Augmented Reality and 3D Model for Children Chinese Character Recognition - Hong Kong Primary School Education

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Abstract:
Unlike other phonetic alphabet languages, the pronunciation and writing of Chinese are different learning modes. This study intends to motivate primary students to learn Chinese characters and improve learning performance by integrating Augmented Reality (AR) technology with 3D models. The paper first describes the exertion of AR and 3D models to construct a Chinese character recognition application and then presents the findings of the pilot test in assessing the effectiveness of AR and 3D models in learning Chinese characters. Data collection methods are pre-test, post-test, teacher focus group, and student focus group. The study reveals that the prototype of this AR learning application enables students to have a better understanding of the recognition of Chinese characters. This enhances the learning motivation, concentration, and interest of school children. In summary, the study shows an interactive and interesting way to promote Chinese character learning via the AR environment and 3D models. Implications for future development in using AR and 3D models in supporting Chinese language learning discusses at the end of the paper.

Keywords: Augmented Reality (AR), 3D models, Chinese character recognition, e-learning, game-based learning, learning effectiveness

1. Introduction & Literature Review

Unlike other phonetic alphabet languages, the learning of Chinese is an abstract learning mode for primary school students. The pronunciation and writing of Chinese are different learning modes. We pronounce “big” as “dà”, but we write “big” as “大”. Besides, many Chinese characters are similar (Lou, 2000), such as “大” (big), “太” (super) and “犬” (dog). Students easily write wrong Chinese characters by adding “more stroke” (e.g. write 大 as 太) or “less stroke” (e.g. write 犬 as 大). In schools, students need to copy each Chinese character three times in doing homework in Chinese language subject. When they write a Chinese character wrong, teachers will punish them by copying the correct Chinese character five times. So, students are frustrated to learn Chinese characters due to lack of motivation. This is the reason why the study is conducted. This study aims to examine the efficiency of employing Augmented Reality (AR) technology with three-dimensional (3D) models in Chinese language learning. We would like to find out if the technologies could motivate Hong Kong primary students to learn Chinese characters better thus improve their ability in Chinese character recognition. The paper first describes the exertion of AR and 3D models to construct a Chinese character recognition application and then presents the findings of a pilot test in assessing the effectiveness of the application of AR and 3D models in learning Chinese characters. Data collection methods are pre-test, post-test, teacher focus group, and student focus group.

1.1 Chinese Language Medium

In Hong Kong, we are generally taught Chinese language subject by using Cantonese and traditional Chinese writing. According to the HKSAR Legislative Council Panel on Education (HKSAR, 2018). Putonghua has been encouraged by the local government to be the education medium of the Chinese language subject since 2008. Currently, about 71.7% of elementary schools and 36.9% of secondary schools in Hong Kong have adopted Putonghua as a medium of instruction in teaching Chinese.

1.2 Background of Implementing Chinese Language Education

Chinese education has encountered drawbacks in Hong Kong. Hong Kong Education Bureau established a uniform standard for the handwritten Chinese characters in 1986. Teachers generally followed the rules listed on "List of Graphemes of Commonly-used Chinese Characters" to grade students' handwriting. However, some parents complained that teachers were too strict with the students' handwriting. The "correct" writing of Chinese characters' was varied to teachers' judgments (Li, 2018). Students felt frustrated from learning Chinese as they might be punished by not writing a "proper" Chinese characters fulfilling to the invisible and vague teachers' standard (Li, 2018).

1.3 Common Difficulties in Learning Chinese Language

Chinese learners always face three difficulties in mastering the Chinese language – (1) many Chinese characters and difficult to recognize, (2) many shapes and difficult to write, and (3) many pronunciation and difficult to pronounce (Tse, 2000). As local primary school students, they usually encountered the first two difficulties in studying the Chinese language - character recognition and character writing. Unlike English, the Chinese word, Hanzi, can either operate solely or integrate with more than one character to compose a word. A word can be interpreted as a "multicharacter" word, such as 好 (good) is integrated with 女 (girl) and 子 (son). We usually compose a story to remember the multicharacter word (i.e. If a lady has a daughter and a son, she is good). However, primary students may find the Chinese characters difficult to distinguish because they do not have a systematic learning mode. If students could not recognize the meaning of the Chinese characters, it is even more difficult for them to memorize the script of the words (Jyun, 2017). A research conducted by Chan and Nunes (1998) shown evidence that the writing strokes arrangement of Chinese characters could consolidate the comprehension of learners about the Chinese characters to a certain extent.

1.4 Effectiveness of Technology-Assisted Education

The complementarity of technology in education has been proven its constructive effect on learning. The application of technology was generally associated with positive influence in language education. Zhao (2003) found that it could effectively raise the value of the input, efficiency of message transmission and ensure the relevance and validity of the feedback. Golonka, Bowles, Frank, Richardson & Freynik (2014) also pinpointed technology as an impressive instrument to boost learning desire and language-learning performance. Nevertheless, the learning outcome of practicing technology also hinge upon the practical application of technology and the teaching environment. Hence, more research regarding the proper technology operation format and context was encouraged to be done (Salaberry, 2001).

1.5 Augmented Reality as Language Learning Medium

Learning languages can be experienced through a wide variety of media. Students traditionally learned language through interaction with teachers and peers. They would learn from non- interactive media such as textbooks, copybooks, and instructional broadcasting programs. In past decades, digital media has been used in enhancing language learning efficiencies such as power-point slides, projectors, and interactive whiteboards. Furthermore, the ways of interaction with language learning experiences are changing. Students interact with on-screen content with fingers, paper, and real-world environments. Augmented Reality (AR) is an interactive experience of a real-world environment to offer perceptually enriched learning experiences. AR is used as a complementary tool in terms of text, graphics, video, and audio to provide students a real-time learning environment in language education institutions (Yuen, Yaoyuneyong & Johnson, 2011). Interactive AR media strongly influences students' learning in terms of visual 3D functions and specific content to scaffold student learning (Radu, 2014). Researchers researched AR technology assisting in different language learnings, such as English (Chang, Lee, Wang & Chen, 2010; Liu & Tsai, 2013), Thai (Thiengtham & Sriboonruang, 2012) and French (Perry, 2015). AR technology improved students' understanding and learning motivation in language learning.

2 Application of Augmented Reality (AR) technology with 3D models

An application provides a scenario for students to recognize Chinese characters at their own pace. The application provides games in 6 learning sections. Each section has 3 learning exercises. Students took a bone card to scan through a back-end camera of an electronic device. After scanning

the “bone card” (Figure 2), a 3D animal model (Figure 4) popped up. Then, students pressed an animal cartoon (Figure 5) to listen to the animal sound and pressed a Chinese character (Figure 5) to listen to the pronunciation. Then, students entered the Game 1 (Figure 6) to recognize the pronunciation of the character and the animal cartoon. After finishing Game 1, students automatically entered Game 2 (Figure 7). Students pressed the underscore “ __ ” and a window popped up (Figure 8). Students picked and scanned a relevant pinyin card (Figure 3). When students answered correctly, students automatically entered Game 3 (Figure 9). In Game 3, students pressed the animal to listen to the pronunciation and matched with the correct Chinese character. Students repeated the games with different “bone cards” (Figure 2).

3 Pilot Test on Chinese Character Recognition

This is an AR interactive language learning application. The application provides a systematic language learning experience for primary school students. A pilot test is conducted to examine the effectiveness of the application in assisting primary school students to recognize Chinese characters.

3.1 Participants and Procedures

A local primary school participated in a pilot test. Mandarin is the language of instruction in the Chinese language subject. Students learned traditional Chinese characters in the school. Three teachers and 30 students recruited to participate in the pilot test. After the pilot test, the teachers and six students participated in focus groups separately. Before the execution of all pilot tests, a parental consensus for the information collection of the participants was collected.

Three teachers shared a similar experience in Chinese language subject teaching. The students were native Chinese speakers. They were from 6-year-old to 7-year-old, who were beginners in Chinese learning. 10 students were randomly selected for three groups, including one control group and two experimental groups.

The pilot test lasted 40 minutes each session. We did one session for each group in the school. All groups spent the first 5-minute in a pre-test. Then, they spent the next 30-minute to learn six characters. Finally, they spent the last 5-minute in a post-test. The pre- and post-test were administered by students individually. Each focus group lasted 15 minutes.

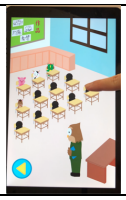


Figure 1. Gabi for Chinese Character Recognition

Figure 2. Learning Material (Bone Cards)

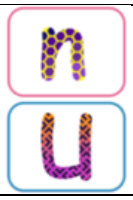


Figure 3. Pinyin Card

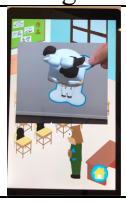


Figure 4. AR Technology & 3D Model for Chinese Character Recognition

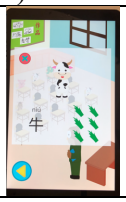


Figure 5. Interaction Animation and Interactive Sound Attraction

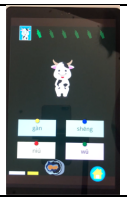
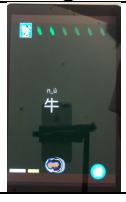
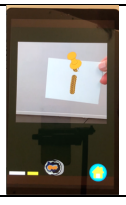


Figure 6. Learning Material





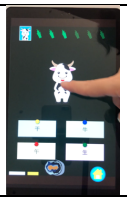


Figure 7. Interaction Animation and Interactive Sound Attraction	Figure 8. AR Technology for Chinese Character Recognition	Figure 9. Interactive Sound Attraction and Learning Material

3.2 Grouping Arrangement

The same set of pre- and post-test was used in the three groups. Group 1 was a traditional class (control group), which teacher (Miss YIP) taught students by using PowerPoint with the blackboard. Group 2 was a semi-traditional class (experimental group), which teachers (Miss LEE) taught students by using PowerPoint with the Augmented Reality Technology with 3D Models Application. Group 3 (experimental group) was a non-traditional class, which teachers (Miss LEUNG) taught students by using the Augmented Reality (AR) Technology with 3D Models Application.

		
Group 1	Group 2	Group 3

3.3 Curriculum Materials & Pilot Test Materials

There were nine modules in a curriculum. We used Module One in the pilot test. It was about *Twelve Zodiacs (Appendix)*, which was integrated with AR technology, bone cards, animal cartoons, 3D animals' models, sound attraction and pronunciation. The goal of this pilot test was to examine the effectiveness of using Augmented Reality (AR) technology with 3D models in motivating primary students to learn Chinese characters and improve learning performance. The curriculum design, user interface (UI) design and user experience (UX) design were produced by the first author. Twelve Zodiacs (Figure 1) were chosen as the content of the curriculum because the application wants to bring out the topic of Chinese culture. Six zodiacs were chosen for this pilot test. The six zodiacs were six Chinese characters to represent six animals in Chinese, including Cow (牛), Sheep (羊), Rabbit (兔), Tiger (虎), Snake (蛇) and Dog (狗). The pre- (Figure 10) and post-test (Figure 11) assessment we used consisted of 1 assessment item with six zodiacs, cow, sheep, rabbit, tiger, snake, and dog.

	
Figure 10. Pre-test	Figure 11. Post-test

4. Findings

4.1 Analysis of learning performance

About *Table 1*, the sample size of each group was ten students. The full scores of each test were 6. The average pre-test scores of Group 1 were 5.8. The average pre-test scores of Group 2 were 5.9. The average pre-test scores of Group 3 were 5.0. The average pre-test scores of Group 1 and Group 2 were extremely similar and exhibited a difference of 0.1. The average pre-test scores of Group 1 were quite obvious to Group 3 and exhibited a difference of 0.8.

Table 1: Mean scores, sample size and improvement for pre-test and post-test

Variables	Pre-test	Post-test	Difference	Improvement	Sample Size
	Mean	Mean	Mean	%	N
Group 1	5.8	6.0	0.2	3.45	10

Group 2	5.9	6.0	0.1	1.69	10
Group 3	5.0	5.8	0.8	16	10

After all learning activities were completed, the average post-test scores of Group 1 and Group 2 were 6.0 respectively. The average post-test scores of Group 3 were 5.8. The average post-test scores of Group 1 and Group 2 were the same. The percentage of scores in Group 1 increased by 3.45%. The percentage of scores in Group 2 increased by 1.69%. The percentage of scores in Group 3 increased by 16%. By comparing the improvement of total score gain in three groups, Groups 3 exhibited the most significant improvement after performing the learning activities by the full employment of AR technology with 3D models.

Regarding *Table 2*, the improvement of each character was recorded among all three groups. After the intervention of tutorial guidance, students' learning performance was generally improved. Nevertheless, the non-traditional class achieved considerable progress. For those Chinese characters with more strokes, such as horse (馬), snake (蛇), and dog (狗), the improvement was relatively significant by the employment of AR technology with 3D models. The improvement rate was from 10% to 20%.

Table 2: Chinese Character Recognition Improvement

	Cow 牛	Rabbit 兔	Horse 馬	Snake 蛇	Dog 狗	Sheep 羊
Group 1	--	--	--	+10%	+10%	--
Group 2	+10%	--	--	+10%	+10%	--
Group 3	--	+10%	+20%	+20%	+20%	+10%

4.2 Student Focus Group

All interviewees expressed their endorsement to the technology employed in the pilot test as they found the 3D animal models fantastic. Majority of interviewees mentioned that they have used similar applications to learn English, but they never use to learn Chinese. Moreover, all interviewees were able to tell all the words they learned. For Group 3's interviewees, they could also connect the related features of the words they learnt, such as the animals' sound. It demonstrated that the application could effectively consolidate learners' memories. Students suggested including functions that could show them the common mistakes they made in writing.

4.3 Teacher Focus Group

Teachers agreed that the technology exerted in the lesson could efficiently boost students' learning motivation. Students were keen to finish the writing and listening exercises correctly as they wanted to collect the whole serial of the 3D animal models. The application enabled learners to master the Chinese language in an enjoyable environment. However, teachers raised their concern in using electronic devices during lessons. When students had technical problems in using the application, schools may not have enough technical assistance. Besides, teachers may need to spend extra energy on class discipline to be in order. If the application acts as a supplementary tool for learning, it could effectively tackle the problem of individual learning difference. Furthermore, teachers mentioned the difficulties and insufficient support provided by the school's management team.

5. Conclusion and Discussion

The study reveals that the prototype of this AR learning application enables school children to have a better understanding of the recognition of Chinese characters, thus strengthen the interest of study, concentration, and improvement of Chinese character recognition. The pilot tests provide a satisfactory result on Chinese character recognition. The result supports the fact that Augmented Reality (AR) technology with 3D models could motivate students to learn Chinese characters and improve their learning performance. Both teachers and students provided positive feedback to the 3D animal models as powerful tools to enhance students the learning motivation. No doubt, the larger sample size will be more convincing.

Some teachers prefer using traditional teaching methods in the lesson because it is easier to control the lessons' orders and follow the lesson plan. When teachers adopt electronic devices in teaching, more man-power is needed to control class discipline. Besides, teachers may be easier to lag behind the planned schedule due to individual learning differences. All interviewed teachers agreed that technology could enhance learning efficiency and effectiveness. We still need to discuss how we could take the balance in between. In the future, we will conduct pilot tests with a larger sample size. So, the performance will be more significant. Apart from Chinese character recognition, we will conduct pilot tests in Chinese character writing in future research.

Acknowledgements

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Appendix

Twelve Zodiacs, known as Sheng Xiao, is based on a twelve-year cycle. Each year in that cycle related to an animal sign. These signs in order are the mouse, cow, tiger, rabbit, dragon, snake, horse, sheep, monkey, chicken, dog and pig. It is calculated according to Chinese lunar calendar.

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