ABC3D - Using An Augmented Reality Mobile Game to Enhance Literacy in Early Childhood

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Abstract:

This paper presents a work-in-progress project detailing a novel augmented reality game designed to enhance preschool-aged children's knowledge of print-based literacy. National testing scores suggest children struggle with aspects of literacy in later grades. With the rise of videogames as popular entertainment and the potential of augmented reality to present unique affordances for learning, these factors suggest a confluence deserving of investigation. We present ABC3D, a custom-deigned augmented reality (AR) mobile game that harnesses the motivating power of interest and the affordances of augmented reality to engage children in practicing print-based literacy. ABC3D is bimodal, consisting of 1) a "scanning" mode which allows children to scan drawn letters and view 3D images of content starting with the same letter and 2) a "vehicle" mode which tasks children with collecting objects starting with certain letters as specified by software or instructor. Future work involves further polishing of the software, implementation of audio pronunciation and eventual user testing.

I. Introduction:

Literacy is essential to functioning in modern Western society. It has undergone a few substantial evolutions in research literature, transforming from a monolithic model of simply encoding and decoding to a spectrum that includes not only the reading and writing of print-based literature but the multimodal, participatory practices that are emerging from the "new literacies" brought about by the Internet [17]. While the concept of literacy has certainly expanded, print based encoding and decoding nonetheless remains an important component, especially in early childhood [4]. Tehcnology in the early childhood classroom seems poised to provide potential solutions - a study of 297 early education teachers found that around 80% of preschool classrooms had computers [6]. Unfortunately, the body of research surrounding early childhood literacy and technology is still lacking [5].

There is compelling evidence that suggests our children today are struggling with reading and reading comprehension. According to data from the National Assessment for Educational Progress (NAEP), 64% of fourth-graders have reading scores that are designated as below "Proficient" [23]. One potential way to increase reading performance and comprehension is to get children interested in reading more [9]. Interest has been shown to be a significant form of motivation in the completion of tasks [10]. The skyrocketing popularity of video games [22] suggests video games may be a way to tap into children's interests and promote reading. Augmented reality (AR) is poised to be an interesting and powerful tool for education, and its usage in early childhood education is ripe for investigation. In this paper, we present a novel educational, mobile game that utilizes AR to encourage young children to practice techniques to improve reading comprehension.

II. Related Work/Literature:

We utilize the concept of "considerate" texts [1] as a metric to guide our implementation of functionality. The construct of "considerate texts" is applied by Linda Labbo and Melanie Kuhn [13] as a way to examine parts of a CD-ROM that support children in creating stronger "chains of cognition" as they develop an understanding of what they read, versus "inconsiderate" parts which distract.

Eric Klopfer and Kurt Squire [20] established a definition of augmented reality as "a situation in which a real world context is dynamically overlaid with coherent location or context sensitive virtual information". Wu et. al's review of the AR literature [25] demonstrates that AR possesses affordances useful to education such as being able to view content in 3D and experience lessons in a situated context.

Klopfer and Squire's studies with AR [20] support the idea that AR can be used to provide students with a situated learning experience as opposed to the "skill and drill" experiences that abstract the learning away from its usage. Their work developing the game Environmental Detectives offered support for AR allowing situated experiences that might otherwise be dangerous, expensive or impractical. Kerwalla, Luckin, Seljeflot and Wollard studied children and their interaction with AR in class using a "virtual mirror" interface [11] of the earth and sun's rotation. This interface invovles users standing in front of a monitor equipped with a camera while holding a special card. The card is recognized by the AR system and the 3D image is drawn on screen on top of the card. While students showed positive interaction and enjoyed the technology, the AR implementation was fairly limited and teachers regulated the children to a passive role. The aforementioned studies were conducted with upper elementary students; our project proposes an extension to study AR interactions in early childhood.

The rise of video games as a legitimate and popular form of entertainment has prompted a parallel academic interest.

Games as an area of interest for scholars has been championed by researchers such as James Gee [8] and Jonathan Alexander, who assert that gaming involves a "complex use of multiple modes of writing" and a "variety of complex literacy skills"[1]. A study by Steinkeuhler showed video games touch on the important component of interest and can be used to catalyze literacy practices that often emerge surrounding games[21]. While this study was conducted with older and only male students (the aforementioned Pew study shows a clear gender difference in reading performance), we believe it lends precedence to the idea of interest generated by games and the potential for games to act as literacy facilitators.

III. Project Design

In order to enhance the reading ability of children, we propose to design a mobile game to attract children to play, and drive them to learn. In our game, we first design a vocabulary list. Each entry of the vocabulary list contains a letter, a word, and a 3D module which is used for the AR display. One entry sample is described as below:

Letter	Word	Module Idx
'A'	'Apple'	Module_Apple
'T'	'Tree'	Module_Tree
…	…	…

Our game is designed in two modules: a letter recognition and an object collection game module. In the following sections, we will discuss the design of these two modules respectively.

A. Letter Recognition Module

The purpose of the letter recognition module is to drive the user to read and write letters by giving a visual representation of an item associated with that letter. The user will first write down a single, capital letter. The user[s] will then scan the letter through the mobile device's camera. The system will then display the letter's corresponding model in AR space. Next to the model, a text spelling of the object will appear. By providing the user with a visual context, we believe the user's interest will be stimulated, motivating them to pursue more independent action. To further tap into this interest, we have developed an accompanying game module to reinforce the context from the first module.

B. Object Collection Game Module

In this module, we store the objects generated in the first module into a list. For example, if the user scanned the letter "T" and the system displayed a "tree" model, the game would store the tree object in a list. The objects from the list will populate the game world, along with a several other randomly selected objects. The player will be tasked with collecting objects they had scanned in from the first module. We anticipate that adding a game element that interacts with objects from the first module will enhance engagement and reinforce interest in exploring more vocabulary.

IV. Implementation

We will discuss the implementation of ABC3D in the following sections:

A. UI and Game Mechanics

At the start of the application, the player will be placed at a start screen with two options, "Learn" and "Exit." Upon pressing the exit button, the player will be taken back to the device's main menu. Upon pressing the learn button, the player will progress to the scan menu. There, they will be prompted to scan a capital letter, ideally one written by the player. A map of the UI layout can be seen in Fig. 1.

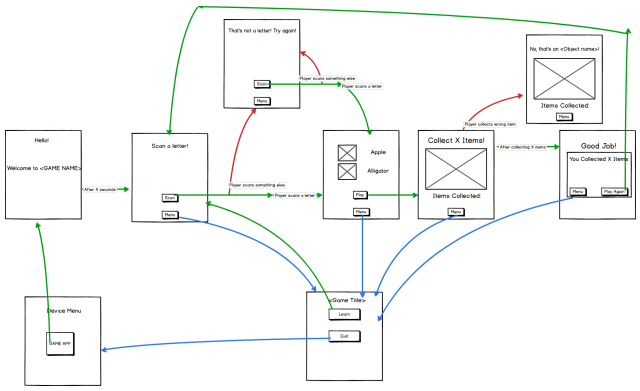

Fig.1 A mockup for the game UI

B. Recognition with AR

At the scan screen, the system will scan in the capital letter, and generate a list of objects that start with the scanned letter. The objects will be rendered in AR space along with a text name. From there the player will be presented with a "play" button at which point they will be transferred to the object collection game proper.

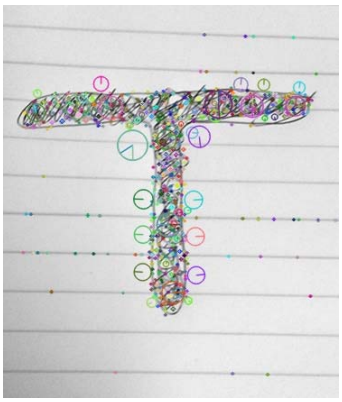

Fig.2 Sift feature visualization

During the scanning process, the the system will first extract visual features from images. In our project, we choose to use the Scale Invariant Feature Transformation(SIFT)[24] technique, a widely used, robust

visual technique. We compiled several letter templates in our system and extracted the respective features of each template; the vizualization of the features of a template is shown in Fig. 2. When a letter is scanned, we pair match the letter features to the features in the templates and define the best match as the recognized letter.

We used Unity 3D to create our Augmented Reality software. For image processing, we used the Vuforia 5 SDK.The device camera will scan the letter and parse it through the Vuforia text recognition library. The game will then compare the information with a cloud database and retrieve the appropriate item name (such as "tree" for T).

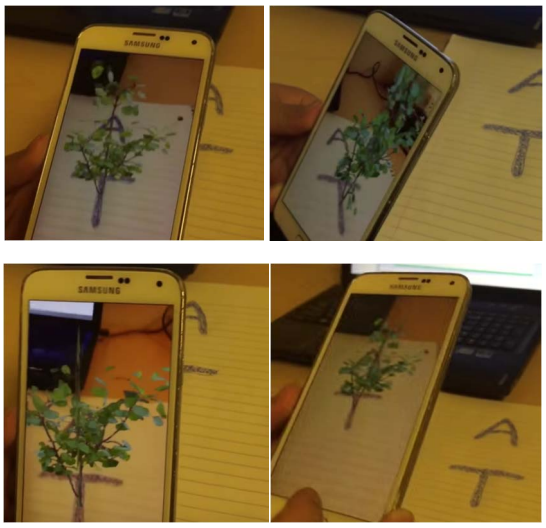

Fig.3 A running example of the AR software

After the letter is identified, the next step is to overlay it with our AR element. The Unity 3D game design engine can easily integrate AR components into a mobile interface. As seen in Fig. 3, our application successfully detected the location of the written letter "T". The AR module also displays the model statically; the image positioning and orientation stayed constant despite testing several different viewing angles and lightning conditions.

C. Object Collection Game

Based on what items were scanned within the AR portion, the player will be prompted to collect a certain number of items in the game portion. The player will be placed within a bounded world as a car and will collect items by touching them. Whenever a player collects the correct item, a counter on the UI will increment. Whenever a player collects an incorrect item, the game will notify the player with the message "No, that is a [item name]." Upon collecting all the required items, the player will be presented with a victory screen at which point they may choose to return to the main menu or scan another letter.

Fig.4 Player (Tank) approaching to collect the car

Fig.5 Player collected the car and score is incremented

V. Future Work

As a future design, we plan to implement a "read" button, which will pronounce the name of the object that is being displayed. Another future implementation is a button labeled "show another object" which would allow a user to cycle through several models beginning with a corresponding letter such as "turtle" or "tree" for the letter "T." All models will be displayed in AR space and have an accompanying pronunciation audio. We also intend to expand the amount of objects in our 3D library and animate the 3D models to further enhance user interest.

Future versions will have enhanced functionality. The user will have control over the level of vocabulary complexity active in the learning phase. For example, a three-year-old scanning the letter "A" will trigger "apple", while for a five-year-old the same "A" will bring out "Alligator". We also want to have an interface where the teacher or parents of the user can load in certain vocabulary, so that ABC3D can be integrated into users' everyday education.

We want to carry out a user study with three to five-year-olds and their parents. The subjects will be balanced both on gender and current literacy level. We will have one group of subjects using ABC3D and the other group using traditional education methods like books. We will measure and compare 1) subjects' improvement in their level of literacy, and 2) their motivation and interest in continuing to learn.

VI. Conclusion

Our approach draws upon Hidi's concept of interest as a motivational variable for learning [10]. ABC3D is consistent with Labbo and Kuhn's work as it creates cognitive chains by capturing user interest through a process of constant, self-sustaining engagement [13]. Our system highlights the exploration of trends within and technology as agents of education. With the expansion of technological accessibility in classrooms [5] we propose ABC3D explores a new medium from which to approach education, both from the platforms of interactive media and the situated experiences of augmented reality.

VII. References

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