The Impact of Interactive AR on Learning Ability of Children's Chinese Characters Self-learning

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Abstract. Augmented reality has become an effective teaching and learning tool to improve children's engagement and experience during. This study presented 2 kinds of Chinese characters learning method (traditional picture learning and AR-assisted learning), and compared the impact of traditional learning and AR-assisted learning methods on children's learning ability in the process of learning by applying AR technology to traditional Chinese pictographs learning method. It involves the impact on children's concentrated ability, cognitive ability and learning initiative. These finds enriches the application and research of AR technology in Chinese language teaching, and provides reference for applied research in other related fields.

Keywords: Augmented reality · Chinese characters · Learning ability

1 Introduction

Chinese character is a significant and important component of early education for Chinese children. As it is related to their reading ability, which plays a crucial role in their academic achievement [1]. While younger students always show insufficient learning ability for characters learning, such as lacking enough cognitive ability, and feeling difficulty to concentrate [2]. It lowers the learning quality, especially when they are learning by themselves. To make a better foundation of future study, it's important to enhance students' learning ability at the characters learning stage.

With the technology developing, augmented reality (AR) technology has been gradually developed in various fields, as well as the field of children's language education in recent years. Ruowei Chen using AR flashcards to help children to learn English vocabulary [3]. Xiaodong Wei etc. developed an mobile AR-assisted sandbox game to help students learning Chinese characters [4]. In addition, AR technology is proved to be effective in improving students' learning experience. Perry, B found that AR can further bridge the gap between games and education, attracting players to immerse themselves in learning, improving student's learning performance [5]. Hsu found that autonomous AR language learning could make a better learning flow experience, and to a certain extent, reduce the sense of learning anxiety [6].

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However, most of the previous studies on AR-assisted learning only focus on students' learning experience or a few sub-aspects of learning results, lacking exhaustive and quantitative research about learning ability. Our research compared the differences impact on children's learning ability through the different learning process. Our conclusion involved the concentration ability cognitive ability, and learning initiative.

2 Design Paradigm

In China, the most common method to teach children simple Chinese characters is image teaching. For one thing, students are overconfident in their ability to learn language vocabulary and the majority of students believe pictures would be more effective [7]. For another thing, Chinese characters are combinations of sound, shape, and meaning, which are derived from pictographs [8]. Based on that, we developed 2 different method (Traditional learning and AR-assisted learning) to teach children simple Chinese characters.

2.1 Traditional Learning

With the features of pictographs, the traditional learning shows children the pictures of specific things that pictographs refer to, outline the respective shapes, and let children see the similarities between graphics and Chinese characters, to help them remember the shapes of Chinese characters (Fig. 1 shows an example).

Fig. 1. The picture of "rain" (*left*), the similar shape between the picture and the Chinese character (*middle*), the Chinese character "雨" (*right*)

2.2 AR-Assisted Learning

The AR-assisted learning requires children learning by mobile device. It is based on the traditional, but more vividly and interactive. Firstly, it turns the 2D images into AR 3D scene, so that children can observe figures from multi-angled; Secondly, an animation about the 3D model changing to the Chinese characters will be show when children click the model in the scene, it also shows the stroke of the characters. (Figure 2 shows an example).

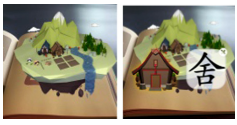

Fig. 2. The AR 3D scene showing on the mobile interface (left), the animation about "house" model in the scene changing to Chinese character "舍" (right)

3 Method and Data

3.1 Participants and Procedure

According to Neilson's usability test, most or 80% of usability issues will be discovered by 5 participants [9]. Therefore, we invited 10 children from 5–6 years old and divided them into 2 groups for traditional and AR-assisted learning.

First of all, each participant underwent pre-test of their vocabulary to make sure they would learn the new Chinese characters. Then each groups used learn for 45 min at home with 2 approaches. Their parents observe participants' learning state and fill a questionnaire according to their observation. The second day, a pictures-characters test was conducted. Finally, we interviewed their parents after several days.

3.2 Learning Tasks

Each group children should learn 12 Chinese characters of "cloud", "mountain", "wood", "woods", "house", "stone", "fire", "sheep", "river", "well"," "grass", "field": "云","山","木","林","舍","石","火","羊","川","井","草","田". For traditional learning group, children learn through similar shapes outlined from specific figures. For AR-assisted learning group, children learn with AR-3D models (Fig. 3 shows an example).

Fig. 3. The traditional learning method (left), the AR-assisted learning method (right)

3.3 Measurement of Learning Ability

In this study, we divided the children's learning ability into concentration ability, cognitive ability, and their learning initiative.

For concentration ability, the parents' questionnaire about children attention was measured, which is part of Achenbanch's child Behavior Checklist [11]. It consists of five items, with responses provided through Likert scales ranging from one (never) to three (always), with higher scores representing a greater degree of distractibility or a greater difficulty in switching attention between tasks. The items are:

1. Easily distracted when studying, visit any outside voice;
2. Unfocused during self-learning, often looking away or dazed;
3. Dragging in the learning process, playing while learning;
4. Inattentive to learning details, careless mistakes often occur in doing exercises;
5. Difficulty to keep on learning, do other things before completing learning tasks.

For cognitive ability, we conducted a pictures-Chinese character test to investigate the children's learning results and cognitive ability. It includes 10 items, and there are 1

Chinese characters from learning tasks and 4 pictures in each item. Each Chinese character relates to 1 picture. Each item corresponds to 1 point. For the test, with higher scores representing a greater level of learning results, with a maximum of 10 points and a minimum of 0 points.

For learning initiative, a short interview with the parents was conducted after several days, to know the children's subsequent autonomous learning status.

4 Results

Table 1 summarizes the analyzed results of children's concentration ability. The means and SD were calculated to compare average concentration ability of each groups. The independent t-test was used to investigate the difference of concentration ability between 2 groups. As showed by the Means and SD, children in AR group were more concentrated. For the t-tests, it shows significant differences in the impact of two learning methods on helping children to focus and pay attention to details.

Table 1. The analyzed data of children's concentration ability

Items	Traditional group		AR-assisted group		T-tests
	Means	SD	Means	SD	
Easily distracted	2.40	1.09	1.80	0.98	0.38
Unfocused	2.20	0.98	1.60	1.19	0.04*
Dragging	1.80	0.98	1.60	1.79	0.67
Inattentive	2.40	1.79	1.20	0.89	0.03*
Difficulty to keep	1.80	0.98	1.60	1.10	0.54

ap < .05 **p < .01

Table 2 shows the children's learning results. According to the average scores of each group, the children in AR group showed a greater level than the traditional learning group. However, for the t-test, it shows no significant difference in the impact of two methods on children's cognitive ability existed.

Table 2. The analyzed data of children's cognitive ability

Groups	Means	Means	T-tests
Traditional learning	8.20	1.1	0.42
AR-assisted learning	8.80	1.8	

ap < .05 **p < .01

Table 3 presents the interview results about children's learning initiative. After completing learning tasks, all the children can associate Chinese characters with objects in life on their own initiative. In addition, children in AR group shows more interest and initiative. The usage of mobile devices also increases their probability of playing digital games.

Table 3. The interview results about children's learning initiative

	Positive	Negative
Traditional group's feedback	Children actively outline the characteristics of objects in life and associate with Chinese characters	Children occasionally play games on mobile devices
AR-assisted group's feedback	Children often think of the learned Chinese characters themselves when they see the related objects around Children are pleased to learn Children's learning time increased	Children doodle Chinese characters in other textbooks The learning forms in traditional books are single, Children's interest being diminishing

5 Conclusion

In this paper, we analyzed and compared the impact of traditional learning and AR-assisted learning on children's learning ability by applying AR technology to traditional Chinese pictographs learning method. It shows that both methods can improve children's cognitive ability of Chinese character and there is no significant difference of impact between the two methods during a short learning time. In addition, the children learning with AR technology are more focused and pay attention to learning details. They also show more learning interests and initiative as they enjoyed themselves into interactive AR learning activities. While learning on mobile devices provides them the chance to play mobile games.

However, there are still some limitations in this study. The primary limitation is the sample size. It is advisable to work with a larger sample, while we invited only 10 children who is convenient to test in our case. Further, to make sure the natural experiment condition, we collected most observation information from parents. Although it is not the first-hand data, but it guarantees children's real learning status. Besides that, the individual factor influences like users' learning habit, learning level should be considered more.

Over all, more research is needed to find the potential and forms of AR technology for education, as well as other fields.

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