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The Design and Practice of Scientific Inquiry Activities for Children Aged 5-6 Based on an AR Flashcard Environment

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Abstract: In this study, a design framework for scientific inquiry activities for children aged 5-6 based on an AR flashcard environment is constructed, cases of scientific inquiry activities are designed according to this framework, and quasi-experimental studies are carried out. And it selectes two large classes of students in a kindergarten in Xiahe County, Gansu Province of China as experimental subjects, and sets up an experimental class and a control class, with 20 students each.The research results indicate that compared with the traditional learning environment, the implementation effect of 5-6 children's scientific inquiry activities based on an AR flashcard environment is obvious. AR technology fully mobilize children's interest and enthusiasm for inquiry, obtain a better inquiry experience, and thus improve children's scientific inquiry abilities.

Keywords: AR flashcard, children 's science education,, children 's scientific inquiry abilities

1. Introduction

In April 2022, the Ministry of Education issued the "Science Curriculum Standards for Primary Schools of Compulsory Education".Subsequently, the Ministry of Education of China issued the "Guidelines for the Learning and Development of Children Aged 3-6",and the Guide emphasizes that the essence of children 's science education is to stimulate children's interest in inquiry, allowing them to experience the process of inquiry, and cultivating their early inquiry abilities (Zhanlan Liu,2008). Children's scientific inquiry activities belong to the important content of kindergarten science education. Generally speaking, children's scientific inquiry activities are divided into formal and informal scientific inquiry activities (Lan Lu, & Mei Hang,2011).

However, there are many urgent problems that need to be solved in children's scientific inquiry activities in reality, such as the "formalization" of inquiry, the lack of necessary learning resources, which are not conducive to the development of children's scientific inquiry abilities. In the virtual and real environment created by AR flashcards, children can interact with the 3D models in real-time after scanning the AR flash card through the smart mobile device, which can stimulate children's interest in learning and inquiry, and put themselves in a safe environment for experimental operation and independent inquiry, thereby improving the problems existing in children's science activities.

Based on the above reasons, this study aims to apply the AR flash card-based learning environment to the design and implementation of scientific inquiry activities for children aged 5-6, mainly studying the following issues:

1. How to design a framework for scientific inquiry activities for children aged 5-6 based on the AR flashcard environment?
2. Can the framework for scientific inquiry activities for children aged 5-6 based on the AR flashcard environment effectively improve children's scientific inquiry abilities?

2. Literature Review

2.1 AR Technology Features and its application in early childhood education

AR technology can interact with virtual and real objects due to its characteristics, with the technical characteristics of AR, the use of technology tools in education can provide new learning opportunities to increase the interaction between individuals and entertainment learning, bring a rich learning experience and make the learning process more positive, effective and meaningful(Alsumait,& and Musawi,2013).

Through literature review, it is found that the current expression of early childhood education content is mainly cognitive cards, games, picture books, etc.AR technology blends the physical and virtual worlds to provide a new learning platform, and the technology is now widely used in the educational environment of elementary, high school and college students. In the study , the experimental results showed that AR improved students' learning motivation, engagement and achievement compared with traditional teaching media(Bacca J. et al.,2014).Similarly, in one survey, students were found to understand and remember content and perform better, cooperate more, and show more motivation and focus when using AR compared to non-AR traditions or media(Radu I,2014).According to the above statement due to the problems encountered by children aged 5-6 in the implementation of scientific activities, as well as the current goals and requirements of children 's science education and the application of AR technology, AR technology is undoubtedly a suitable tool or product for children's learning.

3. Design of Scientific Inquiry Activities for Children Aged 5-6 Based on an AR Flashcard Environment

3.1 Framework Construction

This study aims to improve children's scientific inquiry abilities, and according to the ADDIE teaching design model(Merrienboer,1997), from the five stages of analysis, design, development, implementation, and evaluation, this study benchmarks the preliminary analysis, activity process design, activity resource development and preparation, and activity case implementation of children's scientific inquiry activities based on an AR flashcard environment. A design framework in Figure 1 for scientific inquiry activities for children aged 5-6 based on an AR flashcard environment is constructed. Among them, in the activity process design stage, the "5E" teaching modethat is in line with the goals and concepts of science education is selected as the basis, which is a new teaching method developed by American educators in the field of biology(BSCS), which is five links: Engagement, Exploration, Explanation, Elaboration, and Evaluation.

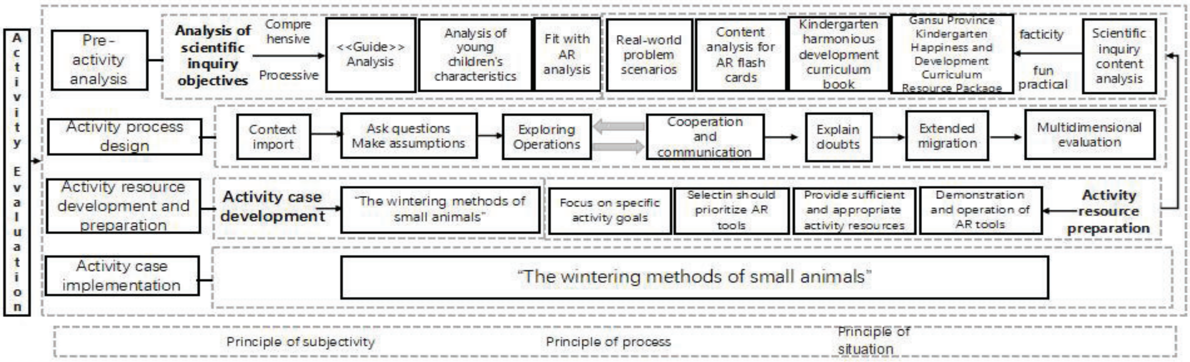

Figure 1. A Framework for Scientific Inquiry Activities for Children Aged Based 5-6 on an AR Flashcard Environment

3.2 Learning Activities Design

3.2.1 Activity Case Design

The theme of this research activity is selected from the " Harmonious development curriculum teacher's Book ". Table 1 is a concrete example of an activity case.

Table 1. *Activity Case Design*

Activity theme	The wintering methods of small animals	
Activity session (Activity content)	**Teacher activities**	**Children activities**
Context import (Create problem situations to stimulate children's interest)	•**A.** Play a video of Julie hibernating from SpongeBob SquarePants. 1."Children, have you seen SpongeBob SquarePants?" and "What animals are in ?" 2. "Why doesn't Julie sleep for months instead of playing with her friends?"	•**A.** Freely answer the animated characters in the cartoons . •**B.** Watch the video and answer your teacher's questions.
Ask questions Make assumptions (Throw questions, elicit activities)	•**B.** Show pictures of multiple animals through PPT. 1. "We have already known many small animals before, so how these small animals survive the cold winter?"	•**C**. Exchange existing experiences, name animals, and how to spend the winter.
Explore operations (Children use AR tools to explore how animals survive the winter)	•**C.** Use AR flashcards to show children the characteristics of animals . •**D.** Guide children to use AR tools to explore the way animals survive the winter. •**E.** Distribute tablets, AR flashcards, and log sheets, and explain the use of AR flashcards and log sheets. •**F.** Patrol and guide children during the observation process, encourage children to participate in activities, and remind children to take notes in a timely manner.	•**D.** Use AR tools to explore the names, characteristics, and wintering styles of animals. •**E.** The group works together to complete the activity record sheet.
Share and communicate (Share findings)	•**G.** Ask the children in each group to report on their record sheets and talk about their gains.	•**F**. Share their own findings and what they have learned.
Explain doubts (Teachers answer questions and integrate knowledge)	•**H.** Summarize the results of the inquiry and answer the children's questions.	•**G**. Listen carefully to the teacher's questions and summaries.
Extended migration (Guide children to solve problems with new knowledge)	•**I.** Start from the life situation again and guide children to solve problems with new knowledge. •**J.** Show the task content and let the toddler think. 1. "Can such small animals live together?" "Why?" "How to classify it?"	•**H.** Based on what has been observed before, think and answer questions in relation to the present.
Multidimensional evaluation (Self-evaluation and mutual evaluation are encouraged)	•**K.** Encourage children to self-evaluate the completion of their own group record sheets and to peer-evaluate the completion of other groups.	•I. Evaluate the reporting of their own groups and Peer reporting.

4. Methods

4.1 Research Methods and Design

This study adopts quasi-experiment and collects relevant data of children through scale and interview content before and after the experiment. Comprehensive qualitative and quantitative methods are used to analyze and compare whether the traditional learning environment and the AR flash card-based learning environment cause differences in the cultivation of children's scientific inquiry abilities, and whether the children's scientific inquiry abilities are significantly improved.

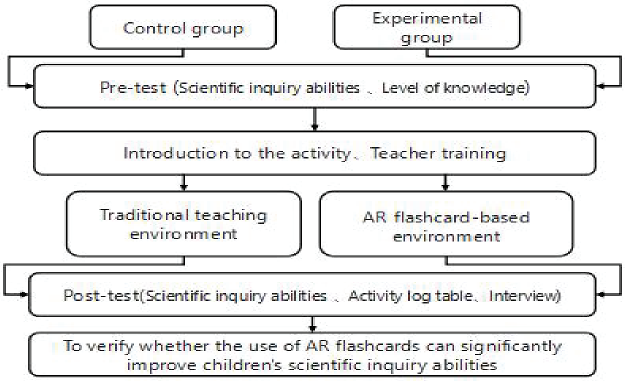

Figure 3. Specific Experimental Procedures

4.2 Research Objects and Implementation

In this study, two large groups in a kindergarten in Xia he County, Gansu Province are selected as experimental objects. The number of students in both the experimental and the control group is 20. The experimental group adopts the scientific inquiry activity process based on an AR flashcard environment to teach, while the control group adopts the traditional teaching environment , and conducts 30 teaching activities in total for 10 weeks. Before the experiment begins, the research tools are used to pre-test the scientific inquiry abilities of children, so as to ensure that the level of students in the two groups is similar and homogeneous. In the experimental group, two students cooperate to control the tablet and complete the exploration task. According to the teacher's explanation and demonstration as well as the student's performance, the post-test data is collected and analyzed after the teaching activities.

Figure 4. Teaching Implementation Examples

4.3 Measurement Tools

4.3.1 Test Scale

The test scale of this study is the "Evaluation Table of Children's Scientific Inquiry Abilities". Its observation indicators are divided into six dimensions. There are 5 grading scales under each dimension. Its Chronbach's Alpha coefficient is 0.814, indicating good reliability. The KMO value is 0.727, indicating that the validity meets the requirements.

4.3.2 Interview Outline

This study designs the teacher and children interview outlines. The teacher interview designs six questions, such as: "To implement scientific inquiry activities based on an AR flashcard environment, what are the changes in your teaching methods?". The children's interview also designs six questions, such as: "What do the children learn in class today?".

4.4 Data Analysis

4.4.1 Pre-experimental Homogeneous Analysis

The data in Table 2 shows that the Sig of the both of groups are all greater than 0.05 in six dimensions, which do not reach a significant difference. It shows that the experimental group and control group can carry out the next intervention experiment with the same level of scientific inquiry abilities.

Table 2. *Homogeneous Analysis of Scientific Inquiry Abilities in Experimental and Control Groups*

	Group	N	M	SD	T	Sig.
Curiosity and interest	Experimental group	20	10.50	3.591	.929	.359
	Control group	20	9.50	3.204		
Propensity for inquiry	Experimental group	20	10.25	3.024	.523	.604
	Control group	20	9.75	3.024		
Operability of materials	Experimental group	20	10.00	3.627	.213	.833
	Control group	20	9.75	3.796		
Depth of inquiry	Experimental group	20	12.75	3.024	.284	.778
	Control group	20	13.00	2.513		
Ability to record information	Experimental group	20	10.25	3.796	.237	.814
	Control group	20	10.00	2.810		
Ability to collaborate and communicate	Experimental group	20	11.00	3.078	.737	.466
	Control group	20	11.75	3.354		
Total score	Experimental group	20	10.50	3.591	.377	.708
	Control group	20	9.50	3.204		

4.4.2 Post-experimental Significance of Differences Analysis

According to the data analysis results of Table 3, The average score of the experimental group is significantly higher than that of the control group, indicating that the implementation effect of the experimental group is better than that of the control group.

The results in Table 3 below of the independent samples T-test analysis of the experimental group and the control group shows that the significance of the T-test is 0.000<0.05, indicating that there is a significant difference between the average value of the total score of scientific inquiry abilities of students in the experimental group and the control group.

Table 3. *Independent Samples T-test of Scientific Inquiry Abilities in Experimental and Control Groups*

	Group	N	M (Relative score)	SD	F	t	Sig.
Total score	Experimental group	20	99.75	6.172	.854	3.531	.000
	Control group	20	88.75	4.833			

According to the T-test analysis results of paired samples in Table 4 below, the average score difference of six dimensions of scientific inquiry abilities is 28.75, and the correlation significance of the total score of paired samples is less than 0.05, indicating that there is a significant difference between children's total score of scientific inquiry abilities before and after the practice of inquiry activities.

Table 4. *Paired Samples T-test of Scientific Inquiry Abilities in Experimental Group*

	N	M (Relative score)	df	t	Sig.
Pretest-Total score	20	64.75	19	-1	0.000
Posttest-Total score	20	93.50		8.243	

4.4.3 Interview Analysis

Through the analysis of interviews between teachers and young children, it can be seen that teachers are satisfied with the design and implementation of scientific inquiry activities based on the AR environment, children's scientific inquiry abilities have been improved in the experiment, and teachers are also willing to use AR in future activities. It was agreed that AR tools were more fun and convenient than previous activities and that children could explore and record in an active atmosphere.

5. Conclusion

Through this experiment, this study mainly draws the following conclusions:

1. The design framework of scientific inquiry activities for children aged 5-6 based on the AR flashcard is effective.
2. AR flashcards can promote the effective development of children's scientific inquiry activities.

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