonado, R. (2024). Evidence-based multimodal learning analytics for feedback and reflection in collaborative learning. British *Journal of Educational Technology, 55(5), 1900-1925.* https://doi.org/10.1111/bjet.13498

Yin, X., & Ding, H. (2024). A preliminary study of strategies for the application of intelligent interaction in elementary school mathematics teaching. *Anhui Education Research, (25), 77-80*.Xun Academy of Fine Arts University.

Yin，Z & Yuan，X. (2023). Interaction, Experience, and Animation: An Analysis of Audiovisual Technology in Interactive Animation Design. *Da Guan (05), 123-125.* doi:CNKI:SUN:DAGN.0.2023-05-041.

Yue，W., Zhou,Y., & Hou,W. (2020). Feasibility study on the integrated development of "VR+preschool education." *Journal of Weifang University (04), 116-120.* doi:CNKI:SUN:WFXY.0.2020-04-028.

Zanolli, K., Daggett, J., & Pestine, H. (1995). The influence of the pace of teacher attention on preschool children's engagement. *Behavior Modification*, *19*(3), 339-356. https://doi.org/10.1177/01454455950193005

Zeng, M. (2018). Research on Public Space Design of Primary and Secondary School Buildings Based on the Concept of Innovative Education (Master's thesis). Hunan University.

Zeng, W., & Yu, J. (2021). The connotation, constituent elements, and assessment of key skills in early childhood learning: An analysis based on the OECD's International Framework for the Assessment of Early Learning and Child Well-being. *Shanghai Education Research (11), 11-16.* doi:10.16194/j.cnki.31-1059/g4.2021.11.003.

Zhang，D. (1996). An Introduction to Traditional Chinese Culture. Peking University Press.

Zhang,D, & Fang,K. (2004). Introduction to Traditional Chinese Culture (2nd edition). Beijing: Peking University Press.

Zhang，J. (2024). Research on the application of information technology in science teaching in kindergartens. *Primary and Secondary School Audio-Visual Education (05), 33-35.* doi:CNKI:SUN:ZXDJ.0.2024-05-010.

Zhang，M, Yang，F, & Du，R. (2024). A study on the development of narrative skills in storytelling among children aged 3-5. *Journal of Shaanxi Preschool Teachers College (07), 9-18.* doi:CNKI:SUN:SHAA.0.2024-07-002.

Zhang, X. (2020). Application of digital painting in character design of animation. *Popular Literature and Art, (18), 134–135*.doi:CNKI:SUN:TOYZ.0.2024-08-028.

Zhang, X., Breazeal, C., & Park, H. W. (2023). A social robot reading partner for explorative guidance. *In proceedings of the 2023 ACM/IEEE international conference on human-robot interaction,2023(1),341-349.*https://doi.org/10.1145/3568162.3576968.

Zheng, Z. (2014). A Brief Discussion on the Artistic Characteristics of Experimental Animation. *Popular Literature and Art (21), 196.* doi:CNKI:SUN:DZLU.0.2014-21-161.

Zhang, Z., Wu, L., & Yu, H. (2023). The effect of cartoon images on children's touch screen learning. *Education Technology, l28(1), 12845-12858.* https://doi.org/10.1007/s10639-023-117166

Zhao, J. (2023). The role of kindergarten festival-themed activities in enhancing children's cultural cognition. *Children's education,3(2),15-21.*https://zzcbjt.com/index.php/lbd-2-11-30077

Zhao, J., Dalal, S., Abu Bakar, M. S., & Wan Yahaya, W. A. (2024). Designing for sustainability: exploring the intersection of creative arts in digital sustainable ecology by interactive animation. Idealogy *Journal, 9(1), 27-42.* https://ir.uitm.edu.my/id/eprint/96146

Zheng, H., Xiao, D., & Zhou, J. (2024). Enhancing perceived value in human-computer interaction: The mediating role of user participation and the moderating role of task complexity. *International Journal of Human–Computer Interaction, 41(7),1-10.*https://doi.org/10.1080/10447318.2024.2350839

Zhou,C., Xu,K., Shi,Q., Liu,Y., Hu,Z., Xie,Z., & Zhang Lu. (2023). Analysis of the impact of excessive use of electronic device screens on the behavior of preschool children in Wuhan. *International Journal of Psychiatry (05), 1018-1021.* doi:10.13479/j.cnki.jip.2023.05.029.

Zhou, L. (2024). Exploring Diversified Teaching Models in Preschool Education: Taking the Course "Preschool Children's Play Education" as an Example. *New Wisdom (05), 106-108.* doi:CNKI:SUN:XZHH.0.2024-05-039.

Zhou, Y. (2020). Research on Online Thinking Education Products for Children Focusing on the Cultivation of Mathematical and Logical Intelligence (Master's Thesis, Beijing Institute of Printing). https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202002&filename=1020762523.nh

# APPENDIX

# APPENDIX

## APPENDIX A Satisfaction Survey Questionnaire Items

Students' interest in animation content and interaction

1. Do you enjoy learning about traditional culture through interactive animations?
2. Do you find the traditional cultural content in interactive animations interesting?
3. Have you learned a lot of new knowledge about traditional culture through interactive animations?
4. Which character or traditional cultural story do you like best in interactive animations? Why?
5. Do you find the interactive elements in interactive animations fun? Have they helped you learn better?
6. If there are similar interactive animations for learning traditional culture in the future, would you be willing to participate again?

Parent satisfaction with learning outcomes

1. Is your child interested in the traditional cultural content in interactive animations?
2. Do you think interactive animations are effective in helping your child master and understand traditional cultural knowledge?
3. After using interactive animations for learning, have you observed an increase in your child's interest in traditional culture?
4. Which elements of interactive animations (such as animated characters, storylines, interactive segments, etc.) do you think are most helpful to your child in learning traditional culture?

Parent evaluation of teaching suitability

1. Are you satisfied with the traditional cultural educational resources provided by Interactive Animation (e.g., content richness, accuracy, etc.)?
2. Do you think the technical platform of Interactive Animation (e.g., user-friendly interface, ease of operation, etc.) is suitable for children to use?
3. Does Interactive Animation provide a personalized learning experience tailored to your child's age, interests, and learning progress?

Teachers' evaluation of instructional technology development

1. How effective do you think interactive animation is in helping children understand and master traditional cultural knowledge?

2. Through interactive animation learning, have children achieved your expected educational goals, such as enhancing cultural identity and improving aesthetic abilities?

3. Are you satisfied with the technical performance (such as image quality and smooth operation) of interactive animation as a teaching aid?

4. Is interactive animation easy for you to integrate into your daily teaching plans and activities?

Teacher satisfaction with teaching effectiveness

1. Do children show higher levels of interest and enthusiasm when watching and participating in interactive animation to learn traditional culture?

2. Does interactive animation promote teacher-student interaction in the classroom?

3. Do you think the traditional cultural content in interactive animation is appropriate for the age group of children you teach?

Continuous development of satisfaction

1. In what areas do you think interactive animations could be improved to make learning more enjoyable and efficient?

2. How satisfied are you overall with your child's learning of traditional culture content through interactive animations?

3. In the future, would you be willing to continue or use interactive animations more frequently as part of traditional culture education?

## APPENDIX B Learning Competency Evaluation Sheet

| Learning Competency Evaluation Sheet (Total Score: 50) | | | | |
|---|---|---|---|---|
| Student Name: | | Date: | | Evaluator: |
| A. Festival Knowledge Comprehension — 15 points | | | | |
| Item | Assessment Content | Score Range | Score | |
| A1. Ability to name festival customs | Can the student name a festival customs? | 0 – 7 | | |
| A2. Ability to explain the cultural meaning of festivals | Can the student describe the cultural significance of the festival? | 0 – 8 | | |
| Subtotal | | 0 – 15 | | |
| B. Custom Recognition — 15 points | | | | |
| Item | Assessment Content | Score Range | Score | |
| B1. Festival-item matching ability | Can you correctly match festivals with traditional items? | 0 – 8 | | |
| B2. Visual recognition of festival customs | Can the student identify festival activities or items through images ? | 0 – 7 | | |
| Subtotal | | 0 – 15 | | |
| C. Idiom Story Recitation — 10 points | | | | |
| Item | Assessment Content | Score Range | Score | |

| | | | | |
|---|---|---|---|---|
| C1. Ability to explain idiom meaning | Can the student explain the meaning of an idiom or idiom story? | 0 – 5 | | |
| C2. Ability to retell story sequence | Can the student clearly retell key story events in order? | 0 – 5 | | |
| Subtotal | | 0 – 10 | | |
| D. Imaginative Thinking — 10 points | | | | |
| Item | Assessment Content | Score Range | Score | |
| D1. Open-ended imaginative response | Which cartoon plot impressed you the most and why? | 0 – 10 | | |
| Subtotal | | 0 – 10 | | |
| Total Score (50) | | | | |

# APPENDIX C Preschool Student Satisfaction Survey Questionnaire

## Satisfaction Survey on "Interactive Animation for Children's Traditional Culture Learning"

**1. Research Project Title**

Doctoral research on "Promoting preschool students' learning of traditional Chinese culture through interactive animation"

**2. Purpose of the interviews**

The purpose of this questionnaire was to obtain feedback from preschool students on their learning opinions of interactive animation to promote preschool students learning of traditional Chinese culture.

**3. Interview format**

Interviews were conducted at a time and place convenient to the interviewee, and the interviews were audio recorded with permission.

4. **Confidentiality Statement**

All information will be kept strictly confidential and used solely for academic research. Data will be securely destroyed after the completion of the study.

5. **Participation Consent**

Please check the box below. If you check 'Agree', it means that you agree to participate in the study.

☐ Agree ☐ Disagree

**6. Contact Information**

Researcher: Jingyue Zhang, Faculty of Architecture, Art, and Design.

Phone: 842843710

Email: jingyuez65@nu.ac.th

Human Research Ethics Committee, Naresuan University, Group 2, Division of Research and Innovation, 4th Floor, Maha Dhammaracha Building.

Phone: 055-968642 or Email: nu-irb-board2@nu.ac.th

Dear kids:

Hello! We're glad you learned a lot of interesting traditional cultural content through interactive animation. Now, we would like to hear your feelings and thoughts about this learning experience. Please answer the following questions based on your true feelings, and remember to be honest!

**Likeness:**

- Do you enjoy learning traditional cultural content through interactive animation?

☐ like it very much ☐ like it ☐ not bad ☐ little ☐ not at all

**Interesting level:**

- Do you find the traditional cultural content in the interactive animation interesting?

☐ very interesting ☐ interesting ☐ not bad ☐ not interesting ☐ not at all

**Learning Gains:**

- Have you learned a lot of new things about traditional culture through interactive animation?

☐ Learned a lot ☐ Learned some ☐ Learned a little ☐ Did not learn

**Characters and Stories:**

- What is your favorite character or traditional cultural story in interactive animation? Why?

**Interactive experience:**

- Did you find the interactive sessions in the interactive animation fun? Did they help you learn better?

☐ Very fun and helpful ☐ a little helpful ☐ Fair, not very helpful ☐ Not fun, not helpful

**Re-engagement:**

- If there are similar interactive animations to learn about traditional culture in the future, would you still like to participate?

☐ Very willing ☐ Willing ☐ Don't know ☐ Not very willing ☐ Not at all willing

**Suggestions for Improvement (children can ask their parents to help them write):**

- In what ways do you wish interactive animation could be better to make learning more enjoyable and productive?

**Share the moment:**

- Can you share one of the most interesting traditional cultural tidbits you've learned through interactive animation with your mom, dad, or buddies?

Thank you very much for your answer and sharing! Your feedback is very important to us and will help us create more interesting and educational interactive animation content. We wish you good luck in your studies and have fun every day!

# APPENDIX D Parent Satisfaction Survey Questionnaire

## Satisfaction Survey on "Interactive Animation for Children's Traditional Culture Learning"

**1. Research Project Title**

Doctoral research on "Promoting preschool students' learning of traditional Chinese culture through interactive animation"

**2. Purpose of the interviews**

The purpose of this questionnaire was to obtain feedback from parents of preschool students on their learning opinions of interactive animation to promote preschool students learning of traditional Chinese culture.

**3. Interview format**

The survey was conducted at a time and place convenient to the questionnaire respondent, and the content was recorded with permission.

4. **Confidentiality Statement**

All information will be kept strictly confidential and used solely for academic research. Data will be securely destroyed after the completion of the study.

5. **Participation Consent**

Please check the box below. If you check 'Agree', it means that you agree to participate in the study.

☐ Agree ☐ Disagree

**6. Contact Information**

Researcher: Jingyue Zhang, Faculty of Architecture, Art, and Design.

Phone: 842843710

Email: jingyuez65@nu.ac.th

Human Research Ethics Committee, Naresuan University, Group 2, Division of Research and Innovation, 4th Floor, Maha Dhammaracha Building.

Phone: 055-968642 or Email: nu-irb-board2@nu.ac.th

Dear Parents of Kids:

Hello! We are conducting a study on the effectiveness of interactive animation in promoting children's learning of traditional culture. Thank you for choosing interactive animation as a way for your child to learn about traditional culture. We are very interested in your child's learning experience and the feedback from parents on this educational approach. Below are some questions about your satisfaction with your child's learning of traditional cultural content through interactive animation. Please answer the questions based on your own experience.

We hope that this questionnaire will let us know the children's real feelings and satisfaction when they experience learning traditional culture through interactive animation, so that we can further optimize the educational resources and improve the learning effect. Your opinion is very important to us, please be patient to fill in the following questionnaire.

Basic information (child's name):

Age of child: ____

Sex of child: ☐ Male ☐ Female ☐ Do not wish to disclose

**Overall satisfaction:**

- How satisfied are you overall with your child's learning of traditional cultural content through interactive animation?

☐ Very satisfied ☐ Satisfied ☐ Average ☐ Dissatisfied ☐ Very dissatisfied

- Is your child interested in traditional cultural content in interactive animation?

☐ Very interested ☐ Interested ☐ Fairly interested ☐ Not very interested

☐ Not at all

**Learning Effect:**

- Do you think the interactive animation is effective in helping your child acquire and understand traditional cultural knowledge?

☐ Very effective ☐ Effective ☐ Fair ☐ Not very effective ☐ Not at all

**Interest Stimulation:**

- Have you observed an increase in your child's interest in traditional culture after learning with interactive animation?

☐ significant increase ☐ some increase ☐ no significant change ☐ some decrease ☐ complete decrease

- What elements of interactive animation (e.g., animated characters, storyline, interactive sessions, etc.) do your children find most helpful for them to learn about traditional culture? (Multiple choices allowed)

☐ Vivid animated characters ☐ Interesting storyline ☐ Rich interactive sessions ☐ Clear explanatory notes ☐ Others, please specify: _____

**Family Interaction:**

- Did the interactive animation facilitate communication and discussion about traditional culture between you and your child?

☐ often facilitated ☐ sometimes facilitated ☐ rarely facilitated ☐ not facilitated

**Educational Resources:**

- Are you satisfied with the traditional cultural education resources (e.g. content richness, accuracy, etc.) provided by Interactive Animation?

☐ Very satisfied ☐ Satisfied ☐ Average ☐ Dissatisfied ☐ Very dissatisfied

**Technology use:**

- Do you feel that the technical platform of interactive animation (e.g., interface friendliness, ease of operation, etc.) is appropriate for children?

☐ very suitable ☐ suitable ☐ fair ☐ not suitable ☐ not at all suitable

**Personalized Learning:**

- Does the interactive animation provide a personalized learning experience based on your child's age, interests and learning pace?

☐ Yes, completely personalized ☐ Comparatively personalized ☐ Fairly personalized ☐ Not very personalized ☐ Not personalized at all

**Willingness to follow up**:

- In the future, would you like to continue to let your children learn more traditional cultural content through interactive animation?

☐ Very willing ☐ Willing ☐ Fairly willing ☐ Not very willing ☐ Not at all willing

**Recommendations for improvement**:

- What do you think could be improved in interactive animation to promote children's traditional cultural learning? (Open-ended question)

**Willingness to recommend:**

- Would you recommend this way of learning about traditional culture through interactive animation to other parents? Why?
- Do you have any recommendations for traditional cultural themes or content that you would like to see in interactive animation in the future? (Open-ended question)

Thank you for your valuable time and sincere feedback! This will have a positive impact on our ability to further optimize the interactive animation content and enhance your child's learning experience. Your feedback is our motivation for continuous improvement. We will seriously consider every suggestion and strive to create a richer, more interesting and effective traditional culture learning experience for children.

Good luck with your child's learning and happiness!

# APPENDIX E Teachers Satisfaction Survey Questionnaire

## Satisfaction Survey on "Interactive Animation for Children's Traditional Culture Learning"

**1. Research Project Title**

Doctoral research on "Promoting preschool students' learning of traditional Chinese culture through interactive animation"

**2. Purpose of the interviews**

The purpose of this questionnaire was to obtain feedback from kindergarten teachers on their learning opinions of interactive animation to promote preschool students learning of traditional Chinese culture.

**3. Interview format**

The survey was conducted at a time and place convenient to the questionnaire respondent, and the content was recorded with permission.

4. **Confidentiality Statement**

All information will be kept strictly confidential and used solely for academic research. Data will be securely destroyed after the completion of the study.

5. **Participation Consent**

Please check the box below. If you check 'Agree', it means that you agree to participate in the study.

☐ Agree ☐ Disagree

**6. Contact Information**

Researcher: Jingyue Zhang, Faculty of Architecture, Art, and Design.

Phone: 842843710

Email: jingyuez65@nu.ac.th

Human Research Ethics Committee, Naresuan University, Group 2, Division of Research and Innovation, 4th Floor, Maha Dhammaracha Building.

Phone: 055-968642 or Email: nu-irb-board2@nu.ac.th

Dear teacher:

Greetings! Thank you for introducing interactive animation as an innovative way for children to learn about traditional culture in kindergarten. We value your professional opinion and feedback in order to better optimize this educational resource. Below are some survey questions about your satisfaction with the traditional cultural content you and your children have learned through interactive animation, please answer them based on your own observations and feelings.

**Assessment of Teaching Effectiveness:**

- How effective do you think interactive animation is in helping children understand and master traditional cultural knowledge?

☐ Very effective ☐ Effective ☐ Fair ☐ Not very effective ☐ Ineffective

**Interest in learning is stimulated:**

- Do children show higher interest and motivation in learning when watching and participating in interactive animations to learn about traditional culture?

☐ Yes, significant improvement ☐ Some improvement ☐ Maintained ☐ Some decrease ☐ Significant decrease

**Classroom Interactivity:**

- Does interactive animation promote teacher-student and student-student interaction in the classroom?

☐ Great promotion ☐ Some promotion ☐ Average ☐ Little promotion ☐ No promotion

**Appropriateness of educational content:**

- Do you think the traditional cultural content in the interactive animation is appropriate for the age group you teach?

☐ very suitable ☐ suitable ☐ fair ☐ not suitable ☐ not at all suitable

**Educational goals are reached:**

- Did the children achieve the educational goals you expected through interactive animation learning, such as enhancing their cultural identity and improving their aesthetic skills?

☐ Fully achieved ☐ Basically achieved ☐ Partially achieved ☐ Rarely achieved ☐ Not achieved

**The effectiveness of technology-assisted instruction:**

- Are you satisfied with the technical performance (e.g., picture quality, smoothness of operation, etc.) of interactive animation as an auxiliary teaching tool?

☐ Very satisfied ☐ Satisfied ☐ Average ☐ Dissatisfied ☐ Very dissatisfied

**Resource consolidation and utilization:**

- Are interactive animations easy for you to integrate into your daily lesson plans and activities?

☐ very convenient ☐ convenient ☐ average ☐ not very convenient ☐ not at all convenient

**Willingness to follow up on use:**

- In the future, would you like to continue or use interactive animation more frequently as part of teaching traditional culture?

☐ Very willing ☐ Willing ☐ Depends ☐ Not very willing ☐ Not at all willing

**Recommendations for improvement:**

- What do you think could be improved in interactive animation to promote children's traditional cultural learning? What specific suggestions or needs do you have?

**Other feedback:**

- What other ideas or experiences do you want to share about using interactive animation for teaching traditional culture?

Thank you for your patience and valuable comments! Your feedback will have a positive impact on our ability to continuously improve our interactive animation content and enhance our teaching effectiveness.

# APPENDIX F Psychologist Interview Questionnaire

## Questionnaire on the beta version of "Interactive Animation for Children's Traditional Culture Learning"

**1. Research Project Title**

Doctoral research on "Promoting preschool students' learning of traditional Chinese culture through interactive animation"

**2. Purpose of the interviews**

The purpose of this questionnaire was to obtain feedback from child psychologist on their learning opinions of interactive animation to promote preschool students learning of traditional Chinese culture.

**3. Interview format**

The survey was conducted at a time and place convenient to the questionnaire respondent, and the content was recorded with permission.

4. **Confidentiality Statement**

All information will be kept strictly confidential and used solely for academic research. Data will be securely destroyed after the completion of the study.

5. **Participation Consent**

Please check the box below. If you check 'Agree', it means that you agree to participate in the study.

☐ Agree ☐ Disagree

**6. Contact Information**

Researcher: Jingyue Zhang, Faculty of Architecture, Art, and Design.

Phone: 842843710

Email: jingyuez65@nu.ac.th

Human Research Ethics Committee, Naresuan University, Group 2, Division of Research and Innovation, 4th Floor, Maha Dhammaracha Building.

Phone: 055-968642 or Email: nu-irb-board2@nu.ac.th

Dear child psychologist:

Hello! We are exploring how interactive animation can more effectively promote children's learning and understanding of traditional culture. Given your deep knowledge in the field of children's psychological development, we sincerely invite you to participate in this survey to get your professional insights and suggestions. Your feedback will help us optimize the design of interactive animation and enhance children's learning experience.

I. Basic information

Your area of specialization and research interests:

The number of years you have worked in the field of child psychology:

II. Assessment of the impact of interactive animation elements on children's learning

Below is a list of elements included in a series of interactive animations, please evaluate the potential impact of these elements on children's learning of traditional culture and give your recommendations based on your expertise and experience. (1 being the lowest and 5 being the highest).

| | concern | 5 Very Satisfied | 4 Satisfied | 3 Neutral | 2 Unsatisfied | 1 Very Unsatisfied (please specify why) |
|---|---|---|---|---|---|---|
| Characterization | Do you think the characters in this movie have qualities (e.g., relatability, diversity, cultural representation) that would better engage children and | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | promote learning? | | | | | |
| storyline | What do you think about the design of the animated storyline (e.g. entertaining, emotional resonance, cultural depth) to stimulate children's interest and deepen their understandin g of traditional culture? | | | | | |
| Interactive design | You believe that the interactions in this animation (e.g., problem solving, role-playing, feedback mechanisms) stimulate children's engagement and motivation to learn | | | | | |
| Visual and Auditory Elements | Do you think the color, graphic style and sound effects of this animation can influence children's | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | learning experience and emotional engagement? | | | | | |
| Integration of knowledge points | Do you think this animated film balances entertainment and education, so that traditional cultural knowledge points are naturally integrated into the interactive animation without being obtrusive? | | | | | |
| cognitive development | Do you think this animation supports children's learning needs at different stages of cognitive development (e.g., perceptual motor, preoperational, concrete, etc.)? | | | | | |

Observations and recommendations

- Have you ever observed or studied the impact of interactive animation on children's learning? If so, please share your observations or findings.

- What innovative directions or trends do you see in the future for interactive animation to promote children's traditional cultural learning?

Thank you for taking the time to participate in this survey. Your professional insights will provide us with valuable references to help us design interactive animation learning tools that are more in line with children's psychological development and more effective.

# APPENDIX G Interactive Animation Expert Interview Questionnaire

## Questionnaire on the beta version of "Interactive Animation for Children's Traditional Culture Learning"

**1. Research Project Title**

Doctoral research on "Promoting preschool students' learning of traditional Chinese culture through interactive animation"

**2. Purpose of the interviews**

The purpose of this questionnaire was to obtain feedback from animation expertson their learning opinions of interactive animation to promote preschool students learning of traditional Chinese culture.

**3. Interview format**

The survey was conducted at a time and place convenient to the questionnaire respondent, and the content was recorded with permission.

4. **Confidentiality Statement**

All information will be kept strictly confidential and used solely for academic research. Data will be securely destroyed after the completion of the study.

5. **Participation Consent**

Please check the box below. If you check 'Agree', it means that you agree to participate in the study.

☐ Agree ☐ Disagree

**6. Contact Information**

Researcher: Jingyue Zhang, Faculty of Architecture, Art, and Design.

Phone: 842843710

Email: jingyuez65@nu.ac.th

Human Research Ethics Committee, Naresuan University, Group 2, Division of Research and Innovation, 4th Floor, Maha Dhammaracha Building.

Phone: 055-968642 or Email: nu-irb-board2@nu.ac.th

Dear animation experts:

Hello! We are conducting a study on how interactive animation promotes children's learning of traditional culture, aiming to evaluate and optimize key elements in interactive animation through your professional perspective. Your opinion is crucial to us and will directly guide us in designing more effective educational tools. Please take a few minutes to fill out the following questionnaire.

I. Basic information

Your gender:

A. Male

B. Women

C. Reluctance to disclose

Your years of experience in the field of interactive animation:

A. Less than 1 year

B. 1-3 years

C. 3-5 years

D. Overall satisfaction over 5 years:

II. Evaluation of interactive animation elements

Below are the elements that appear in the interactive animation, please rate them according to how well they promote children's learning of traditional culture (1 being the lowest and 5 being the highest).

| | concern | 5 Very Satisfied | 4 Satisfied | 3 Neutral | 2 Unsatisfied | 1 Very Unsatisfied (please specify why) |
|---|---|---|---|---|---|---|
| Character Design | Do the characters feature traditional culture and | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | can they appeal to children's interests? | | | | | |
| storyline | Does the story incorporate traditional cultural elements and is the plot compelling? | | | | | |
| interactive session | Are the interactions well designed to enhance children's understanding and memorization of traditional cultural content? | | | | | |
| Sound effects and soundtracks | Do the sound effects and soundtrack fit the traditional cultural atmosphere and enhance the learning experience? | | | | | |
| visual effect | Are the graphics beautiful, the color scheme harmonious, and do they stimulate children's visual interest? | | | | | |
| Integration of knowledge | Are points of traditional cultural | | | | | |

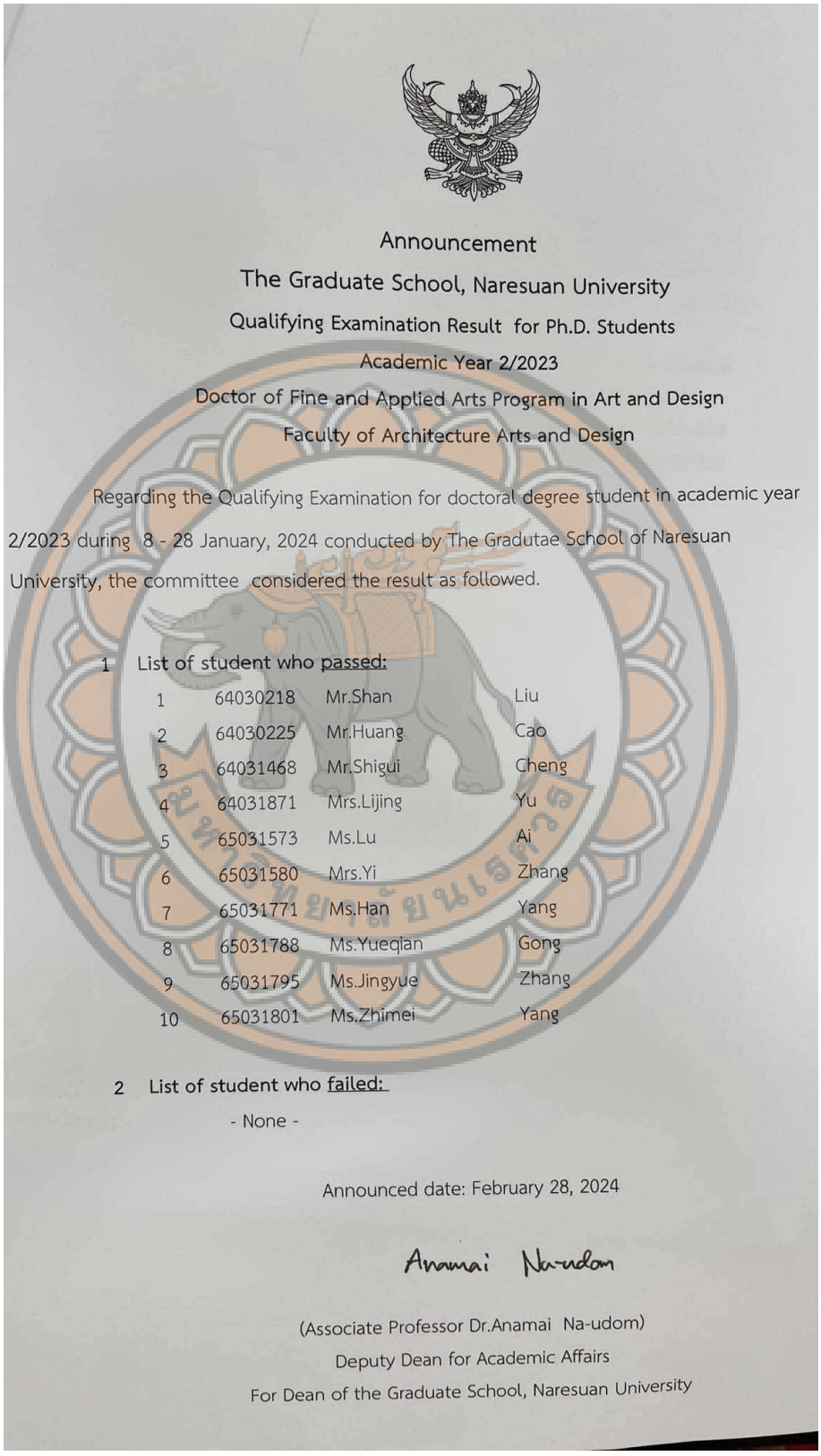
| | | | | | | |
|---|---|---|---|---|---|---|
| points | knowledge naturally integrated into the animation to avoid rigid didacticism? | | | | | |
| Feedback mechanisms | Are the feedback mechanisms in the animation (e.g., rewards for correct answers) effective in motivating children to continue learning? | | | | | |

Observations and recommendations

- What traditional cultural elements (e.g., historical figures, poems and songs, traditional festivals, etc.) do you think are most suitable for learning in interactive animation?
- What do you think are the shortcomings of the interactive animations currently on the market in promoting children's traditional cultural learning?
- What specific suggestions or innovations do you have to further enhance the effectiveness of interactive animation in traditional culture learning?

Thank you for taking your valuable time to complete this questionnaire! Your comments will have a significant impact on our research and we look forward to your insights.

# APPENDIX H Qualifying Examination Result for Ph.D. Students



Announcement

The Graduate School, Naresuan University

Qualifying Examination Result for Ph.D. Students

Academic Year 2/2023

Doctor of Fine and Applied Arts Program in Art and Design

Faculty of Architecture Arts and Design

Regarding the Qualifying Examination for doctoral degree student in academic year 2/2023 during 8 - 28 January, 2024 conducted by The Gradutae School of Naresuan University, the committee considered the result as followed.

1 List of student who passed:

| | | | |
|---|---|---|---|
| 1 | 64030218 | Mr.Shan | Liu |
| 2 | 64030225 | Mr.Huang | Cao |
| 3 | 64031468 | Mr.Shigui | Cheng |
| 4 | 64031871 | Mrs.Lijing | Yu |
| 5 | 65031573 | Ms.Lu | Ai |
| 6 | 65031580 | Mrs.Yi | Zhang |
| 7 | 65031771 | Ms.Han | Yang |
| 8 | 65031788 | Ms.Yueqian | Gong |
| 9 | 65031795 | Ms.Jingyue | Zhang |
| 10 | 65031801 | Ms.Zhimei | Yang |

2 List of student who failed:

- None -

Announced date: February 28, 2024

Anamai Na-udom

(Associate Professor Dr.Anamai Na-udom)

Deputy Dean for Academic Affairs

For Dean of the Graduate School, Naresuan University

## APPENDIX I Research Ethics Certificate

NO. 2605124

RIIE RESEARCH AND INNOVATION INSTITUTE OF EXCELLENCE WALAILAK UNIVERSITY

GRAD COLLEGE OF GRADUATE STUDIES WALAILAK UNIVERSITY

# CERTIFICATE

## OF PARTICIPATION

Human Research Ethics Committee of Walailak University
certifies that

**Jingyue Zhang**

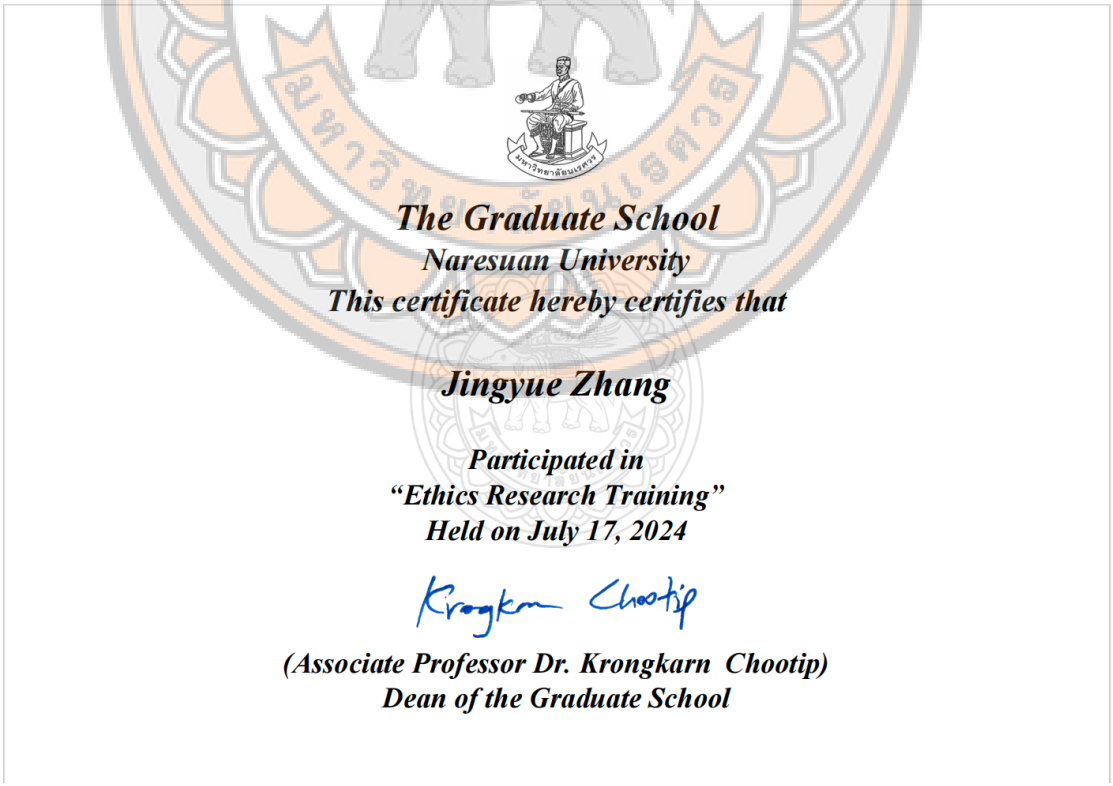
Has Completed the Online Research Ethics Training Course
**"The Human Subject Protection Training"**
Completion Date: 26 May 2024 Expiration: 25 May 2026

Chuchard Punsawad

(Associate Professor Chuchard Punsawad Ph.D)
Chairman of the Ethics Committee in Human Research
Walailak University

S. Panichkul

(Colonel Associate Professor Suthee Panichkul)
Chairman of the Forum for Ethical Review Committee
in Thailand (FERCIT)



***The Graduate School***
***Naresuan University***
***This certificate hereby certifies that***

***Jingyue Zhang***

***Participated in***
***"Ethics Research Training"***
***Held on July 17, 2024***

Krongkarn Chootip

***(Associate Professor Dr. Krongkarn Chootip)***
***Dean of the Graduate School***

**APPENDIX J The Graduate School, Naresuan UniversityAppointment of thesis Advisory Committeefor Doctoral Degree Program**

**Announcement**
**The Graduate School, Naresuan University**
**Appointment of thesis Advisory Committee**
**for Doctoral Degree Program**

.....

Following the principle of the Office of the Higher Education Commission and Naresuan University Rules and Regulations for Graduate Student 2016. The Graduate School announces the appointment of Thesis advisory committee for Doctoral degree program. The committee for **Ms.Jingyue Zhang**, student ID: 65031795 in Doctor of Fine and Applied Arts Program in Art and Design consists of the following names:

1. Assistant Professor Dr. Thirawut Bunyasakseri Advisor

Announced date: July 11, 2024

(Associate Professor Dr. Krongkarn Chootip)
Dean of the Graduate School, Naresuan University

# APPENDIX K Certificate of Approval(Initial Submission) of Institional Review Board

COA No. 001/2025 AF 11/6.0

IRB No. P2-0370/2567

INSTITUTIONAL REVIEW BOARD, NARESUAN UNIVERSITY

99 Moo 9, Tha Pho Subdistrict, Mueang Phitsanulok District, Phitsanulok Province 65000, Tel 66 5596 8642

## Certificate of Approval (Initial Submission)

The Institutional Review Board of the Naresuan University, Phitsanulok, Thailand, has approved the following study which is to be carried out in compliance with the international guidelines for human research protection as Declaration of Helsinki, The Belmont Report, CIOMS Guideline and International Conference on Harmonization in Good Clinical Practice (ICH-GCP)

Study Title : Interactive animation design to promote traditional culture learning skills of Chinese preschool students

Principal Investigator : MS.JINGYUE ZHANG

Faculty : Faculty of Architecture art and design

Advisor : Asst.Prof.Dr.Thirawut Bunyasakseri

Review Medthod : Expedited Review

Continuing Report : Submit a progress report at least once a year.

Document Reviewed

1. IF01 Research Ethical Application (Non-Intervention Study) Version 3.0 Date 16 December 2024
2. IF02 Conflict of Interest and Funding Form Version 1.0 Date 12 September 2024
3. IF03 ENG (For parents/legal representatives of volunteers aged 0 – 12 years) Version 2.0 Date 11 November 2024
4. IF03 CHN (For parents/legal representatives of volunteers aged 0 – 12 years) Version 2.0 Date 11 November 2024
5. IF04 ENG (For parents/legal representatives of volunteers aged 0 – 12 years) Version 2.0 Date 11 November 2024
6. IF04 CHN (For parents/legal representatives of volunteers aged 0 – 12 years) Version 2.0 Date 11 November 2024
7. Research Project (Full Protocol) 1.0 Date 2 October 2024
8. IF05 CV Investigator Version 1.0 Date 17 September 2024
9. Interview (ENG+CHN) PLASE 1 Version 1.0 Date 2 October 2024
10. Questionnaire (ENG+CHN) PLASE 2 Version 1.0 Date 2 October 2024
11. Interview (ENG+CHN) PLASE 3 Version 1.0 Date 2 October 2024

12. Questionnaire (ENG+CHN) PLASE 3 Version 1.0 Date 2 October 2024
13. Satisfaction Survey on "Interactive Animation for Children's Traditional Culture Learning" (ENG+CHN) Version 3.0 Date 16 December 2024
14. Questionnaire For Kids (ENG+CHN) Version 3.0 Date 16 December 2024
15. IF06 Budget Version 1.0 Date 17 September 2024

Signature:.....

(Associate Professor Dr.Sirilak Teeraputon)

Chairperson of The Institutional Review Board

Naresuan University

Date of Approval : 3 January 2025

Approval Expired Date : 3 January 2026

Approval is granted subject to the following conditions: (see back of this Certificate)

Institutional Review Board
NU-IRB
Naresuan University
มหาวิทยาลัยนเรศวร

All approval investigators must comply with the following conditions:

1. Strictly conduct the research as required by the protocol.
2. Use only the information sheet, consent form (and recruitment materials, if any), interview outlines and/or Questionnaires bearing the Institutional Review Board's seal of approval; and return one copy of such documents of the first subject recruited to the Institutional Review Board (IRB) for the record.
3. Report to the Institutional Review board any serious adverse or any changes in the research activity according to the standard operating procedures.
4. Provide reports to the Institutional Review Board concerning the progress of the research upon the specified period of time or when requested.
5. If the study cannot be finished within the expired date of the approval certificate, the investigator is obliged to reapply for approval at least one month before the date of expiration.
6. Expiry of COA, Investigator can not recruit new participants.
7. Complete and submit the final report form to the NU-IRB, as soon as possible after the completeness of research.

*A list of the Institutional Review Board members (names and positions) present at the meeting of Institutional Review Board on the date of approval of this study has been attached (per requested). All approved documents will be forwarded to the principal investigator.

# APPENDIX L Doctoral Dissertation Proposal Appointment Letter

**Announcement**

**The Graduate School, Naresuan University**

**Approval of Thesis Proposal to Conduct Research**

**No. 029/2025**

.....

The Graduate School approved **Ms.Jingyue Zhang**, student ID: 65031795; Doctor of Fine and Applied Arts Program in Art and Design, to conduct research. The approved thesis proposal entitled: **"INTERACTIVE ANIMATION DESIGN TO PROMOTE TRADITIONAL CULTURE LEARNING SKILLS OF CHINESE PRESCHOOL STUDENTS"** with Assistant Professor Dr.Thirawut Bunyasakseri as the thesis advisor.

When conducting research involving Research Ethics for Human Subjects, Research Ethics for the Use of Laboratory Animals, or Research Ethics on Biosafety, it is mandatory to obtain approval from the relevant committee. Research activities in these areas may commence only after receiving the necessary approvals.

Announced date: February 27, 2025

(Associate Professor Dr. Krongkarn Chootip)
Dean of the Graduate School, Naresuan University

## APPENDIX M The Graduate School, Naresuan University Changing of advisory committeefor Doctoral Degree Program

คณะสหวิทยาการ ศิลปะและการออกแบบ
มหาวิทยาลัยนเรศวร
รับที่ 065
วันที่ 15 ส.ค. 2568
เวลา 13.54 น.

**Announcement**

**The Graduate School, Naresuan University**

**Changing of advisory committee**

**for Doctoral Degree Program**

.....

Following the principle of the Office of the Higher Education Commission and Naresuan University Rules and Regulations for Graduate Student 2016. The Graduate School, Naresuan University announces for changing of advisory committee for **Ms.Jingyue Zhang**, ID 65031795, Doctor of Fine and Applied Arts Program in Art and Design on July 11, 2024 and approves the appointment of advisory committee name as follows:

1. Assistant Professor Dr.Chayanis Chuenchaichon Advisor

Announced date: August 8, 2025

Krongkarn Chootip

(Associate Professor Dr. Krongkarn Chootip)

Dean of the Graduate School, Naresuan University