

# THE POTENTIAL OF AUGMENTED REALITY BOOKS TO INFLUENCE READING ATTITUDES OF 8-9 YEAR-OLD CHILDREN: AN EXPLORATORY STUDY

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## Abstract

Augmented reality (AR) is a fast growing field in entertainment, and more recently in education. Augmented reality books merge traditional text with digital content using technologies such as a smartphone or tablet combined with the use of an app which plays video, and allows for interaction with the text. AR books show potential for creating a more motivating and engaging reading experience, especially for young, struggling readers. But to what extent can AR books affect young children's reading attitudes?

Recent research focused on AR books in relation to reading skills, cognitive load, motivation, and attitudes, and children's and parents' behavioral patterns. A research gap was identified in relation to the examination of the potential effect of AR on the reading attitudes and habits of young children. This exploratory case-study attempted to address this gap.

Participants included 30 children (16 boys, 14 girls) aged 8-9 years old, with no prior experience with AR, selected through convenience sampling. Children first completed a reading attitudes questionnaire, of 5 statements in 10-point likert-scale. They then individually interacted with an AR book about "the world's famous landmarks" and a tablet or smart-phone. A researcher completed field-notes. Children finally completed a "reading attitudes in relation to AR books questionnaire", of 8 statements in 10-point likert-scale.

Results of the quantitative data analysis showed that prior to the AR experience, children in general had positive attitudes towards reading ( $M=8.35$  out of 10,  $SD=1.63$ ,  $N=30$ ) and considered themselves good in reading ( $M=8.27$ ,  $SD=2.43$ ,  $N=30$ ). Approximately one in three children reported that they read books daily (33.3%, 10/30), often (30%, 9/30) or sometimes (36.7%, 11/30). After their first reading experience of an AR book, children in general had positive attitudes towards AR ( $M=8.11$ ,  $SD=1.09$ ,  $N=30$ ). More specifically, they liked reading an AR book ( $M=8.97$ ,  $SD=1.52$ ) and enjoyed using the tablet while reading the AR book ( $M=9.53$ ,  $SD=1.38$ ) at a great extent. They also reported that they would read books more often if those books were AR books ( $M=9$ ,  $SD=1.66$ ). Nine-year-old children indicated a statistically significant ( $t=-2.15$ ,  $DF=28$ ,  $p=0.04$ ) stronger preference towards obtaining an AR book ( $M=8.5$ ,  $SD=2.06$ ) compared to 8-year-olds ( $M=6.6$ ,  $SD=2.82$ ).

The qualitative data analysis of field notes resulted in the classification of children in four types of readers: a) enthusiastic with reading but not with AR (40%, 12/30), b) enthusiastic with AR but not with reading (33.3%, 10/30), c) enthusiastic with both AR and reading (23.3%, 7/30), and d) showing no interest in reading nor AR (3.3%, 1/30).

The quantitative data analysis of this study provided a strong indication that 8-9-year-old children who already have positive attitudes towards reading, enjoy reading an AR book. Children also claim that they would read books more often if those were AR books. However, qualitative data analysis revealed that an important percentage of children (40%, 12/30) seem to prefer "traditional reading" compared to "reading enhanced with the AR experience".

Future studies that will examine the connection between AR and reading attitudes in young children should be longitudinal and focus specifically on struggling readers or children with negative attitudes towards reading.

Keywords: augmented reality (AR), young children, reading, attitudes.

## 1 INTRODUCTION

Augmented reality (AR) is a fast growing field in entertainment, and more recently in education. Augmented reality books are a subset of this field, as they merge traditional text with digital content using technologies such as a smartphone or tablet combined with the use of an app which plays video, and allows for interaction with the text. AR books allow the user to see and manipulate virtual 3D objects in a real environment [1]. Simulations, 3D graphics, interactive representations, cartoons add additional textual and visual characteristics invite readers to explore and interact with their pages. AR does not only refer to books, it also refers to tabletops, which also contribute to supporting and enhancing learning, reading and collaboration among children [2]. Educators who take advantage of the AR dynamic expect a better and deeper student understanding of complicated content as students have the capability of actively managing, manipulating and exploring content [1].

According to Garcia-Sanchez (2017) [3], data suggests there is a global reduction in the number of readers, and a decreasing amount of time spent on reading. The primary reasons for this falling performance is the lack of time to read and the lack of motivation. Augmented reality shows a promising potential to increase literacy as it fosters cognitive attainment and has a positive impact on overall learning effectiveness. Augmented reality technology contributes to increasing engagement, invites participation, and develops appreciation of the context. Augmented reality books are therefore proposed to incentivize curiosity, facilitate the interpretation of text and illustrations, and provide a learning tool that relates to the reader skills [3].

The Horizon Report [4] has shown AR for learning as a soon-to-be-adopted technology. AR books show potential for creating an immersive, more motivating and more engaging way of reading, especially for young, struggling readers. But to what extent can AR books affect young children's reading attitudes?

## 2 LITERATURE REVIEW

AR technology is not considered mature enough yet, therefore there is a gap between the capabilities of AR applications, their advantages, their use and the research methodology that is adopted for their evaluation [5]. In agreement with Bacca et al. (2014) [5] is the research of Yuen, Yaoyuneyong and Johnson (2011) [6], in which it is argued that AR is in an embryotic stage with respect to educational applications. However, despite some reported reservations, the connection of AR with education is a topic for which there is a growing interest in the research community in the last years. There seems to be a need for more research on the impact of e-books, AR books, and other digital media on the reading behaviors of diverse learners of all ages [7].

In general, AR applications seem to have a positive effect on learning [8]. In their meta-analysis, Yilmaz and Batdi (2016) [9] found the effect size of AR applications on academic success to be  $ES = +0.360$ , a rather small effect, while their thematic assessment showed that AR applications have a positive effect on social, cognitive and emotional improvement and they can make the learning environment more realistic.

Recent research on AR books in particular has focused on the use of this technology in relation to reading comprehension [10], reading skills [3], cognitive load, motivation, and attitudes [11], and children's and parents' behavioral patterns [12, 13]. Most research focused on higher education [11] rather than on young children and several studies used a combination of AR with another technology or approach, for example game-based learning [10] or experiential learning (Huand et al., 2016). To the best of the authors' knowledge, no studies were identified that focused on AR books and the reading attitudes of young children.

Tobar-Muñoz et al. (2017) [10] focused on AR and reading comprehension, using a methodology that combined augmented reality and game-based learning. They explored the extent to which the use of augmented reality games in the classroom benefits students in terms of performance and motivation and the extent to which the reading activity is enriched through AR and game-based learning to promote reading comprehension. They developed an augmented reality game using a design-based research approach and tested it in a real classroom, using dyads of 6<sup>th</sup> grade children. Their findings showed that while results in reading comprehension using the game showed no difference compared to results from the more traditional approaches, children displayed greater motivation and interest in

the activity and the activity was enriched as it promoted problem solving, exploration, and socialization behavior. However, it is important to note that the results of this study cannot be attributed to AR only, as a combination of AR and game-based learning approach was used.

As research on the effect of AR books is still in its infancy, there are several ongoing initiatives for which results are not yet published. For example, Garcia-Sanchez (2017) [3] describes an ongoing Mexican national textbook publishing program that attempts to improve educational outcomes with respect to literacy by using augmented reality in order to provide complementary digital learning experiences to the printed content that give readers the advantage of two media. The study will examine the effect of AR books on children's reading, vocabulary, pronunciation, grammatical rules and writing. With respect to the affordances of AR technology for reading skills, according to the author, the students would not only read how and where the characters live, but they would also have an immersive experience with videos and animations showing their towns, homes and main historical sites in detail. Therefore, it is expected that AR will provide a richer context about particular social groups and will facilitate reading comprehension for 4<sup>th</sup> grade students. However, results from this study are not yet published [3].

In the context of higher education, Cheng (2017) [11] focused on the investigation of undergraduate students' learning experiences with AR in an attempt to help educators to implement AR learning. In his quantitative survey using three questionnaires, he explored the relationships among 153 students' perceived cognitive load, motivation, and attitudes of perceived control, perceived usefulness, behaviour of learning, and behaviour of AR learning, when they engaged in an AR book reading activity. The results indicated that, in general, the students perceived less cognitive load, stronger motivation, and more positive attitudes towards the experiences when reading an AR book. Cheng (2017) [11] also reported that motivation mediated the relationships between the students' perceived cognitive load and behavioural intention to learn. Perceptions of motivational factors that played a role in the students' behavioral intentions to take part in future AR learning included attention and confidence.

Cheng and Tsai (2016) [13] approached AR book reading from a different perspective as they focused on the interaction involved in child-parent shared book reading and explored how children and parents read an AR picture book through a series of analyses of behavioral patterns and cognitive attainment. Thirty-three (33) child-parent pairs participated in the study. Participating children ranged in age from 5 to 10 years old ( $M=7.85$  years old,  $SD=1.58$ ). Only 5 children were preschoolers, whereas the others were all elementary school students. Cheng and Tsai (2016) [13] identified four patterns of AR picture book reading: parent as dominator, child as dominator, communicative child-parent pair, and low communicative child-parent pair. They then examined the relationships between the child-parent reading behaviors and the children's cognitive attainment and identified that the child-parent behaviors of "parent as dominator" and "low communicative child-parent pair" were associated with low-level cognitive attainment while the "child as dominator" and "communicative child-parent pair" behaviors resulted in high level cognitive attainment.

A research gap was identified in the literature in relation to the examination of the potential effect of AR on the reading attitudes of young children. Some argue that children inherently enjoy reading books. Others argue that technological advancements are an impediment to the learning process and push children away from books. What happens though when technology is combined with books? What happens when children interact with AR? Does this affect their relationship with books and if yes, in what way? This exploratory case-study attempted to address the following research question: What are young children's reading attitudes in relation to AR books?

### **3 METHODOLOGY**

#### **3.1 Research question**

What are young children's (8-9 year-olds) reading attitudes in relation to AR books?

#### **3.2 Participants**

Participants included 30 children (16 boys and 14 girls) aged 8-9 years old (10 8-year-old children and 20 9-year-old children) identified through convenience sampling who interacted with an AR book focusing on the world's most famous landmarks, and a tablet or smart phone. None of the children had

any prior experience with AR. The initial sample included 32 children but two of them were excluded because they did not successfully complete the research procedure.

The cover of the AR book that was used in the study, titled “Young explorers and the world’s famous landmarks”, which is written in greek, targets children aged 7-14 and was first published in 2016, is shown in Figure 1.



Figure 1. Cover of the AR book that was used in the study

### 3.3 Data sources and context of the study

There were three data sources in the study:

- a) a questionnaire examining children’s reading attitudes and reading habits,
- b) the researchers’ field notes, and
- c) a questionnaire examining children’s reading attitudes in relation to AR books.

The first data source was a questionnaire examining children’s reading attitudes and reading habits, which consisted of 5 statements, and was completed at the beginning of the study. Two questions referred to the extent to which children enjoy a) reading books from school when they take them home and b) reading books they have at home. They used a 10-point likert-scale, in which 1 represented “does not apply to me at all” and 10 represented “I enjoy that very much”. The third question was a self-evaluation, according to which children evaluated their reading ability on a scale of 1 to 10. The fourth question examined the frequency with which children read books they have at home (with a scale of “never”, “sometimes”, “often”, “every day”) and the fifth question examined the frequency with which parents bought books for them (with a scale of “never”, “sometimes”, “often”).

After completing this questionnaire, children individually interacted with the AR book with a researcher (one of the four first authors) who acted as a facilitator, followed a protocol so that she would not intervene unless it was considered necessary and completed field-notes, which constituted the second data source of the study. Children finally completed a questionnaire examining their reading attitudes in relation to AR books, the third data source of the study, which consisted of 8 statements in 10-point likert-scale, in which 1 represented “does not apply to me at all” and 10 represented “I enjoyed it very much or I’d like that very much”.

These statements were the following:

1. I enjoyed reading an AR book.
2. I enjoyed using a tablet with the book.
3. I'd like to read the same story without a tablet.
4. I'd like it if the school library included AR books
5. I'd like to read books more often if those were AR books.
6. I'd like Santa to bring me an AR book as a present.
7. I'd like my parents to buy an AR book for me.
8. I'd like to read more AR books from this series.

### 3.4 Data analysis

Quantitative data were input in a program for statistical analysis (SPSS24.0). One negatively phrased question (question 3: I'd like to read the same story *without* a tablet) was reversed. Children's responses to the 8 statements that measured their attitudes towards reading AR books were then added so that a mean score could be calculated.

The researchers' field notes were analyzed qualitatively, using codes such as: "excitement for AR", "ignoring AR", "expressing desire to read", "denying to read". "Excitement for AR" was coded when expressions such as "wow!" were used by children, or when children clearly showed an interest in checking out the next AR images of the book by skipping the text that preceded them. "Ignoring AR" was coded when children skipped AR images and chose to proceed with reading the text that followed them, without therefore interacting with AR images. "Expressing desire to read" was coded when children reached the end of a page and then continued reading without being prompted to do so or when children chose to read and answered positively when they were asked by the researcher if they would like to continue reading. "Denying to read" was coded when children were preoccupied with AR images and answered negatively when they were asked by the researcher if they would like to continue reading.

## 4 RESULTS

Results showed that prior to the AR experience, children in general had positive attitudes towards reading ( $M=8.35$  out of 10,  $SD=1.63$ ,  $N=30$ ) and considered themselves good in reading ( $M=8.27$ ,  $SD=2.43$ ,  $N=30$ ). Approximately one in three children reported that they read books daily (33.3%, 10/30), often (30%, 9/30) or sometimes (36.7%, 11/30). The vast majority of children (93.4%, 19/30) reported that their parents either sometimes (56.7%, 17/30) or often (36.7%, 11/30) buy books for them.

After their first reading experience of an AR book, children in general had positive attitudes towards AR ( $M=8.11$ ,  $SD=1.09$ ,  $N=30$ ). More specifically, they liked reading an AR book ( $M=8.97$ ,  $SD=1.52$ ) and enjoyed using the tablet while reading the AR book ( $M=9.53$ ,  $SD=1.38$ ) at a great extent. They also reported that they would like to read more books of the same series ( $M=9.2$ ,  $SD=1.6$ ), and that they would read books more often if those books were AR books ( $M=9$ ,  $SD=1.66$ ). There were no statistically significant differences between boys and girls or between 8 and 9-year-olds in these results, with the exception of 9-year-olds indicating a statistically significant ( $t=-2.15$ ,  $DF=28$ ,  $p=0.04$ ) stronger preference towards obtaining an AR book ( $M=8.5$ ,  $SD=2.06$ ) compared to 8-year-olds ( $M=6.6$ ,  $SD=2.82$ ).

The qualitative data analysis of field notes resulted in the classification of children in four types of readers: a) enthusiastic with reading but not with AR (40%, 12/30), b) enthusiastic with AR but not with reading (33.3%, 10/30), c) enthusiastic with both AR and reading (23.3%, 7/30), and d) showing no interest in reading nor AR (3.3%, 1/30).

## **5 DISCUSSION**

The quantitative data analysis of this study provided a strong indication that 8-9-year-old children who already have positive attitudes towards reading tend to enjoy their first experience with reading an AR book, report that they would like to read more AR books and claim that they would read books more often if they were AR books. This finding is in accordance with previous studies that documented greater motivation and interest in the activity when the latter involved AR [10] and with studies conducted with undergraduate students that documented stronger motivation, and more positive attitudes towards the learning experience when reading an AR book [11].

However, the qualitative data analysis of this study revealed that a rather high percentage of children (40%, 12/30) seemed to prefer reading compared to reading enhanced with the AR experience. Future studies that will examine the connection between AR and reading attitudes in young children should be longitudinal and focus specifically on struggling readers or children with negative attitudes towards reading. It is also preferable for future studies that will be conducted with young children as participants to also involve their parents, given the importance of their mediating role, especially of young children's extra-curricular reading activities.

### **5.1 Limitations**

Some of the most important limitations of the study refer to the small sample size ( $n=30$ ), the sampling procedure that was used (convenience sampling), and the lack of a control group, which are limitations that do not allow generalizability of results. Additional limitations refer to the small duration of the study, which did not allow to examine children's reading attitudes over time, and the limited exposure of children to AR books, which did not exceed 20 minutes per child. As all children had their very first experience with AR in the context of this study, this might have contributed to a novelty effect, the tendency for performance or attitudes to initially improve when new technology is instituted, not because of any actual improvement in learning or achievement, but in response to increased interest in the new technology. To control for the novelty effect, it would have been better if children familiarized themselves with AR technology prior to the data collection phase of the study.

### **5.2 Directions for future research**

The findings of this case study showed that children who already have positive attitudes towards reading tend to enjoy their first experience with reading an AR book, report that they would like to read more AR books and suggest that they would read books more often if they were AR books. Due to an inconsistency between the findings from quantitative and qualitative data analysis described in the results section, further research involving young children and their parents should attempt to examine the accuracy of the statements that were made by children with regard to their reading attitudes and habits, especially over time.

Future studies that will examine the connection between AR and reading attitudes in young children should be longitudinal to avoid novelty effects, include a control group, focus specifically on struggling readers or children with negative attitudes towards reading, and preferably include their parents or teachers as participants as well.

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