The Research and Design of Children's Art Education Products Based on Cognitive Psychology

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Abstract: Children's art education plays a crucial role in cognitive and emotional development. However, existing educational products still have limitations in integrating cognitive psychology theories to enhance learning effectiveness. This study, based on the Observation-Association-Construction model from cognitive psychology, proposes a product design framework to support children's art education, aiming to improve cognitive efficiency and creativity during the art learning process. The research combines theoretical analysis with empirical study: first, a theoretical model is constructed and design objectives are clarified; second, data is collected through surveys, experimental observations, and user interviews; finally, both quantitative and qualitative analysis methods are used to verify the impact of the product design on children's cognitive development. The results indicate that children's art education products designed based on the Observation-Association-Construction model can effectively enhance children's visual observation, associative abilities, and artistic construction skills. Experiments show that this design framework is significantly applicable across different age groups, providing important practical guidance for the development of educational products. At the same time, the study highlights key issues in current educational product designs and proposes optimization strategies.

Keywords: Children's Art Education, Cognitive Psychology, Observation-Association-Construction Model, Product Design, Empirical Research

1 Introduction

1.1 Research Background

In modern society, with the continuous advancement of technology and the ever-changing social environment, children's art education has become increasingly important in cultivating children's comprehensive qualities and innovative abilities. Art education is not only a part of cultural inheritance, but also an effective means to support children's cognitive development, emotional expression, and social adaptation [24]. Particularly in the field of art education, there is a close relationship between children's cognitive abilities and artistic creation [7]. In recent years, the application of cognitive psychology in education has gradually become a hot topic. Cognitive psychology provides strong theoretical support, especially in understanding how children learn art through multiple senses, such as vision and hearing [42].

However, existing children's art education products still have certain shortcomings. Traditional teaching models and product designs often lack a deep understanding and effective application to children's cognitive development patterns [28]. For example, many art education tools fail to adequately consider children's psychological load, leading to learning experiences that not only fail to achieve the desired results, but may also cause cognitive fatigue [16]. Therefore, integrating cognitive psychology theories with art education to design educational products more aligned with children's developmental characteristics is an important issue that needs to be addressed.

1.2 Research Significance

The core significance of this study lies in exploring the application of cognitive psychology in children's art education and providing theoretical support for art education product design. By combining basic theories of cognitive psychology, such as cognitive load theory and the Observation-Association model, the quality of educational product design can be effectively enhanced, thereby helping children better understand and master the basic elements of artistic creation [11]. This design not only improves children's artistic cognitive abilities but also promotes the development of their creativity, further contributing to the improvement of their overall quality [49].

Additionally, this research holds important social and educational value. On a societal level, with the update of educational concepts, parents and society are placing increasing

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importance on children's art education. The ability to stand out among many art education products and become scientifically valid and effective has become a market demand. From an educational perspective, this study helps fill the cognitive gaps in current educational products and, through scientific design principles, provides theoretical and practical guidance for educational practices.

1.3 Research Questions and Objectives

This study aims to address th Research Questions and Objectives following core questions: First, how can cognitive psychology theories be applied to enhance the effectiveness of children's art education products? Second, what design innovations can be brought about by combining cognitive load theory with children's artistic cognitive development? Finally, how can more targeted educational product design plans be formulated based on children's cognitive development stages and artistic cognitive characteristics?

Specifically, the objectives of this study include: First, to clarify the application paths of cognitive psychology theories in children's art education; Second, to empirically verify the impact of different design elements on children's art learning; Third, to summarize cognitive models applicable to children's art education product design and promote the integration of theory and practice in the field of art education.

2 Literature Review

2.1 Application of Cognitive Psychology in Education

Cognition, as one of the most fundamental psychological activities of human beings, represents the process through which individuals acquire and apply knowledge. Historically, the origins of modern cognitive psychology can be traced back to ancient Greece, when Greek scholars first philosophically explored how humans come to know and understand the world—a process that inherently involved memory and thinking.

By the late 19th century, with Wilhelm Wundt's establishment of experimental psychology, the study of cognition gradually shifted from a philosophical inquiry to a physiological one. Wundt divided complex human cognitive processes into isolated components, an approach later termed elementarism or structuralism.

In the early 20th century, the rise of Gestalt psychology brought a new perspective by emphasizing holistic organization rather than elemental analysis. However, its focus remained largely on perceptual phenomena and fell short of explaining complex human cognitive behavior.

Cognitive psychology subsequently emerged as a dominant framework, integrating insights from both elementarism and Gestalt psychology to form a more comprehensive theoretical system. The widely accepted modern cognitive psychology theory took shape in the mid-20th century and has since attracted significant academic attention. Following the publication of Cognitive Psychology by the renowned psychologist Ulric Neisser in 1967—the first seminal work in the field—interest in the theory surged. By the 1980s, cognitive psychology, centered around the information processing model, had become a leading paradigm within Western psychology

Cognitive Load Theory (CLT) has widespread applications in the field of education. It emphasizes the limited capacity of human working memory and how effectively managing this finite cognitive resource in instructional design is key to improving learning outcomes [35]. Studies show that when information is presented in ways that align with cognitive load theory, students are able to process information more efficiently, thus enhancing learning efficiency. Furthermore, CLT places particular importance on distinguishing between intrinsic load, extraneous load, and germane load, providing strategies for optimizing instructional design to help teachers create more effective learning content.

In children's art education, the application of cognitive load theory is especially important. Children's cognitive development significantly differs from that of adults, so designing educational products that are aligned with children's cognitive development requires scientifically managing the cognitive load of instructional content [12]. Additionally, with the continuous advancement of digital learning tools, researchers have found that appropriate design can enhance students' learning motivation while effectively reducing unnecessary extraneous cognitive load, thereby fostering a better learning experience [29].

2.2 Current Research on Children's Art Education

The term art originated in 17th-century Europe (specifically in France around 1747), yet the existence of art appears to be as ancient as human civilization itself. Expressive visual forms of art can be traced back to the Paleolithic era [27]. From the Mesolithic to the Neolithic period, and with the first appearance of pottery, small sculptures and decorative images on objects such as vessels and handles were already serving as expressions of artistic intention.With the refinement of pictographic writing and the emergence of written language, narrative picture books came into use, while artistic forms such as poetry, novels, and drama became integral to everyday life. Scholars often refer to the question of the origin of art as the "Sphinx's riddle," due to the scarcity of knowledge and evidence concerning early human history and prehistoric artworks. Nevertheless, many researchers have proposed theories from different perspectives, including the Mimesis Theory, Expression Theory, and Magic Theory.

Mimesis Theory: Discussions on the origin of art date back to ancient Greece, when philosophers began to reflect on the fundamental question of where art begins. The theory of mimesis (imitation) emerged during this period. Democritus was among the first to suggest that art originated from imitation. Through continuous imitation of the external environment, human behavior and thought gradually developed, and all artworks are ultimately products of human imitation. The objects of artistic imitation derive from the real world,

not only capturing the external form and posture of things but also abstracting their inner essence and developmental logic.

Expression Theory: Expression theory holds that art arises from the human need to communicate emotions. Literary figures and aestheticians such as Leo Tolstoy were strong proponents of this view. They believed that the primary motivation for the creation of art was to express personal feelings. Early humans created various art forms—such as paintings and music—to convey their emotional states. The primary driving force behind the evolution of art, according to this theory, is the desire to express diverse emotions such as joy, anger, sorrow, and delight. The diversity of emotional expression among individuals has, in turn, led to the diversity of artistic forms [8].

Magic Theory: The magic theory, which remains highly influential in Western scholarship on the origins of art, investigates the relationship between primitive religious rituals and early artistic practices. This theory adopts a pragmatic perspective, suggesting that early humans engaged in artistic activities because they attributed significant functional value to them. For example, prehistoric humans believed that all things possessed souls, and that altering the external representation of an object could influence its actual nature. Accordingly, by painting desired animals and adding injury marks to them on cave walls, they believed this would improve their chances of capturing them in real-life hunts. Archaeological findings of prehistoric rock art have revealed beast images with scratch-like markings, providing strong evidence in support of the magic theory.

The unresolved question of the origin of art has also led to a diversity of classification approaches. The most common method classifies art based on its form of expression. Broadly speaking, art can be divided into visual arts, literary arts, performing arts, and integrated arts. Visual arts include painting, calligraphy, photography, sculpture, and architecture; literary arts encompass poetry, essays, and novels; performing arts involve drama, dance, and music; and integrated arts refer to forms such as film and musical theatre [27].

Research in children's art education primarily focuses on cognitive development and the cultivation of creative abilities. Studies indicate that children's artistic cognitive abilities are closely related to age, with their artistic expression becoming increasingly complex as they grow older [31]. However, many existing art education products fail to consider this developmental pattern adequately, with many products not adjusting the complexity and presentation of content according to the cognitive stage of children [17].

For example, many current art education products lack a systematic analysis of children's cognitive abilities in their content design, which may lead to excessive cognitive load, negatively affecting learning outcomes [44]. Therefore, it is crucial to redesign art education products that align with children's cognitive development principles, incorporating cognitive psychology theories into the design process [23].

2.3 Integration of Cognitive Psychology and Children's Art Education

Cognitive psychology theories can provide strong support for the design of children's art education products. By combining cognitive load theory with art education, it becomes possible to design educational products that not only align with children's cognitive development patterns but also effectively enhance their artistic abilities [1]. For example, using cognitive load theory as a guide in design can reduce extraneous load, allowing children to focus on the core elements of artistic creation, thus improving their creativity and expressive skills [48].

At the same time, the Observation-Association model offers new perspectives for art education. Research shows that children can establish basic frameworks for artistic creation through observing the behavior of others and associating it with their own experiences. This process helps children gradually develop the thinking and expressive skills needed for artistic creation [32]. Therefore, combining cognitive psychology with children's art education can provide innovative guidance for educational product design, pushing children's art education to a higher level [18].

From the literature review, it is evident that the integration of cognitive psychology and children's art education is gradually receiving more attention in academia and is having a positive impact on educational product design and teaching practice. However, current research still has limitations, especially in terms of how to precisely integrate cognitive development characteristics of children across different age groups into the design of educational products. Further exploration and verification are needed in this area [3].

3 Theoretical Framework

3.1 Cognitive Associative Model Based on Observation

The Cognitive Associative Model emphasizes that learners establish associations between concepts and skills by observing the behavior of others or study materials. When applied to art education, this model helps children gradually form cognitive understandings and skill mastery of artistic creation through observing art works [36]. Specifically, when children observe artworks or the artistic creations of others, they can connect visual information with existing knowledge, promoting the internalization of new knowledge and transforming it into their own artistic abilities [30].

The construction of this model is based on the fundamental principles of cognitive psychology, particularly in the roles of memory and attention during the learning process. Research has shown that the observation-association process not only enhances children's memory but also boosts their confidence and creativity in artistic expression [13]. By observing others' behaviors, children can gain cognitive inspiration and apply these insights to their own art creation through association, thus developing a unique personal art style [45].

In the Cognitive Associative Model, the development of children's artistic cognition is a progressive process. As their

cognitive abilities increase, children gradually transition from the imitation stage to the stage of creative expression [50]. This model provides theoretical support for designing art education products that align with children's cognitive characteristics, emphasizing the combination of observation and association strategies in the teaching process to promote children's artistic cognitive growth [2].

3.2 Application of the Model in Art Education Product Design

Based on the Cognitive Associative Model's theoretical framework, designers of art education products need to fully consider the cognitive development stages of children and optimize educational content according to the cognitive ability differences across different age groups. Research has shown that children's artistic cognitive abilities exhibit different developmental stages, transitioning from perception to operation, and finally to creative expression, requiring product designers to adjust the difficulty and complexity of the content flexibly [22].

Specifically, the design of art education products should focus on several aspects: First, the product should provide sufficient visual stimuli to help children establish associative relationships during observation. Second, the design should consider children's cognitive load, avoiding excessive information interference and cognitive overload, allowing children to engage in artistic creation in a relaxed environment [47]. Moreover, interactive elements should be incorporated into the design, stimulating children's interest in art creation and enhancing their innovative abilities through mechanisms of imitation and feedback.

The application of this model can significantly enhance the effectiveness of educational products. By leveraging the Cognitive Associative Model, designers can not only help children master the fundamental skills of artistic creation but also foster their creative development. Studies have shown that art education products incorporating the Cognitive Associative Model can increase children's engagement in art learning, thereby improving their artistic performance and innovative thinking [25].

Under the guidance of this theory, the design of children's art education products will not be limited to skill training but will also provide more scientifically grounded educational support for children's holistic development, from the perspective of cognitive psychology [33].

4 Methods

4.1 Research Design

This study adopts a mixed-methods approach, combining the strengths of both quantitative and qualitative research to comprehensively explore the effects of applying cognitive psychology theories in children's art education product design. The specific research design includes the following key steps: First, a literature review is conducted to clarify the theoretical basis and practical significance of Cognitive Load Theory and the Observation-Association Model in children's art education; Second, an experimental design is used to construct art education products driven by cognitive psychology principles, which are then tested in real-world settings; Finally, data analysis methods are employed to assess the impact of various design elements on children's art learning outcomes [14].

The experimental study uses a pre-test/post-test design. Initially, children are provided with a traditional art education product as the control group. Following this, the cognitive psychology-driven art education product is used as the experimental group. By comparing the changes in art cognition, creation skills, and creativity between the two groups, the study seeks to validate the effectiveness of the cognitive psychology-based design in improving children's art learning outcomes [15].

During the visual interface design process, standard colors, font sizes, icons, and UI components were strictly aligned with the visual design guidelines to ensure a consistent visual style. An overview of the UI design for the puzzle-based product is shown in Figure 5.17.

Figure 1. Descriptive caption of the image.

4.2 Research Sample

The sample for this study consists of 120 children aged 6 to 12 years, all of whom are from primary and secondary schools in urban areas. Participants are grouped according to their art cognition levels to ensure representativeness and diversity. Prior art cognition assessments are used to ensure that there are no significant differences between the experimental and control groups in baseline measurements, eliminating the influence of pre-existing cognitive levels.

Regarding sample selection criteria, all participants must have a certain level of artistic background and have received brief art cognition training prior to the study. Based on age, the sample is further divided into three groups: 6-8 years, 9-10 years, and 11-12 years, so that the study can observe differences in cognitive load responses and art learning effects across various age groups during the experiment [43].

4.3 Data Collection

The main sources of data for this study include both qualitative and quantitative data. Qualitative data is collected through interviews and classroom observations. The interviewees include teachers, students, and parents, aiming to gain in-depth insights into children's learning experiences and feedback

Category	Option	Number of Participants	%
Age	6–7 yrs	8	44.4%
	8–9 yrs	7	38.9%
	10–11 yrs	3	16.7%
Gender	Male	10	55.6%
	Female	8	44.4%

Table 1. Composition of the Experimental Sample

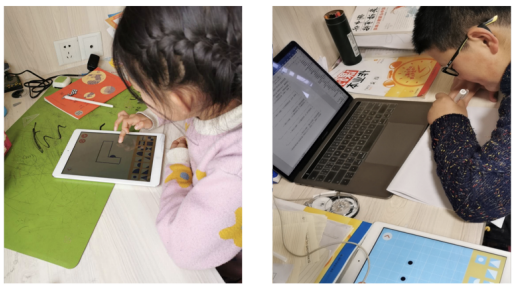

Figure 2. Descriptive caption of the image.

after using different art education products. Additionally, the researchers will observe participants' performances during the creation process, recording changes in their artistic ideas, creative techniques, and emotional expression [5].

Quantitative data is collected through standardized surveys and testing tools, measuring children's art cognition ability, creativity, and emotional expression levels. The survey includes questions on art learning motivation, mastery of art skills, and creative level, with all quantitative data measured both before and after the experiment to allow for comparative analysis [9].

4.4 Data Analysis

This study uses a combination of quantitative and qualitative analysis methods for data processing. Quantitative data will be processed using statistical methods such as correlation analysis and regression analysis, aiming to explore the impact of Cognitive Load Theory and the Observation-Association Model on children's art education outcomes. For instance, ANOVA (Analysis of Variance) will be used to examine whether different product designs have a statistically significant impact on children's art learning achievements [19].

Qualitative data will be analyzed using content analysis, with the researchers extracting key themes and patterns from interview and observation records. They will focus on analyzing the emotional and cognitive changes observed in children during the art learning process. Qualitative analysis can further complement the quantitative analysis by uncovering the underlying mechanisms through which cognitive psychology models influence children's art education [38].

To evaluate the effectiveness of the proposed cognition-based art education approach for children, a paired-sample t-test was conducted to compare participants' visual imagery scores before and after the intervention. As shown in Table 6.2, the post-test mean score of visual imagery richness was 10.11, indicating an improvement compared to the pre-test mean of 8.83. The difference was statistically significant ($p < 0.01$), suggesting a notable enhancement in participants' visual imagery abilities following the intervention. These findings support the validity of the first experimental hypothesis, indicating that the proposed educational approach can effectively enrich children's visual imagination within the cognitive framework.

Measure	Pre-test		Post-test		t	p
	Mean	SD	Mean	SD		
Visual Imagery	8.83	1.47	10.11	1.60	-9.436	0.000*

Table 2. Paired-sample t-test for visual imagery richness

5 Results

5.1 Statistical Results

This study used a pre-test/post-test design to assess the art cognition ability, creativity, and artistic expression of 120 children aged 6 to 12 years. After data collection, descriptive statistical analysis was applied to summarize and organize the basic characteristics and scores of the experimental and control groups. The results indicated that the experimental group scored significantly higher than the control group in terms of art cognition, creative skills, and creativity, with differences reaching statistical significance ($p < 0.05$). Notably, the experimental group showed a much higher average score in creativity, suggesting that the cognitive psychology-driven art education products were effective in promoting children's artistic creativity [10].

Specifically, the experimental group children in the 6-8 years age group had an average score in art cognition assessments that was 15% higher than that of the control group. In the 9-10 years and 11-12 years age groups, the differences were 18% and 20%, respectively. In terms of creative skills and emotional expression, children in the experimental group demonstrated greater independence in their artistic creation and more expressive artistic abilities, especially with notable improvement in the innovativeness and complexity of emotional expression [39].

In this experiment, Excel was used as a tool to organize and analyze the experimental data, with bar charts generated from the tabular results. The score of each item reflects the children's evaluation of the product. A score of 0.8 serves as a critical threshold: values below 0.8 indicate negative evaluations, while values above 0.8 indicate positive evaluations. In practical application, to avoid the use of extreme response categories, it is often observed that values exceeding +2 or falling below -2 rarely occur. Therefore, the evaluation range was set between -2 and +2. As shown in Figure 4.

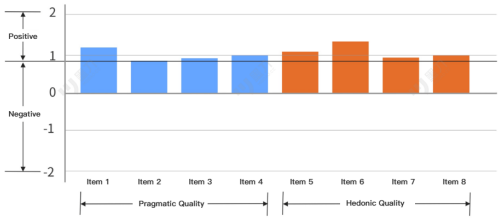

Figure 3. Descriptive caption of the image.

5.2 Key Findings

Based on the quantitative analysis results, the study identified the following key findings:

Optimization of Cognitive Load: Children in the experimental group, using art education products designed based on cognitive load theory, reported lower levels of perceived cognitive load and exhibited higher levels of engagement in the learning process. This suggests that reasonable optimization of cognitive load can enhance children's learning enthusiasm and interest in artistic creation [20].

Application of the Associative Model: With the use of art education products based on the Observation-Association Model, children in the experimental group demonstrated higher associative abilities and more creative thinking during their artistic creation. Particularly in drawing and sculpture, the experimental group exhibited more unique ideas and complex structures, characteristics that were less prevalent in the control group.

Age Differences: Significant differences were observed in the artistic expression between age groups. Younger children (6-8 years) showed a more sensitive response to cognitive load, with excessive cognitive load negatively impacting their learning motivation and creative output. In contrast, older children (9-12 years) exhibited greater autonomy and complexity in their artistic expressions during the creation process.

Feedback from Teachers and Parents: Interview data from teachers and parents generally indicated that art education products based on cognitive psychology theories were effective in stimulating children's creativity and learning interest. Specifically, children appeared to be more focused and engaged during the creative process, with noticeable improvements in emotional expression and innovative thinking. These findings suggest that the application of cognitive psychology theories, particularly Cognitive Load Theory and the Observation-Association Model, has a significant positive effect on the design of children's art education products. The results confirm that these psychological principles contribute to enhanced creativity, improved learning motivation, and more expressive and innovative artistic output among children.

6 Discussion

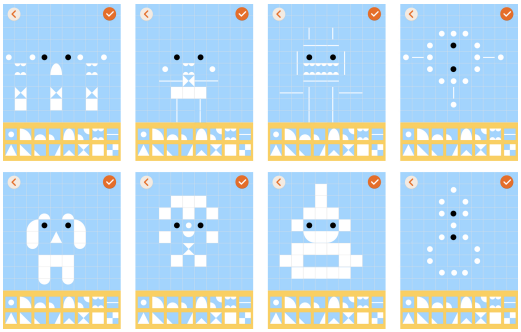

Figure 4. Descriptive caption of the image.

6.1 Interpretation of Results

The findings of this study suggest that art education products designed based on cognitive psychology theories significantly enhance children's art cognition abilities, creative skills, and creativity. This result aligns with existing research on Cognitive Load Theory and the Observation-Association Model, confirming that optimizing cognitive load and providing an effective associative learning environment can effectively stimulate children's learning motivation and creative thinking [41].

Firstly, children in the experimental group perceived lower cognitive load during the artistic creation process, indicating the importance of managing cognitive load in educational design. Cognitive Load Theory posits that when the amount of information is excessive or poorly organized, it increases the cognitive burden on learners, thereby affecting learning outcomes. Our results validate this principle, as the experimental group was able to better master artistic skills and enhance creative abilities when cognitive load was reduced [26]. By applying cognitive load theory to the design of art education products, not only can teaching effectiveness be improved, but children can also maintain higher levels of interest and engagement throughout the learning process.

Secondly, the application of the Observation-Association Model further strengthened the effectiveness of the art education products. Children in the experimental group were able to establish effective associative networks by observing art pieces and others' creative processes, which promoted their creativity and artistic expression abilities. This finding is consistent with existing literature on observational learning and associative learning [34]. The Observation-Association Model emphasizes that by observing others' behaviors and artistic works, children can imitate and gradually internalize these skills, a principle confirmed by our experiment. Children in the experimental group exhibited more independent thinking and complex artistic expressions in their creations, further demonstrating the effectiveness of the associative model.

6.2 Innovations and Contributions of the Study

One of the innovative aspects of this research is the first-time integration of two core cognitive psychology theories—Cognitive Load Theory and the Observation-

Association Model—into the design of children's art education products. This interdisciplinary integration not only provides a new perspective for the theory of children's art education but also offers innovative ideas for educational practice. In particular, the combination of optimizing cognitive load and incorporating associative learning has proven to effectively promote children's art learning and creativity, providing practical theoretical support for future educational product designs [4].

Moreover, this study offers empirical data that highlights cognitive differences across different age groups in art education. We found that younger children (6-8 years) are more sensitive to cognitive load, and excessive cognitive load significantly affects their artistic performance. This finding provides valuable insights for educational product design, suggesting that future art education products should be tailored to the cognitive characteristics of children at different ages to avoid negative effects from excessive cognitive load on learning outcomes [46].

6.3 Limitations and Future Directions

Although this study has made significant strides in validating the impact of cognitive psychology theories on children's art education, there are still some limitations. First, the sample size is somewhat limited, covering only children from urban primary and secondary schools, without adequately considering the influence of factors such as rural-urban differences or cultural backgrounds on art education outcomes. Therefore, future studies could expand the sample size to include a more diverse group of participants, testing the applicability and generalizability of cognitive psychology theories across different contexts and cultural backgrounds.

Second, this study employed a short-term experimental design and did not track the long-term effects of using the art education products on children's development. Future research should consider conducting longitudinal studies to assess the long-term impact of cognitive psychology-driven art education products, especially in areas such as creativity, artistic expression, and overall developmental progress [**?**].

Finally, the art education products used in this study have certain limitations. Future work can refine these products by integrating additional cognitive psychology theories, such as emotional regulation theory and metacognitive theory, to further enhance the educational outcomes [21].By addressing these limitations and expanding the scope of research, future studies could continue to refine the integration of cognitive psychology principles into children's art education, offering further insights into optimizing learning environments and boosting creative potential in young learners.

7 Conclusion

7.1 Summary of the Study

This study applied cognitive psychology theories, particularly Cognitive Load Theory and the Observation-Association Model, to the design and validation of children's art education products. The results indicate that art education products grounded in cognitive psychology significantly improve children's art cognition, creativity, and artistic skills. By optimizing cognitive load, minimizing unnecessary information interference, and promoting creative thinking through observation and associative strategies, this research successfully validates the important role of cognitive psychology in art education [40].

Specifically, children in the experimental group demonstrated higher engagement and autonomy in their art learning after using the cognitive psychology-driven art education products. They exhibited more independent thinking and complex structures in their art creation. Compared to the control group, children in the experimental group showed significant improvements in art cognition, creative skills, and emotional expression. These findings further confirm the broad potential application of cognitive psychology theories, especially Cognitive Load Theory and the Observation-Association Model, in art education [37].

7.2 Practical Recommendations

Based on the findings of this study, the following practical recommendations are offered to developers of children's art education products:

Optimize Cognitive Load: When designing children's art education products, it is essential to consider children's cognitive development characteristics. Avoid overwhelming them with excessive information and organize the steps and presentation of information during the art creation process. By reducing cognitive load, it can enhance children's learning interest and ensure their focus and creativity during the artistic process.

Focus on Associative and Imitative Strategies: Art education products designed using the Observation-Association Model can significantly enhance children's creativity and artistic expression. The design should provide children with rich artwork to observe and use associative learning methods to stimulate creative inspiration.

Age-appropriate Design: Given the cognitive load and art cognition differences among different age groups, art education products should be adjusted to suit the developmental stages of children. Younger children should be shielded from excessive cognitive load, while older children can handle more challenging creative tasks.

Long-term Tracking and Feedback: Future art education product designs should not only focus on short-term effects but also consider the long-term development of children's art cognition and creativity. Designers should incorporate long-term tracking and feedback mechanisms to continually optimize product features and teaching strategies, meeting the evolving needs of children at various developmental stages.

7.3 Future Directions

Future research can further expand the sample size to include children from diverse cultural backgrounds and urban-rural

settings to verify the applicability of cognitive psychology theories across various environments. Additionally, follow-up studies should consider long-term tracking to explore the sustained impact of cognitive psychology-driven art education products on children's artistic abilities over time. Further innovations could integrate other cognitive psychology theories, such as emotional regulation theory and metacognitive theory, to enhance existing art education products and promote children's multidimensional development [6].

Nonetheless, this study has several limitations. First, the sample consisted predominantly of Chinese multilingual learners, which may limit the generalizability of the findings to other cultural contexts. Future research should include more diverse learner populations. Second, the reliance on self-reported data introduces potential biases; incorporating objective measures like usage analytics could provide a more balanced understanding. Third, the cross-sectional design offers only a snapshot in time. Longitudinal studies are needed to examine how acceptance of GenAI evolves with increasing familiarity. Fourth, the study's scope was confined to user perceptions and acceptance, not objectively measured improvements in speaking proficiency, which remains a key area for future research.

This study also provides meaningful implications for researchers, educators, and developers. Developers should prioritize enhancing enjoyment by embedding gamified elements and culturally relevant content into GenAI tools to foster sustained usage. To address the limitations of PU, developers can focus on advanced features like adaptive learning paths and personalized, context-sensitive feedback. Language teachers should acknowledge the limitations of GenAI and create customized scenarios that align with learners' unique contexts to enhance the tools' relevance. Finally, researchers are encouraged to investigate the indirect effects of PU and PEOU through mediators like social norms or external influences. Examining how contextual factors shape technology acceptance will further advance the understanding of GenAI's role in multilingualism. These efforts can maximize the potential of GenAI to support multilingual learners and enhance their language proficiency.

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