The Relationships between Child-Parent Shared Mobile Augmented Reality Picture Book Reading Behaviors and Children's cognitive attainment

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Abstract: Augmented reality (AR) books combining the advantages of physical books with digital content including new interaction possibilities are the one of the noticeable AR media. The application of AR book has been documented its effectiveness for learning, however, studies regarding how users learn in the process of AR book reading is limited. This study selected a mobile AR picture book to examine the relationships between child-parent shared reading behaviors and children's cognitive attainment. The reading behaviors of 33 child-parent pairs participated in this study were video-recorded and the children were interviewed after the activity for understanding their cognitive attainment. Through the correlation analysis, the findings indicated that the more reading and operation (i.e., turning or inspecting the AR book) of the mobile AR picture book the children were involved in, the more cognitive attainment they gained. The parental interaction-oriented behaviors (i.e., commenting, prompting, evaluating, or expanding) were helpful for their children's learning. Another noteworthy issue is that the distraction of the children during the shared reading process was negatively related to their cognitive attainment.

Keywords: augmented reality, picture book, child-parent shard reading, behavioral analysis, cognitive attainment

1. Introduction

The considerable attention of augmented reality (AR) with its technical capability of blending real-time virtual information over users' view of physical world is increasingly paid in education (Wu et al., 2013). AR allows users to transfer seamlessly between the real and virtual world and may create a new learning experience for conveying situational information beyond traditional learning context (Bujak et al., 2013). With the aid of AR, research has indicated its positive supports in science learning such as spatial ability, practical skills, conceptual understanding, and inquiry-based scientific activities (Cheng & Tsai, 2013). Learners could acquire better understanding in terms of physics in an AR system (Enyedy et al., 2012; Lin et al., 2013). It can be hence expected that the pedagogical application of AR probably becomes new learning paradigm (Duh, Klopfer, 2013).

AR books originated from the *MagicBook* (Billinghurst et al., 2001) combine the advantages of physical books with digital content including new interaction possibilities (Dünser, 2008). Researchers indicated that the AR technology may enhance learners' comprehension of book content through the interaction with synthetic information upon the book (Vate-U-Lan, 2012). Although the application of AR book has been documented its effectiveness for learning, studies regarding how users learn in the process of AR book reading is limited. Accordingly, this study selected a mobile AR picture book with artistic introduction, namely "*The adventures of Yuyu: Yuyu Yang artistic journey (published by National Chiao Tung University Press in Taiwan)*," for children and their parents to read together. The exploration of the relationships between child-parent reading behaviors and cognitive attainment of children is the attempts of this study.

2. Method

There were 33 pairs of children and their parents voluntarily participated in this study. The children were aged from 5 to 10 years old (mean=7.85, SD=1.58). They were all in primary school level except 5 children of preschoolers. The parents who ranged in age from 30 to 64 years old (mean=37.91, SD=5.51) generally had had the experience of using smartphones or tablet PCs.

This study invited the children and their parents to freely share the mobile AR picture book reading with an iPad in a pair setting. In the beginning of the activity, the reading process and the usage of the book were briefly instructed by a researcher. The entire reading process was videotaped for exploring the operation behaviors between children and their parents. When the activity finished, each child was interviewed for understanding their cognitive attainment regarding the content of the book. This study conducted quantitative content analysis to examine the video data (coding the behaviors in 5 second time slots) and the interview data of the children. A total of 7,468 coded behaviors of the children and parents were yielded; and 160 codes are classified as low level cognitive attainment and 47 codes are classified as high level cognitive attainment. Through the correlation analysis with the results of the frequency generated from the content analysis, the relationships between child-parent reading behaviors and cognitive attainment of children could be understood.

3. Results

After conducting the Pearson correlation analysis, Table 1 shows that the low level cognitive attainment (simply describing the appearance of the artistic work) of the children was related to the parents' behaviors of commenting ($r=0.54$, $p<0.01$) and raising prompts or questions ($r=0.38$, $p<0.05$) on the details of the AR book and further evaluating their children's responses ($r=0.38$, $p<0.05$). Similarly, in addition to the relationships between and the commenting ($r=0.43$, $p<0.05$), prompting ($r=0.49$, $p<0.01$), and evaluating ($r=0.45$, $p<0.01$) behaviors of the parents and the high level cognitive attainment of the children, it is interesting to note that the children were inclined to explain or create the imagination to describe the content of the AR book or the AR artistic work (high level cognitive attainment) when their parents provided additional information about the AR book for expanding the children's responses ($r=0.54$, $p<0.01$).

Table 1: The correlations between parent reading behaviors and cognitive attainment

	Low level cognitive attainment	High level cognitive attainment
Parent narrates the book for the child	-0.20	-0.11
Parent points at the book	0.11	0.04
Parent comments on the book	0.54**	0.43*
Parent prompts on the book	0.38*	0.49**
Parent evaluates the child's responses	0.38*	0.45**
Parent expands the child's responses	0.32	0.54**
Parent controls the AR book	-0.22	-0.21
Parent turns the AR book	-0.10	0.13
Parent disciplines the child	-0.17	-0.15

** $p<0.01$, * $p<0.05$

As shown in Table 2, the children's behaviors of reading themselves ($r=0.52$, $p<0.01$), turning ($r=0.64$, $p<0.01$), and inspecting ($r=0.50$, $p<0.01$) the AR book were linked to their low level cognitive attainment. However, according to Table 1, the narration and operation behaviors of the parents were not associated with the children's learning outcomes. The findings may imply the importance of the reading and operation of the mobile AR picture book by the children themselves rather than their parents. Moreover, the children's cognitive attainment had relationships with their behaviors of commenting on the AR book ($r=0.47$, $p<0.01$ for low level; $r=0.35$, $p<0.05$ for high level) and responding to their parents' prompts ($r=0.50$, $p<0.01$ for low level; $r=0.49$, $p<0.01$ for high level). Compared with the results in Table 1, this study considers that the children may be benefited when their

parents showed more interaction-oriented behaviors and they could show more tendencies to respond to their parents accordingly. In addition, the behaviors of losing focus on the AR book by the children were negatively related to their cognitive attainment (r=-0.53, p<0.01 for low level; r=-0.36, p<0.05 for high level). As a result, the distraction of the children during the child-parent shared mobile AR book reading process should be a noteworthy issue.

Table 2: The correlations between children reading behaviors and cognitive attainment

	Low level cognitive attainment	High level cognitive attainment
Child read himself/herself	0.52**	0.20
Child points at the book	0.31	-0.08
Child comments on the book	0.47**	0.35*
Child questions about the book	0.16	-0.08
Child responds to parent's prompts	0.50**	0.49**
Child controls the AR book	0.21	0.10
Child turns the AR book	0.64**	0.43*
Child inspects the AR elements	0.50**	0.19
Child intervenes in parent's operation	-0.16	-0.12
Child is distracted	-0.53**	-0.36*

** p<0.01, * p<0.05

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