

# Educational Folktale E-book with Collage Illustratable Tool

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**Abstract.** It is always challenging to teach children foreign languages, due to the difficulty of learning and their short attention span. To address the challenge and take advantage of the popularity of touchable tablets and smartphones, we propose an educational folktale e-book (EFE-Book) application with an interactive illustratable tool. EFE-Book is developed to teach pre-school children to learn foreign languages by telling folktales with illustrations. To encourage effective learning, EFE-Book provides an interactive collage tool that enables users to create collage-based illustrations by hand. To implement this, we propose a paper tile modeling method based on the Voronoi diagram. With EFE-Book, the user can create coloured paper tiles and attach them to the predesigned sketch through touch interface, such as Apple iPad.

**Keywords:** Mobile · E-learning · E-book · Collage · Stylization

## 1 Introduction

Many mobile applications in various fields such as games, e-books and e-learning have been developed in recent years, thanks to the advancement of mobile technology. Touchable screens are now widely used for display devices such as smartphones and tablet PCs, making interaction between users and applications much easier. Many drawing tools are now available through mobile applications, for example converting a photo into an image with artistic styles [2, 8]. In this paper we aim to discuss an educational e-book application which employs an interactive illustratable method. For e-learning applications, interactivity can enhance learning, especially when target users are children. In addition, using suitable stylization techniques can further improve learning.

In this paper, we propose an educational folktale e-book (EFE-Book) suitable pre-school children for learning foreign languages. The EFE-Book by using the collage art technique provides an interactive illustratable tool, thereby making learning foreign languages more effective and enjoyable.

The paper is organized as follows. Section 2, provides an overview of related work in mobile applications for e-learning and collage style rendering. Section 3 provides details of the EFE-Book with interactive illustratable tools. The results are discussed in Sect. 4. Finally, conclusion with a summary of our ideas and our future plans for further developments are discussed in Sect. 5.

## 2 Related Work

Mobile devices have been considered as a good supplementary to support both students and teachers by providing services that facilitate teaching, learning and education related administrative tasks, e-book and e-learning [9]. Jacott [7] explained applications and effectiveness of mobile learning, which provides useful, authoritative and comprehensive guidance for professionals in education. With its wide use and popularity, the smartphone has become a powerful mobile device for e-learning and e-book. In Godwin-Jones's article [4], he explored the state of language learning applications, devices they run on, and how they are developed. Especially for language learning, Mori et al. [11] proposed an interactive e-book application on smartphone. Their application was based on a conversational agent that asks questions or makes comments about the current page, so that these features made the book significantly more interactive and engaging when compared to static e-books.

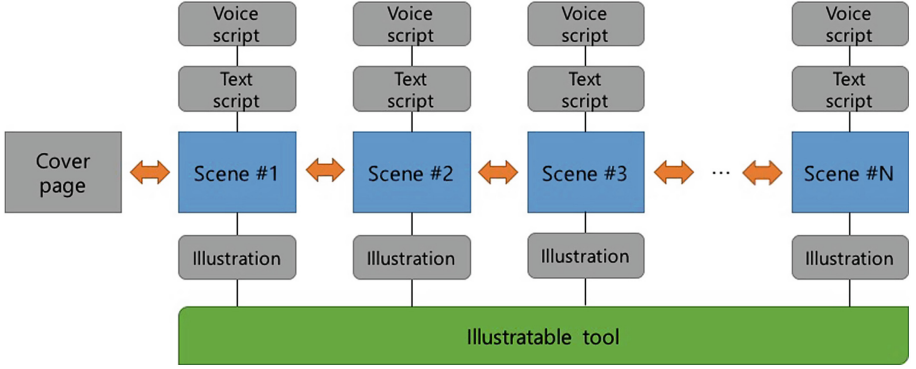
The collage stylization researches based on coloured paper have mainly focused on generating coloured paper tiles and placing them appropriately. Seo et al. [13] proposed a method that converts an input image into a coloured paper mosaic. In their method, the coloured paper tiles are generated by using the Voronoi diagrams [1]. To replicate the torn paper effect, they applied the random midpoint displacement method. Gi et al. [3] proposed a torn simulation-based coloured paper mosaic method. The method tears off paper tiles from given coloured papers, and places them on the most appropriate locations in an image. To locate tiles and minimize gaps and overlaps between tiles, they also proposed an energy function to avoid crossing edges in the image. By minimizing the energy function, a realistic coloured paper mosaic image is generated. In contrast, Han et al. [5] focused on the sequence in which tiles are placed, and proposed a method that sequentially places each tile according to a customizable rule defined by parameters. This method was the first to enable placement of tiles along an edge, or to place tiles that have a similar color to previous tiles, by adjusting the parameters. In this paper we partially employ some of the main ideas of the coloured paper tile stylization proposed in the above studies.

## 3 Development of EFE-Book with Interactive Illustratable Tool for Collage Art

In this section we give an overview of interfaces and functions of our e-book application for foreign language education, and propose an illustratable tool for collage art on the e-book.

### 3.1 The EFE-Book for Preschool Kids Learning Foreign Languages

An overview of the EFE-Book is presented in Fig. 1. The application consists of a cover page and several scenes. Since too many scenes may shorten the span of pre-school children, we limit the length of the scenes to 10. Each scene

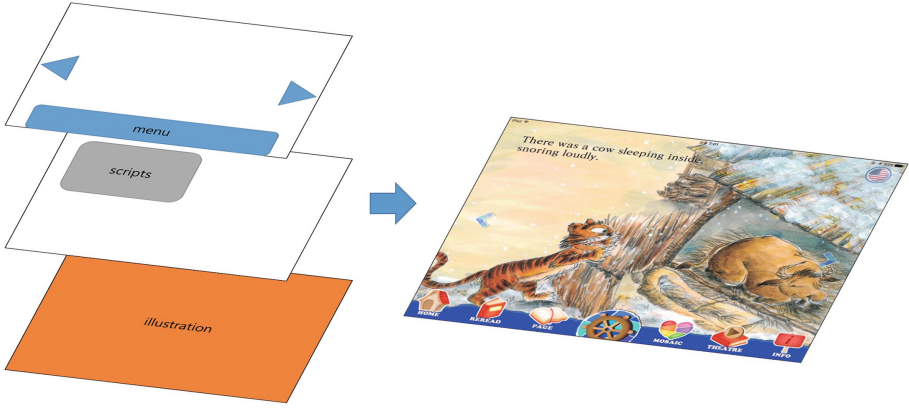


**Fig. 1.** Overview of the EFE-Book. The application consists of illustrated scenes with a short script. At each scene, a script is visually and auditorily played on the illustration. By using a menu on each scene, user can interactively create illustration through the proposed tool for collage art.

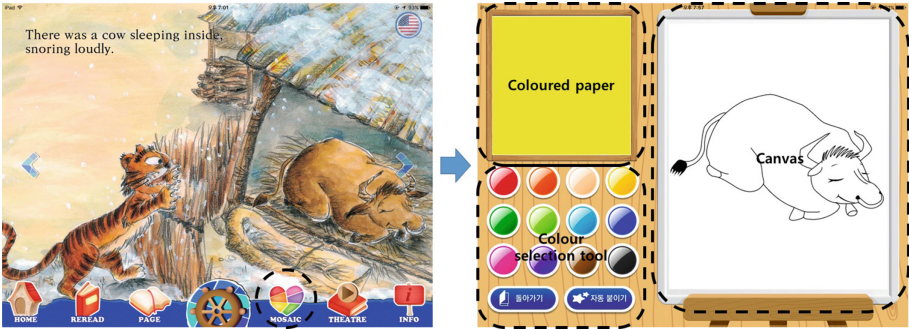
shows a representative illustration with a script which is a tale describing the scene. Figure 2 represents the layers of each scene. On the top layer, a menu bar and navigator buttons are located on the bottom and both sides of the scene, respectively. With navigator buttons, user can move to previous or next scene. The menu bar consists of several functions including replay which restarts the current scene, a table of contents that allows moving to a specific scene, an illustratable tool (more details in Sect. 3.2), and a movie function that plays all the scenes continuously. On the middle layer, a script is placed on a side of a scene. When a user enters a scene, a script is popped up. Then, a voice script is played with background music. At this time, the user may turn off the voice script to concentrate on reading. Moreover, the script can be replaced with another language using a language toggle button on the upper right corner of the scene. The EFE-Book provides scripts (both text and voice) with two languages, English and Korean. On the bottom layer, the illustration fills the entire scene. The illustrations in the EFE-Book are captured from original tale books, so they are static. However, we utilize fade in/out and zoom in/out effects to make the scenes dynamic when user enters each scene. At each scene, the user can create his/her own unique illustration with collage art through an illustratable tool from the menu. The detail of the illustratable tool is described in the next section.

### 3.2 Interactive Illustratable Tool for Collage Art

When a user selects the illustratable tool from the menu bar, the screen changes into the interactive illustratable mode, as shown in Fig. 3. The screen in this mode consists of two panels; a white canvas with a sketch on the right hand side panel, and a coloured paper including a colour selection tool on the left



**Fig. 2.** Three layers of scenes. Menu bar and navigator buttons are located on the top layer; script is located on the middle; and illustration is located on the bottom.



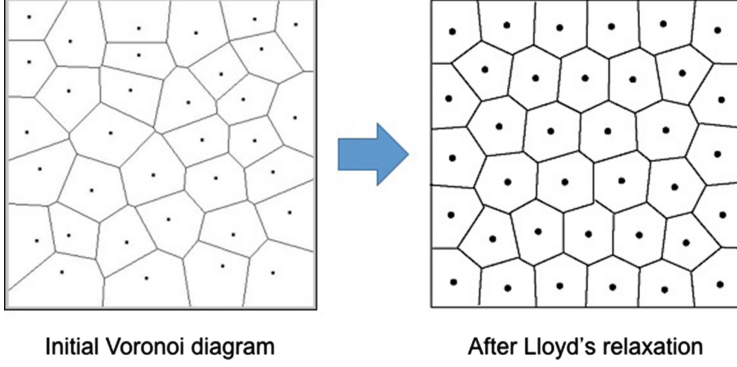
**Fig. 3.** Interactive illustratable mode.

hand panel. On the canvas, the predesigned sketch of an illustrated character is located. The object is not filled with colours, so that user can fill it with coloured paper tiles. When user touches the coloured paper on the left hand panel and drags it to canvas, a small coloured paper tile is torn out from the coloured paper, and moves along to the trajectory of touched finger. Subsequently, the user can attach it to appropriate position on the canvas by keeping dragging. The colour selection tool may be used for changing colours.

**Modeling Coloured Paper Tiles.** When user enters the interactive illustratable mode, the coloured paper on the left panel is pre-divided into many small tiles. To divide the coloured paper into tiles, we employ the Voronoi diagram [6] as shown in Fig. 4. A Voronoi cell  $C_i$  is defined by using its pixel  $c$ , as shown in following equation.

$$C_i = \{c \in C_i | D(c, S_i) < D(c, S_j)\} \text{ for all } j, \quad (1)$$

where  $S_i$  is the site of  $C_i$  and  $D$  is a Euclidean distance function.



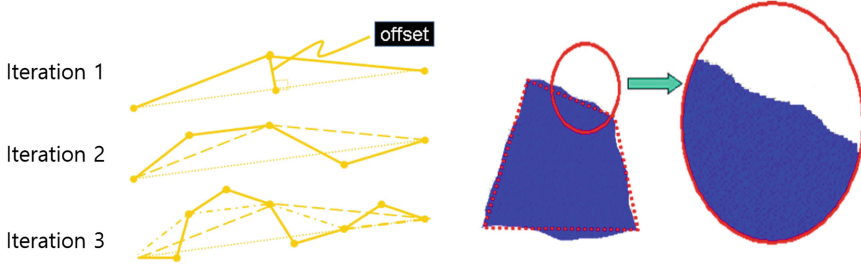
**Fig. 4.** Dividing coloured paper into small tiles with the Voronoi diagram and the Lloyd's relaxation method. Each cell of the Voronoi diagram is used to create coloured paper tiles.

For rectangular coloured paper on the left hand panel, we generate the initial Voronoi diagram by randomly inserting seed points, and relax the distribution of the seed points by using the Lloyd's method [10] to obtain uniform sized Voronoi cells. The coloured paper tiles are then created by converting each cell into polygon and filling them with selected colours. Although the coloured paper is divided into tiles, this is not visible on the panel, as each tile is seamlessly positioned without any gap between tiles.

**Simulating Torn Paper Effect.** In the coloured paper collage art, each tile has unique torn paper effects on their edges. We employ the random midpoint displacement method to simulate the torn effect. On each tile's edge, we select a midpoint, and subdivide the edge into two segments on that midpoint. The midpoint is then randomly displaced along a direction perpendicular to the edge. This is achieved by applying the following equation which calculates the randomly displaced midpoint:

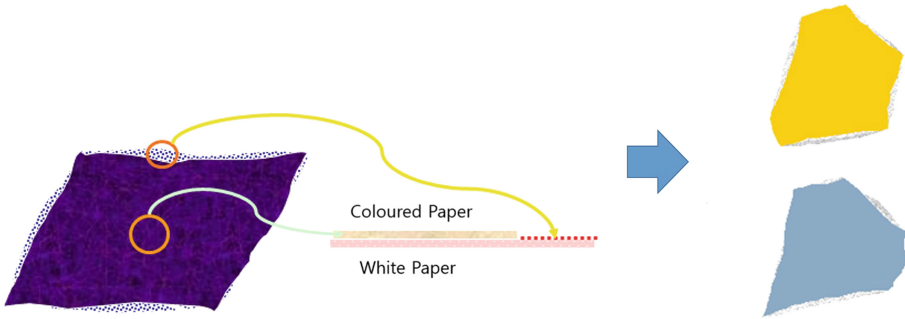
$$f(p_1, p_2) = \frac{1}{2}(p_1 + p_2) + rv_p \quad (2)$$

$$v_p = R_{90} \overrightarrow{p_1 p_2}, R_{90} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad (3)$$



**Fig. 5.** Random midpoint displacement algorithm for torn paper effect.

where  $p_1$  and  $p_2$  are the points on both sides of an edge and  $r$  is a random value within  $[-t : t]$  which adjusts the range of displacement offset. In this study, we use  $t = 0.25$  as the value of  $t$ . Until the subdivided segments reach third iteration, we perform these steps iteratively. This approach generates an irregular torn shape on the edge of tile as shown in Fig. 5. However, in real torn paper, we can observe that the white tissue of paper is revealed. To mimic this effect, under the original Voronoi cell of the tile, we add another white Voronoi polygon which has the same shape with the original cell, and apply the random midpoint displacement algorithm separately. As a result, we can get a torn paper effect similar to that in real torn paper as shown in Fig. 6. When user starts dragging tiles from the coloured paper on the left panel, a torn paper effect is added to the edge of the tile.

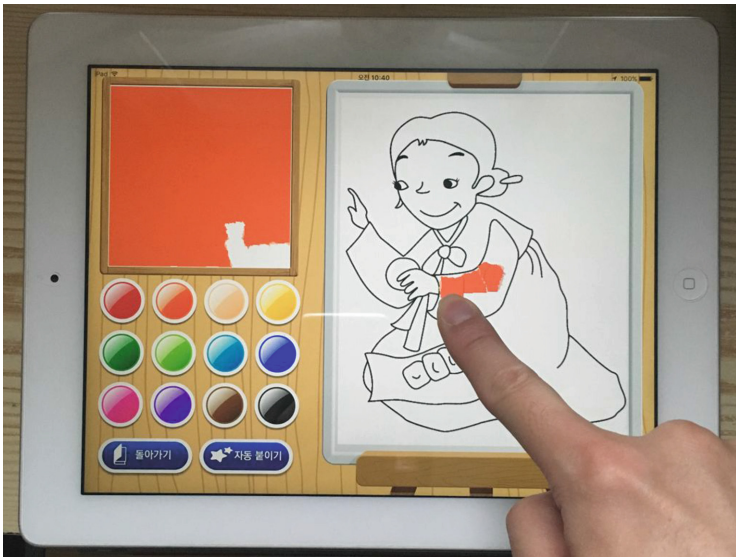


**Fig. 6.** Representation of the realistic torn paper effect. An additional white paper is added under the tile, and the random midpoint displacement algorithm is applied separately.

## 4 Results

We implemented EFE-Book by using OpenGL ES 2.0 [12] on Apple iPad's iOS environment, as shown in Fig. 7.

Figure 8 shows each step of illustration. User can navigate between scenes, and study a folktale with scripts written in a couple of languages including users' native language. Both text scripts and voice scripts are presented or played on each scene, so that user can learn the correct pronunciation of the foreign language such as English. At each scene, user can create illustrations through the illustratable tool. By touching and dragging tiles, the illustration of the paper collage art style can be generated. After the user finishes making collages, the result is displayed on the original scene of the EFE-Book, as shown in the Fig. 8, giving the impression that the user has created the illustration of the book. Figure 9 shows various collage results generated with the EFE-Book.



**Fig. 7.** EFE-Book on Apple iPad.

At the end of the application, we provided a link of webpage for a survey, as illustrated in Fig. 10(a), to evaluate EFE-Book's usability and usefulness. In total 32 users have responded. For the usability, we asked users how easy to use our application was. As shown in Fig. 10(b), most of users responded that our application was relatively easy. For the usefulness, the question is how well our





**Fig. 8.** Procedure of EFE-Book. While reading and listening to the book, user can create illustration through our interactive illustratable tool.

interactive illustratable tool on the EFE-Book helps in attracting children for studying foreign languages. As shown in Fig. 10(c), most of users agreed that the tool was useful for children's learning.





**Fig. 9.** Results generated with the EFE-Book. After the user finishes making collages, the result is displayed on the original scene of EFE-Book.

kids book

우리 아이들 창의력 발달을 위한 모자이크 액션북 작업이 어떠셨나요?

이름  학제당 주소

1. 모자이크 사탕만 제공 시 학생들의 참여에 영향을 미칠까? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

2. 사탕과 사탕을 보충 시킬 수 있는 용접기까지 제공할 계획이신가요? (선택지: 1) 그렇다(전용용, 학생용, 사탕용) 2) 그렇지 않다 3) 모르겠다)

3. 사탕만 제공을 모자이크 액션북 외에 함께 제공할 수 있는 용접기까지 제공할 계획이신가요? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

4. '모자이크 액션북' 제공을 위한 예산을 책정할 계획이신가요? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

5. '모자이크 액션북' 제공을 위한 예산을 책정할 계획이신가요? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

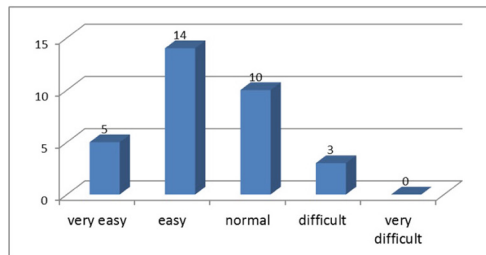
6. '모자이크 액션북' 제공을 위한 예산을 책정할 계획이신가요? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

7. '모자이크 액션북' 제공을 위한 예산을 책정할 계획이신가요? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

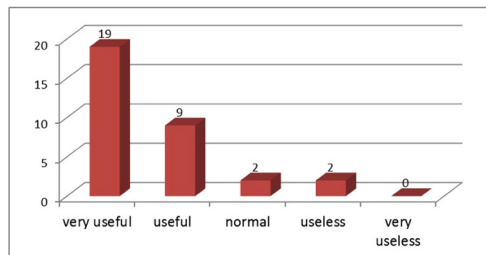
8. '모자이크 액션북' 제공을 위한 예산을 책정할 계획이신가요? (선택지: 1) 그렇다 2) 아니다 3) 모르겠다)

성문형에

(a) Survey form



(b) Results on usability



(c) Results on usefulness

Fig. 10. Evaluation results of a survey on usability and usefulness.

## 5 Conclusion

In this paper we discussed our proposed e-book application (EFF-Book) to teach pre-school children foreign languages using devices such as smartphones or iPads. By utilizing the touch screen, our application provides an interactive illustratable tool for collage art. With folktale contents, our proposed illustratable tool can encourage the pre-school children to concentrate more while learning.

In future work, this will be extended to a book series by implementing a bookcase for additional books. We also intend to evaluate the effectiveness of the EFF-Book application from an educational perspective.

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