User Interface Design Guidelines for Children Mobile Learning Applications

Halimatus Saadiah A. Latiff, Rozilawati Razali, Fatin Filzahti Ismail

Abstract: Mobile learning applications have created new learning opportunities which lead to the transition from traditional learning to modern learning, thus enhancing individuals' learning experiences. Mobile learning applications that come with good and effective user interface allow users to be aware and mindful about the subject matter. This enables users to fully optimise the applications for learning purposes. In order to develop an effective mobile learning application, the user interface should take into account the requirements of its users for mobile learning. Children in particular are immature learners and mobile users, whose characteristics and insights are not quite the same as the adults. To date, there are design guidelines for mobile learning applications, however they are not specifically intended for children. In fact, the existing design guidelines are mostly targeted for desktop applications which are not suitable for mobile learning applications. Therefore, this study aimed to address this concern by identifying the design elements that are required for creating user interface of mobile learning applications for children. This study adopted the qualitative approach that comprises three main activities; Theoretical Study, Prototype Development and Expert Evaluation. The data were analysed using content analysis method. The guideline consists of eight design elements with their respective essential characteristics. The elements are Navigation, Text, Image and Icon, Audio, Content, Colour, Input/Output Support, and Feedback. The guideline could be used by designers to design an effective user interface for mobile learning applications specifically for children.

Keywords : Mobile Learning, User Interface Design, Children Learning Applications

I. INTRODUCTION

Nowadays, mobile devices are widely used as a learning tool because of the existence of mobile learning applications. A mobile device is a portable computing device that has a display screen with a keypad or touch screen. The touch screen allows users to use a virtual keyboard on the screen along with other icons and buttons that can be pressed. Mobile devices are embedded with an operating system and can run mobile applications. Some examples of mobile devices are mobile phones, personal digital assistants (PDAs), smart phones and tablet computers.

Mobile learning is a learning process that occurs when people received benefits from the opportunities provided by mobile technology [5][26]. The main components for a successful mobile learning applications to be accepted by users are ease of use, attractiveness, and user-friendliness. Mobile learning applications are easier and more convenient for learning because users can access information regardless of time and place [12]. Besides that, mobile learning technology can stimulate and maintain user motivation [17]. Furthermore, mobile learning applications help learners to stay focus and facilitate their learning [10]. Thus, mobile learning applications can be considered as a new generation of learning technology.

Both adults and children use mobile learning applications. Pre-school children from age 2 to 5 use mobile learning applications to learn alphabets and numbers [2]. Besides that, school and college students also use mobile learning applications as digital note-taking devices, or as text book collection, and as a quick and casual way to go online and research for follow-up details on any topic taught in class [18].

Despite all the benefits offered through the use of mobile learning applications, even high-quality applications that are available in the market still suffer from losses [1]. These losses happen due to unappealing user interfaces and the applications are too complex for users. Children specifically become confused when using such applications [1]. In terms of mobile learning applications for children, existing design guidelines are mostly targeted for desktop applications [22]. Such guidelines are irrelevant as they do not take into account the mobility aspects and the limitations of mobile devices [20]. Moreover, even though there are a number of design guidelines concerning mobile learning, most of them are much too general and not specific enough for children.

In short, the design for mobile learning applications especially for children has often been neglected. Children require special design requirements because their learning capability, technological skill and language proficiency are different than adults [19]. Therefore, design guidelines for mobile learning applications specifically for children need to be developed.

This paper aims to address the above-mentioned concerns by identifying the elements and characteristics of mobile learning applications specifically for children. The elements that were initially gathered through theoretical study were transformed as a prototype to illustrate them visually.

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The elements were then brought to the experts for evaluation purposes through the prototype. The evaluated elements then become the user interface design guideline for mobile learning applications, particularly for children.

This paper is organised as follows: Section 2 discusses the existing user interface design guidelines for mobile learning applications. Section 3 explains the methodology used in the study. Section 4 presents the findings. Finally, Section 5 concludes the paper and outlines future work.

II. RELATED WORK

This section contains the background information about mobile learning in general and the existing design guidelines of mobile learning applications. As this paper aims to present design guidelines especially for children, previous literature on design guidelines of mobile learning applications for children are also included.

A. General Design Guidelines of Mobile Learning Applications

A mobile learning application is a combination of two concepts namely mobile learning and mobile application. Mobile learning application is defined as learning using mobile devices via wireless connectivity that offers learners the opportunity to enhance their learning experience anywhere and at any time [11]. The mobile application is system software that works on mobile devices. Thus, a mobile learning application is an education application that runs on mobile devices and allows users to learn something anywhere and at any time [24][25].

It is important to design an appropriate user interface for mobile learning applications, especially for children. This is because the user interface is a mediated interaction between users and the application [14][17]. A good and effective user interface allows users to always be aware and mindful of the object and the subject of the application [7][10]. In order to develop an effective user interface design, general user interface design guidelines need to be considered because this forms the basis for the design of mobile learning applications especially for children.

According to general design guidelines, navigation should be intuitive, located at the top and/or bottom of the screen, and must support mobile device keyboards [21]. The navigation buttons should be large enough to interact with using stylus or touch screen [21]. Besides that, the navigation elements should be visualised in the same way on mobile devices with different screen resolutions [21]. The navigation must be consistent on every page [4]. It is advised that complex navigation be avoided [4][13]. This maintains the learner's pace and retains learning interest [8]. Next, it is recommended that frequent scrolling to be minimised [4]. Developers need to provide a dynamic navigation mechanism where users can move to any other page that they want with just one click instead of needing to go to other pages before reaching the desired page [4]. Navigation must be simple for users. It must always let them know where they are, where they have been, and where they can go [6][13]. Navigation should provide functions which are easy to understand, remember, and use [6]. No more than three clicks should be required to get from the initial page to the content [6]. Moreover, each screen should display a title [6]. Besides, allowing options such as undo and redo are important to maintain design freedom [6]. In addition, the application must provide mechanisms to help users find content [6].

It is a crucial requirement to convey necessary and essential information as this is one of the most valuable features of a user interface [21]. The user interface should not be overloaded with information or include colour that negatively affects the perception of the content [6]. It is advised that unnecessary information to be avoided [4] [6]. Unnecessary information not only confuses novice learners but also slows down expert learners [16]. It is recommended that the 'less is more' rule to be implemented [5][16]. The length of the text must be consistent with the size of the screen and must not be more than three times the height of the screen [21]. Besides that, textual information must be reduced and information using graphical and animated format should be used to minimise the learners' cognitive load and motivate them to learn [4]. In addition, the instructions on how to use the mobile application must be visible or easily retrievable when appropriate [6].

Based on the general design guidelines, horizontal scrolling of the text must be avoided [21]. Moreover, a function that can change the font size must be provided [21]. This gives the opportunity for users to increase or decrease the font size when needed as text with a small font size is difficult to read [4]. In addition, serif text fonts should be used due to the lower screen resolution on mobile devices [21]. The text should be easily read and thus should be in contrast to the background [21]. If the application includes audio, which is to be controlled by the user, it would be appropriate to provide a separate screen for the control elements [4]. Also, different input and output options should be allowed in order to improve user accessibility [6].

Besides, the application should provide constructive feedback to users when they have made a significant advancement in order to encourage them and generate trust [6]. The application should also provide support for the learners to achieve their learning goals [6]. If the users make a mistake when performing a task, the application should offer opportunities to get the right answer or at least provide an explanation [6]. The feedback provided should be appropriate to the content, problem or task, and immediate to the activities [6]. For error prevention, the application should request confirmation when the user selects two options at the same time by mistake and zoom in on the options in order to make manual selection easier [6]. It is recommended that the learners' motivation to be increased using learning with games because this can stimulate their interest through fun in learning [6]. Finally, the application should show the learners' achievement scores [6].

The paragraphs above have highlighted design elements based on the perspective of mobile learning applications. To fulfil the aim of the study, reviews are also made on the design guidelines of mobile learning applications for children in the following section.

B. Design Guidelines of Mobile Learning Applications for Children

Designing an application for children requires careful study. A good user interface design for mobile learning applications should emphasise on the requirements of mobile users [15].

There are only a few design guidelines for mobile learning applications for children.

Due to lack of design guidelines for mobile learning applications for children, any design characteristics for learning that highlight the communication, creativity and visual concepts that meet the requirements of children are considered in this study.

For children, it is recommended that the user interface to be simple and resemble the existing objects such as using cartoon drawing style as the illustration [9]. This aligns with the characteristics of children, who like simple things. Besides, the application should display figures or characters that are intelligent, curious and willing to learn so that children follow the nature of these characters [9]. The character figures have to convey story according to the children's everyday life.

It is advised that simple words and commands to be used throughout the system and reduced to a child's level [19]. The application should ensure the vocabulary and sentence structure are age-appropriate [19]. The typography used must be readable and the fonts should be the one that is familiar to the children [9]. For example, the sans serif family font with a large size should be used as well as clear and concise writing.

The application should use colours and backgrounds that are pleasing to the age group [2]. For example, children's applications should have bright, pastel, and lively colours with more graphics that are easily recognisable to children [2][9]. The application should be designed to be enjoyable and interesting to children. This can be done using e-Stories, games, role-play and any other activities that can gain the attention of children and maintain their motivation [19]. The application should provide background sound and sound effects [9]. Background sound, which consists of cheerful music is applied so that children can be encouraged to learn the material [9]. Sound effects use voice interaction such as the sound of objects colliding.

Furthermore, the application should reward the children appropriately with expressive audio, video, text or animations to promote continuous use and learning [19] [2]. This is to increase the children's focus and motivation. The application should also provide immediate feedback on the child's interaction [19]. As the children navigate through various steps of the application, it is important that continuous feedback is given to them in terms of where they are and how far they need to go. This would be a great motivator for learning [2].

III. METHODOLOGY

In general, this study aims to answer the following research question (RQ):

What are the elements and characteristics of a mobile learning applications specifically for children?

To answer the above RQ, a series of qualitative approach have been carried out. The approach was chosen as it allows the researchers to obtain more understanding and detailed information of the study. The approach consist of three main activities, namely Theoretical Study, Prototype Development and Expert Evaluation. Fig. 1 illustrates the research design accordingly.
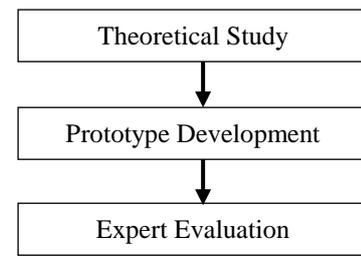

Fig. 1 Research Design

A. Theoretical Study

The theoretical study was the preliminary study conducted to identify problems related to user interface design of mobile learning applications. This phase also identified the design elements and characteristics of user interface for mobile leaning applications from previous studies. The study was conducted by referring to journals and proceedings from multiple online databases namely IEEE Explore, Science Direct, Scopus, and Google Scholar. The keywords used in the search were ("mobile learning" OR "m-learning application") AND ("design guidelines" OR "user interface design") AND ("mobile learning for kids" OR "mobile learning for preschool students" OR "mobile learning for children"). The Snowball technique was also used to obtain more recent and relevant articles based on the reference lists of the articles read. The study further used the following inclusion and exclusion criteria throughout the search process:

The inclusion criteria are:
- Articles that describe general design guidelines for mobile learning applications, or design guidelines for mobile learning applications for children.
- Articles about theoretical and empirical aspects of user interface design guidelines for children.

The exclusion criteria:
- Title and abstract of articles that obviously do not address the main research question.
- Duplicated articles and articles written in languages other than English.
- Articles that are not related to user interface design guidelines.

The search initially revealed a total of 120 relevant articles. However, when the inclusion and exclusion criteria were applied, only 10 articles made the final selection.

The selected articles were analysed using content analysis. Content analysis is one of the qualitative research techniques that are used to analyse written, oral, and visual data [12][23]. The collected data were categorised into several groups of elements based on the relativity of their characteristics. The process was carried out continuously throughout the study until no new characteristics or elements emerged from the data. Based on the content analysis conducted, there are eight elements that were identified. The eight elements are Navigation, Text, Image and Icon, Audio, Content, Colour, Input/output Support, and Feedback.

The results are listed in Table II, under the Theoretical Study column. The results of content analysis formed the theoretical data, which then were transformed as a prototype.

B. Prototype Development

The prototype was built based on the user interface design characteristics of mobile learning applications for children, which were gathered from the theoretical study. The prototype transformed the design characteristics into visuals to act as the medium for the experts to evaluate its usability.

The design of a prototype can be categorised into two types which are high-fidelity prototype and low-fidelity prototype. The prototype used in this study was low-fidelity. The low-fidelity prototype was chosen as it adequately meets the purpose of the usability evaluation.

The prototype was designed using Microsoft PowerPoint (Microsoft Office Professional Plus 2013), as it contains features that are able to construct user interface. In addition, graphics and images from open sources were also used in the design in order to illustrate the interface features more precisely. The built prototype was then evaluated by experts in the next phase.

C. Expert Evaluation

This phase was intended to evaluate whether the proposed elements and characteristics of user interface design for mobile learning applications are valid. The evaluation by experts is important as the experts are credible and experienced in the domain. Thus, their opinions are valuable in improving and strengthening the proposed elements and characteristics. The evaluation was done through a series of one-to-one interview session with the experts. The planning and implementation of the expert evaluation phase are as follows:

1) Sampling

In order to obtain credible opinions, the right and suitable experts in the field have to be identified. Hence, purposive sampling was adopted in order to achieve this objective. Purposive sampling is a method used to choose informants that have the designated criteria according to the research needs. The experts were divided into two categories; the first is on the user interface design area and the second is on children education.

A total of two experts were identified. The number of experts is justified as each expert has a significant experience in their respective areas. The Human Computer Interaction (HCI) expert evaluates the usability aspects for mobile learning applications. Meanwhile, the education expert assesses the suitability and appropriateness of the design features towards children learning process. Table I briefly outlines the profiles of the two experts.

TABLE I.   EXPERTS PROFILE

Expert	Position	Field of Expertise	Experience (years)
Expert 1	Human-Computer Interaction (HCI) Researcher	Empirical Usability and Information System Evaluation, e-Learning	22
Expert 2	Early Childhood Education	Early Childhood Education and	5

Expert	Position	Field of Expertise	Experience (years)
	Researcher	Special Education	

2) Interview protocol

There are several preparatory steps that need to be done prior to the interview. The protocol started by getting the approval for the interview session from the experts. Once their consents were acquired, the experts were interviewed individually at their respective workplace within 60 to 90 minutes per session. Before the interview started, the experts were informed about the research background and purpose of the interview session. The interview sessions were audio recorded. Besides that, interview notes were also made. Data from the interviews were then transcribed into text format and analysed for interpretation.

3) Instrument

The instrument used for the interviews is the prototype. During the session, the experts were asked to evaluate heuristically the developed prototype and give feedback on each design characteristics contained in the prototype. The experts were given a checklist that contains the design elements and characteristics as the evaluation guideline. The results of the evaluation are reported in the next subsequent section.

IV.   RESULTS AND DISCUSSION

Overall, experts agree with most of the proposed elements and characteristics from the theoretical study. To show the enhancement from the experts feedback, Table II lists and simplifies the findings of the proposed design characteristics of the mobile learning applications for children; both from the theoretical and experts evaluation phases. Eight elements were identified, which are Navigation, Text, Image and Icon, Audio, Content, Colour, Input/output Support and Feedback. There are specific characteristics for each of the said elements. The mark ($\checkmark$) indicates that the element found during the theoretical study has been accepted by the experts. Elements with the marks of ($\times$) indicates that the element has been rejected to be included in the final version. Meanwhile, the mark (-) indicates that the element is not previously found during the theoretical study, instead has been suggested to be added or modified by experts. The following paragraphs elaborate the identified elements and its characteristics. Along with the explanations, several examples of the characteristics for each element of the design prototype were also shown in order to better illustrate the characteristics visually.

TABLE II.   THE PROPOSED CHARACTERISTICS OF A CHILDREN MOBILE LEARNING APPLICATION

Element	Characteristic	
	Theoretical Study	*Expert Evaluation*
Navigation	Should be intuitive.	$\checkmark$
	Provide a dynamic navigation mechanism.	$\checkmark$
	Located at the top and/or bottom of the screen.	$\checkmark$

Category	Guideline	Status/Note
	Navigation buttons should be large enough to work with stylus or touch screen.	✓
	Simple and clear; avoid using a complex navigation.	✓
	Consistent on every page.	✓
	Avoid scrolling.	✓
	Easy to understand, remember, and use.	✓
	Not more than three clicks should be required to get from first page to the content.	✓
	Every screen should display a title.	✓
	Allow options such as undo and redo.	✓
	Provide a search function.	No need for search function.
	-	The navigation elements need to be described the same way on mobile devices that have different screen resolutions
Text	Easy to read and in contrast with the background.	✓
	Provide the change size font function.	✓
	Avoid horizontal scrolling.	✓
	Use serif or sans serif font text.	✓
	-	The text does not use any striking colour.
	-	The text should fit on different screen size.
Image	The size of graphic images (in pixels) must be consistent with the size of the screen.	✓
	Illustration style is a cartoon drawing style.	✓
	Display figures or characters that are intelligent, curious, and willing to learn.	✓
	-	Provide an appropriate icon along with text.
	-	Provide character selection.
	-	Characters should be able to move, talk and have expressions.
Content	Provide necessary information and only show essential information.	✓
	Use simple language.	✓
	E-stories, games, simulations, role-playing, and learning activities should be added.	✓
	Show achievement scores for quizzes or time-based assessments.	✓
	Introductory and learning content is communicated by character through storytelling or teaching.	✓
	Reduces text content with content display not exceeding more than three scrolling levels.	✓
	The height and width of the display area cannot exceed the size of the screen.	✓
	Reduce text information and increase pictorial	✓
	-	information or animation.
	-	Provide introductory content, learning content, reinforcement training, games and quizzes or time-based assessments.
	-	Views on each content need to be different.
	-	Prepare tutorial before the game or activity starts.
	-	Learning content, quizzes and games should be levelled up according to difficulty levels such as low, medium and difficult levels.
	-	Provide "rest page" in learning content.
	-	Provide notes for parents or teachers to accompany children when using the app on the first page.
Colour	Use colours and backgrounds that are pleasing to the age group.	✓
	Use pastel colours, lively and bright colours, and colours that are easily recognised by children.	✓
	Do not include colours that negatively affect the visual perception of the content.	✓
	-	Use prominent colour (striking colour) just to emphasize something.
	-	Provide option for theme colour selection.
Audio	Provide sound effects and background music.	Provide sound effects and appropriate background music according to the theme of learning.
	Provide a separate screen for the control elements to be arranged.	✗
	-	Provide option function to disable the sound effects and background music.
	-	Provide sound effects and background music that is adjustable on separate screens.
Input/output support	Allows input and output options such as click, "zoom in" and "zoom out".	✓
	Easy user input such as "tap" and "drag".	✓
	-	Each input option should be assisted and taught by character.
Feedback	Provide immediate feedback on the child's interaction such as his or her progress, encouragement, and support.	✓

	Make feedback appropriate to the content, problem or task, and immediate to the activities.	✓
	Provide text/audio/video feedback.	✓
	Error prevention: when the child selects two options at the same time by mistake, the application should request confirmation, and zoom in on the options in order to make the manual selection easier.	Error Prevention: When users choose unintentionally, the application needs to request verification and provide a chance to "redo".
	-	Feedback must be communicated through characters.

A. Navigation

The first element is navigation. Navigation should be intuitive, and located at the top and/or bottom of the screen in order to avoid confusion for the users (Refer to (A) in Fig. 2). Besides that, the application should provide a dynamic navigation mechanism. This can allow users to have full control in navigating the application. The navigation buttons should also be large enough to work with using stylus or touch screen. The navigation elements should be visualised in the same way even on mobile devices with different screen resolutions. Navigation should be simple and clear; complex navigation should be avoided to cater to the children's level. Besides that, navigation should be consistent on every page. The application should avoid scrolling. Navigation should also provide functions which are easy to understand, remember, and use. Not more than three clicks should be required to get from the first page to the content. Every screen should display a title, in order to remind users which page they are located at the current time (Refer to (B) in Fig 2). Allowing options such as undo and redo are important to maintain the design freedom. Besides that, it is also identified that the search function is not necessary for learning application. In the context of children who are just learning to read, the search function is not suitable as it does not match with the children's capability.

Fig. 2. Navigation element

B. Text

The second element is text. The text should be easy to read

and thus should be in contrast with the background. Even though the text should contrast with the background, the text should not use any striking colour. Serif or sans serif font text should be used. The application can use either serif or san serif fonts as long as the font type has a single story on the letters 'a' or 'g' such as (a) and (g) (Refer to (C) in Fig. 3). Single story letters are the type of letters that are usually taught at pre-school level and are easier to be understood by children. Examples of fonts that have single story letters on 'a' and 'g' are Chinacat and Comic Sans MS. The option to change the font size must also be provided. The font size change function is important to increase the readability of the text. It is also necessary in order to facilitate children with visual problems. However, this functionality does not need to be provided on the application if the function is already available on the mobile device. This is to prevent the screen from being too crowded. Although users can change font size accordingly, it is important to make sure that all font sizes fit for different screen sizes. Horizontal scrolling of the text must be avoided because it will make it difficult for children to learn.

Fig. 3. Text element

C. Images and Icons

Images and icons represent a significant element in the child's learning. Images and icons can make learning process entertaining and appealing as well as increasing the motivation for children to use the application. One of the important features of this element is the size of the graphic image (in pixels) must be consistent with the size of the screen. The illustration style should be of cartoon drawing style, as it reflects the attribute of children that like simple things (Refer to (D) in Fig. 4). In addition, appropriate icons should be provided along with the texts (Refer to (E) in Fig. 4). This is because the children are in the process of recognising the alphabet and learning to read. This can facilitate the understanding of children and facilitate the learning process. Besides that, the learning applications need to provide options for the application's character in order to support children in learning session. Multiple choices of characters should be prepared to give enjoyment in choosing for the children. Apart from that, the application needs to display a figure of smart, curious and ready-to-learn characters in order to encourage the children to follow the good attributes that the character brings. The character also should be able to move, talk and have expressions. This will help in increasing the interaction between the application and the children.

Fig. 4. Images and Icons element

D. Audio

Audio is one of the elements set in the mobile learning application for children and it refers to the background music and sound effects. The background music is the music played during the learning activity game in the application. Meanwhile, the sound effect refers to the sounds that are added to make the application more exciting or real. Examples of the sound effects are the sound when a button is clicked, the sound when the object is dragged, the sound of voice button and the sound of objects colliding. The appropriate background music and sound effect should be used in the learning applications and it must be in accordance to the learning theme. The background music should be cheerful so that children can be encouraged to learn. Besides that, the applications should provide the option of not using the sound effects and music backgrounds depending on the children's desire (Refer to (F) in Fig. 5). Adjustable option for background music and sound effects should be provided on separate screens to facilitate the children in controlling the suitability of the music and the sound volume according to their wishes (Refer to (G) in Fig. 5).
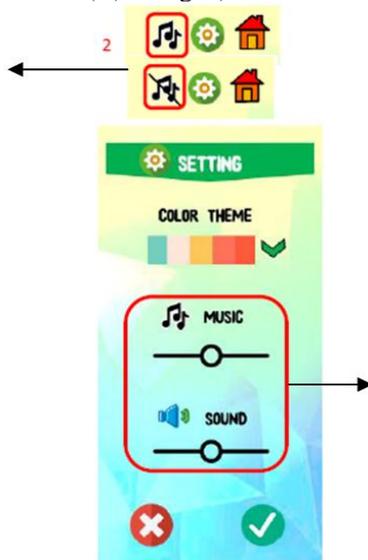

Fig. 5 Audio element

E. Content

Content is an important element that needs to be taken into consideration to ensure the smoothness of the mobile learning applications for children. Content should provide the necessary information and only show essential information. Content should use simple language. The text-based content should be reduced in which no more than three scrolling screens should be applied. This is to maintain focus on the learning content. Besides that, the height and width of the display area also cannot exceed the size of the screen. E-stories, games, simulations, role-playing, and learning activities should be incorporated to make the application more attractive and desirable for children. In this context, the applications should provide introductory content, learning content, reinforcement training, games and quizzes or time-based assessment (Refer to Fig. 6). The display for each content should differ to enhance the creativity and interest in learning. The application also needs to provide tutorials before the activities or games begin. This helps children to easily understand how the activity or game is carried out. Furthermore, the content of the introduction and learning should be conveyed through storytelling or teaching mode by the character. Besides that, the learning content, quizzes and games need to be rated by difficulty level such as low, medium and hard. This is to maintain the children's learning motivation. The application also needs to display children achievement marks for time-based quizzes or assessments. This helps in evaluating the children's level of understanding of the learning session. Furthermore, the application should provide "rest page" during the learning process. "Rest page" works as a relief for the children's mind after learning something. Next, the application needs to provide notes for parents or teachers to accompany the children when using the learning application. This is to improve the children's learning motivation as well as for the parents to monitor children's learning development.

Fig. 6. Content element

F. Colour

Colour plays an important role in the design of the mobile learning application specifically for children as the usage of colour can provide a more appealing visual. The application should use colours and backgrounds that are pleasing to the age group.

It is important to attract the target users who are in this case the children, to use this application. Pastel colours, lively colours, bright colours, and colours easily recognised by children need to be used. Besides that, the application should not include colours that negatively affect the visual perception of the content. Additionally, the application needs to use striking colours only to emphasize or assert something. Next, the application should provide a selection option of colour themes to be chosen by the children according to their preference (Refer to (H) in Fig. 7). Giving children space to choose can increase their motivation to learn.

Fig.7. Colour element

G. Input/Output Support

The next element is input and output support. Applications should enable the input and output options such as click, type, zoom in, and zoom out. This is beneficial to enhance the creativity and interaction of the children. Additionally, the application also need to provide an easy input such as "tap" and "drag" in order to make it easier for the children to use them (Refer to Fig. 8). Besides that, each input option should be assisted and taught by the character.
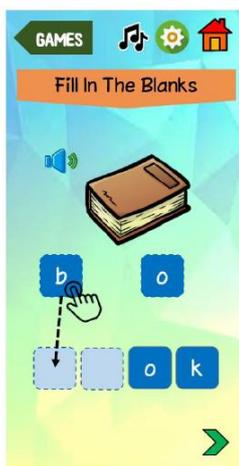
Fig. 8. Input/output support element

H. Feedback

Feedback is a must-have element in the mobile learning application as it helps children to solidify their knowledge and reinforce new skills while interacting with the learning applications. The application should provide immediate feedback on the child's interaction such as his or her progress, encouragement, and support. This is to increase incentives for the children and to create trust in using the learning applications. The provided feedback should be appropriate to

the content, problem or task, and immediate to the activities. In addition, responses to the children interactions should be communicated through characters. Moreover, the application should provide text/audio/video feedback to guide the children. In term of error prevention, the application should provide a verification request and give a chance to "redo" when the children accidentally make error in making choices (Refer to Fig. 9). This is to prevent children from feeling bored and disappointed in using the application.

Fig. 9. Feedback element

V. CONCLUSIONS AND FUTURE WORK

This paper has discussed the elements and characteristics in designing the interface of mobile learning applications specifically for children. The elements and characteristics were gathered and confirmed through a series of studies which are Theoretical Study, Prototype Development and Expert Validation. Based on the theoretical data, a prototype was built to better illustrate the proposed elements and characteristics in visual manner. Later, the prototype was validated by two experts who have experience either in Human Computer Interface (HCI) knowledge or the early childhood education. The opinions by both experts were crucial to confirm the accuracy of the identified elements and characteristics of the user interface design. Through the expert's reviews and validation, this study has concluded eight elements that are required for the user interface design for children mobile learning applications, namely Navigation, Text, Image and Icon, Audio, Content, Colour, Input/output Support, and Feedback. Each element has several specific characteristics according to the nature of the identified element. This study contributes to the design of mobile applications interface, in terms of HCI and children learning areas. From the HCI aspect, this study provides guidance to designers in developing mobile learning applications for children. It also contributes to the enhancement of design features of existing mobile learning application interfaces. From the children learning aspect, this study enhances learning experience through user-friendly and easy-to-learn mobile learning applications that meet the children's needs.

This would encourage children to learn while using the applications, regardless of the time and place.

These findings can be further improved through future work. The work may include testing the identified elements and characteristics through high-fidelity prototypes. Besides, future work may consider refining the elements of mobile learning applications for special needs groups, for example, children with disability.

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