Integrating and Evaluating Helpful Features in Interactive Computer Assisted Learning Courseware for Low Achieving Children

Siti Zulaiha Ahmad [1], Ariffin Abdul Mutalib [2]

[1] *Universiti Teknologi MARA Cawangan Perlis Kampus Arau, Arau, Malaysia*
[2] *Universiti Utara Malaysia, Malaysia, Sintok, Malaysia*

Abstract – With the aim to provide a learning content that is digitally delivered to assist low achieving children, this paper proposes some helpful features in an interactive courseware. The low achieving children usually encounter reading problem. Therefore, common courseware with textual instructions are not suitable for them. Accordingly, this paper discusses an Interactive Computer Assisted Learning courseware for Low Achievers known as *Bijak Matematik*. The application consolidates the well-defined components and elements that induce positive interaction supported with helpful object behavior features in the learning courseware. This study went through a three-stage research process, which are i) design, ii) development and iii) user experience testing. Having design and develop the application, user experience testing was conducted with 30 participants from five primary schools. Result justifies that the prototype (*iCAL4LA-Bijak Matematik*) is significantly very helpful to the targeted users.

Keywords – Helpful, Interactive, Multimedia, Computer Assisted Learning, User Experience.

1. Introduction

Early stage of education is crucial for every child and each of them is obliged to be treated equally regardless of competency. However, learning competency or ability is differed from one child to the other. Children with learning difficulties especially from the lower level of primary school require specific attention from the early stage of their education [1]. Without a proactive solution, the problem could prolong up to their upper education level. It is revealed with the recent report of primary school assessment test (local examination in Malaysia) and Program of International Student Assessment (PISA), which highlighted the higher percentage of low achievement begin in the early primary school level. In Malaysia, it has become a worrying situation as more than 5,000 pupils (more than 30%) obtained the poor result (D and E) for all subjects in the national examination [2]. Besides cognitive ability, many other factors implicating the low achievement in the examination [3]. One of the factors is incompetence in literacy and numeracy, which affect the basic learning skill. Obviously, lack of fundamental skills in reading, writing, and calculating very much impede the learning ability to internalize the lesson content if they are not attended with proper learning assistance.

Featuring helpful elements have been implemented in most of the software application. The availability of the helpful features is expected to enhance user learnability and usability in manipulating the content especially for children with learning difficulties. The whole content has to be designed with familiar and easy-to-understand support in terms of its specific and general interaction design. In addition, facilitation in learning with or without the presence of instructor could provide significant implication towards their learning curve [4]. The incorporation of the helpful features is crucial in delivering a learning assistance for them that commonly known as computer assisted learning (CAL). With recent

learning technology, CAL offers a beneficial assistance to all learners within their learning environment with various approaches in satisfying the requirement of learning process. Learning requirements of those with learning difficulties are different from the normal learners. The low achieving (LA) children require a helpful learning assistance that offers them specific features of instruction and interaction in exploring the learning content. A usable CAL should be accompanied with a helpful interaction measure/implementation. As in athwart, LA children, especially, might encounter with less effective of human computer interaction [5] if the applications were designed with improper design elements. However, based on the review of commercialized CAL applications [6], they revealed that the interaction component has not been critically focused on in most models. The inclusion of this component in the conceptual model is only found in one of the studies, but they are not concentrating in learning problems of LA children. This obviously shows the urgency to further explore the interaction concept, as it is still infancy in a model of interactive CAL for LA children.

However, as discussed earlier, the infancy of interactive CAL with in-depth study of suitable components in LA children learning environment would negatively implicate their fundamental knowledge development, which worsen their educational prospect in the future. The application should be able to offer positive user experience by interactively and attractively support these children in the learning session with enjoyment and encouragement concept. In addition, the students should be actively involved in class activity to absorb the teaching content, which can be supported with an interactive tool. Therefore, the aim of this study is to proposes a courseware (CAL) for LA children named as *iCAL4LA-Bijak Matematik* by strengthening on positive interaction that provide helpful features. Active interaction involvement of LA children can stimulate their learning interest when an effective interactive CAL adapts an appropriate interaction concept.

This paper comprises five main sections that i) introduce the research topic, ii) describe background of the study, ii) explain the research process and its procedures, iv) discuss the findings and finally v) conclude this study with discussion and future work.

2. Background of Study

This section discusses topics related to this study, which covers three main topics. This paper focuses on user experience of LA children with helpful interactive application, as stated in previous section.

2.1. Low Achieving Children

In Malaysia, competency of each student is assessed based on his or her performance in mid-term and final exams in which they are later segregated into appropriate classes. The terms low achievers, underachievers, and low academic achievement represent those who do not perform based on their academic assessment and evaluation [3]. Without appropriate preventive or remedial actions, it may jeopardize the ability of their learning capability in future. LA children require special attention and different learning approach compared to those are average and excellent student or children. Learning material also should be provided according to their need as most of them also have literacy problem as well as oral communication skill [7].

2.2. User Experience

Users usually gain either positive or negative experience when involved in any activity that includes other parties, from which they may blend feelings, thoughts, and perceptions. User experience focuses on the consequence of users' perception in interacting with any product, system, service, or object such as interactive software [8], [9]. Most studies agree that it occurs based on the consequences of the behavior in the interaction process between users and interactive products [10]. User experience in the context of interactive software surrounds the overall aspect in regard to interaction between user and the system. It becomes an essential element with the growth and improvement of recent technologies in fostering positive feelings of the interactive software with special concerns [11]. Specifically, it is crucial to cover a wider perspective of interactivity between users and products which impose the quality of experience such as beauty, fun, pleasure, and satisfaction [12]. These qualities are in line with ten user experience goals suggested by [13] and one of them is fun that satisfying within the interaction design concept.

Accordingly, the understanding of user experience and its elements could provide useful and usable interactive software because positive feeling is able to influence users' capability and satisfaction. As the user experience is vital in developing an interactive software, the appropriate design concept such as interface design with suitable interaction for specific group of users are the main concern of this study. Therefore, this study adopts user experience goal focus on helpful.

2.3. Helpful

Learning assistance in the form of computer-based application or CAL is inevitable as it is a necessity in 21st century of educational environment. CAL and users are two main components involved in this proposed study. In accordance, human and system perspectives have been discussed by highlighting the interaction design concept and user experience aspects that comprise helpful experiences. CAL should specifically address the learning requirements and characteristics of LA children by utilizing interaction design concept. In this study, the indication of helpful is referring the supportive features to assist the LA children in utilizing the digital learning materials. As stated in Merriam Webster online dictionary, the definition of helpful is "giving help", which is associated to ease the task that have been conducted by a person. Similarly, based on other definition, helpfulness is defined as "user's perception that a product/service communicates in a helpful way" [14], [10], in which they are used to assess the utilization of communication devices and services such as mobile phone in terms of its user experience. It is crucial to measure the helpful features for a product to assess its usefulness. Apparently, investigation in terms of the helpfulness on the features provided in the digital content has been conducted by [15], [16]. In addition, [17], [18] measured the helpful features in form of object link (interactivity feature), caption in video and instructional aids (instruction features). Therefore, with the concern of LA children learning requirements and assistance that they needed, this

study focused on the helpful assistance properties that have been designed and implemented into the interactive CAL focusing on interactivity elements, instructional features, and digital content support.

3. Helpful Features in iCAL4LA – *Bijak Matematik*

3.1. Component and Elements of iCAL4LA - *Bijak Matematik*

Basically, the design segment has four main components, which are interaction, multimedia, navigational, and general design. It provides detailed principles to guide developers in designing the user interface of *iCAL4LA-Bijak Matematik*, which emphasizes on helpful features for LA children learning experience. The elements of interaction design segment critically consider the interaction behavior with positive feedbacks and cues to convey the supportive strategies of iCAL4LA. It is supported by multimedia and navigational design principles for the interface design according to general design principles. Eventually, those elements are utilized in designing the *iCAL4LA-Bijak Matematik* courseware based on the components and elements of content segment. Figure 1 depicts the components, elements, and principles of design segments. Then, those components and elements converted into low fidelity prototype using storyboard design. It consists of ideation that shows the flow of *iCAL4LA-Bijak Matematik* courseware including the concept, scripts, and detail explanation for each scene.
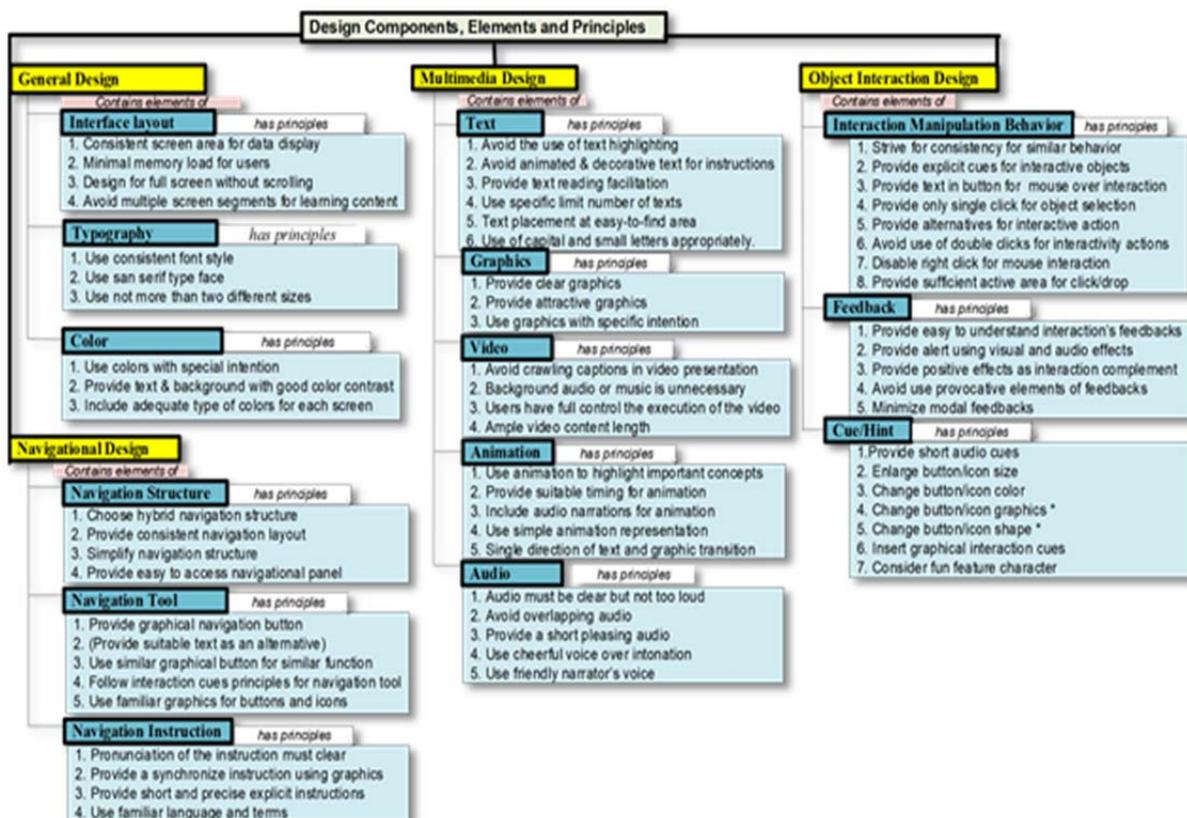

Figure 1. The design components, elements, and principles of iCAL4LA-Bijak Matematik

3.2. The Prototype of iCAL4LA-Bijak Matematik

This phase describes the results of the prototyping approach that has been conducted. Basic topics for Mathematics subject were suggested for the prototyping process. Accordingly, the prototype of *iCAL4LA-Bijak Matematik* is based on the three-phase of the development process described in the previous section. In the final stage, the prototype was produced in the form of courseware for personal computer with DVD packaging, as illustrated in Fig. 3. The inclusion of helpful elements in *iCAL4LA-Bijak Matematik* requires the implementation of iCAL4LA strategies with supportive content for LA children. The prototype must consider the utilization of (i) seen and unseen actors for user interaction, (ii) the interface and interaction design principles, and (iii) element of learning theories, approaches, and techniques, which emphasize on helpful aspects. Accordingly, the *iCAL4LA-Bijak Matematik* is designed based on the design guidelines of iCAL4LA. Basically, it applies the general design component, which comprises the elements of interface layout, theme (optional), typography, and color, as illustrated in Figure 2.
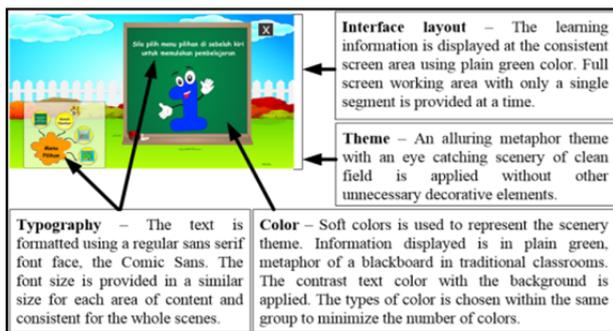
Figure 2. The general design of iCAL4LA-Bijak Matematik

In addition, the elements of each design component contain principles that are applicable for LA children. They are associated to the helpful aspect of learning experience. The helpful aspect refers to all assistance provided in the courseware, which focuses on the multimedia elements, content navigation, and object interaction behavior. As an example, the contents are provided with text reading facilities using clear and friendly voice intonation within *iCAL4LA-Bijak Matematik*. The graphics are used with specific intentions, which help the LA children to recognize their function. The video and animation are presented with the intention to help them in internalizing the lesson contents. The utilization of video and animation principles that adhere to the audio principles provides an assistance to LA children. This is clearly seen in the implementation of addition and subtraction lessons. However, the application of the multimedia elements is not only subjected to those supportive features.

They have been incorporated into the navigational tool and instructions as well as the object interaction behavior, cues and feedbacks to assist the LA children. This infers that the design principles of the proposed model complement each other to cater the helpful aspect. The way these are used in *iCAL4LA-Bijak Matematik* can be seen in Figure 3 as for the sample, which includes the utilization of cues, interaction behaviour, feedback, navigation structure, navigation tool, navigation instruction, and user control.
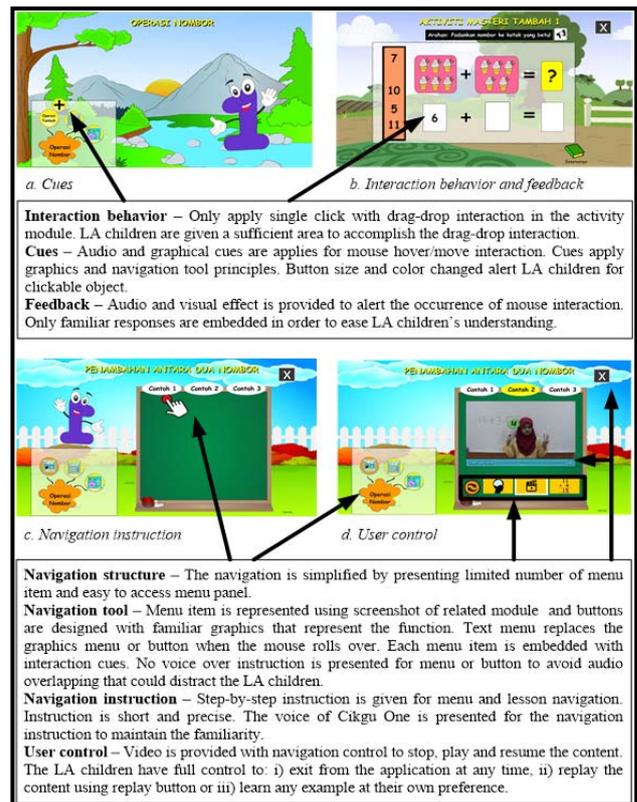
Figure 3. Samples of screenshot that caters for the helpful aspect of iCAL4LA-Bijak Matematik

4. Methodology

Mainly, this study involves a three-stage process (Figure 4) in integrating helpful user experience, developing *iCAL4LA-Bijak Matematik* courseware, and evaluating the helpful features embedded into the application. In the first stage, this study structured all identified components and elements into the design canvas. Having prepared the storyboard, the development process took place using prototyping approach in the second stage. In the last stage, two series of testing have been conducted, in which pilot study (to identify flaws and issues during the testing session) and the actual user experience testing. It is to investigate user experience of helpful features that have been integrated into *iCAL4LA- Bijak Matematik*. This study obtained research approval from Malaysia Ministry of Education and State Education Department.
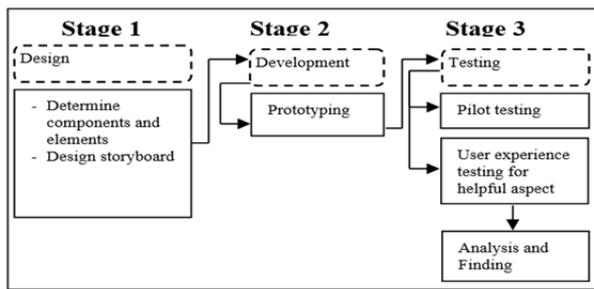
Figure 4. Research methodology

This study carried out the actual user experience testing in five sessions. They were conducted at five different schools in Perlis. Each testing session was conducted with 6 subjects at each school. It is to ensure that the testing procedures are accomplished within the time frame. The selection of the schools was based on the availability of the computer labs and their facilities and the type of school (non-cluster school).

The testing session of user experience were participated by 30 selected LA children aged between 7 to 9 years old. The participants were screened and selected by the Literacy and Numeracy Screening (LINUS) teachers based on their academic performance in the most recent test (for year 1 children) including the previous year of the final examination results. Out of 30 subjects, 56.67% are males and the remaining 44.33% are females. They are from year 1 (seven years old) to year 3 (nine years old). Number of year 1 subjects is significantly higher than year 2, year 3, as most of them is found to be incompetent in Literacy, and Numeracy Screening (LINUS) test. It is also suggested by the LINUS Coordinators from the respective schools. Most of the subjects are ranked in the last class (80%) and the remaining is from the second last class (20%). In addition, 90% of the subjects have problems in literacy and numeracy. Whereas the remaining 10% of the subjects have very slow pace of reading and counting ability. A majority of the subjects has at least two years of experience of using computer whether at home or school. Only four of them (13.33%) have used computers in three years and above. Most of the subjects were able to interact using the mouse with only a few of them required assistance. However, they managed to handle the mouse after a short period of training. This study obtained consent form their legal guardians and teacher to participate in the testing session. Table 1 tabulates the demographic data of the participants.

Table 1. Demographic data of the participants in user experience testing

Item	Category	Frequency	Percentage
Gender	Male	17	56.67
	Female	13	43.33
	Total	**30**	**100.00**
Age	7	15	50.00
	8	11	36.67
	9	4	13.33
	Total	**30**	**100.00**
Class Rank	Last	24	80.00
	Second last	6	20.00
	Total	**30**	**100.00**

The testing utilized two sets of questionnaire instruments known as Q-iCalH [19] that have been developed and validated previously for the LA children and the facilitator. It uses 4-point Likert Smileyometer scales that is understandable and suitable for children as illustrated in Figure 5. The instrument consists of 11 items that focusing on the assistance of interaction, instruction, and content features with the Cronbach Alpha is 0.85 (tested with consistency reliability). The testing session were conducted in the computer lab setting where the participants had a full access to the application. Each participant was given 20 minutes to explore iCAL4LA- Bijak Matematik before the facilitators assist them to fill-in the questionnaire individually. Then, using descriptive statistical procedure this study analyzed and justified the results based on the user experience testing.
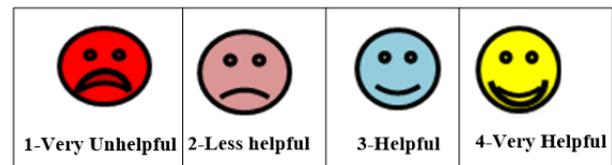

Figure 5. The Smileyometer measurement scales

5. Result and Discussion

The following discussions are related to the findings of helpful features in *iCAL4LA-Bijak Matematik* that reflects to the user experience. The following are the findings for this study. Firstly, the summary of the results containing the mean scores and standard deviations for 11 items in Q-iCalH are shown in Table 2.

Table 2. The Summary of Descriptive Statistics for Helpful Aspect of iCAL4LA-Bijak Matematik

	Items	Overall (N = 30)	
		M	*SD*
1	The graphics design helps me understand the lesson content	3.83	0.379
2	The step-by-step animation helps me understand the lesson content	3.47	0.629
3	The video presentation helps me to understand the lesson content	3.77	0.504
4	The text color helps me read well	3.87	0.346
5	The voice over helps me understand the instructions	3.77	0.626
6	The on-screen text instruction is clear for me	3.77	0.430
7	The cue on the button helps me understand the button function	3.93	0.254
8	The use of graphical button helps me memorize the functions	3.80	0.484
9	The visual cue feature helps me recognize button	3.80	0.407
10	The audio cue feature helps me interact with the courseware	3.47	0.629
11	The button position helps me to navigate the courseware	3.80	0.407

Note: *N- Number of subject, M – Mean score, SD – Standard deviation*

Table 2 illustrates that the element of cues on the buttons (item 7) scores the highest mean (M=3.93). Meanwhile, the step-by-step animation instruction (item 2) and audio cues (item 10) score the lowest (M=3.47). Additionally, the mean score for video presentation (item 3), voice over (item 5), and on-screen text instruction (item 6) are equivalent (M=3.77), while the use of graphical button (item 8), visual cue (item 9), and location of the buttons (item 11) score 3.80. Based on the details, it is clearly shown that the mean for all items is high, in which the lowest is above the average. When further calculated, the overall mean for the items is 3.71 (Table 3). This indicates that the LA children have good views on the helpful aspect of the iCAL4LA. Further, it was empirically analyzed as described in the following paragraphs.

Table 3. The Descriptive Statistics for Overall Helpful Aspect of iCAL4LA-Bijak Matematik

	N	M	SD
Helpful of *iCAL4LA-Bijak Matematik*	30	3.71	.463

Note: N- *Number of subject* **M** *– Mean score* **SD** *– Standard deviation*

In interpreting these scores, this study calculates the gap classification based on the formula adapted from Siti Mahfuzah [20]. Originally, the formula was explained by Zulkarnain [21] in considering the gap classification of interval scale of research instrument. Below is the formula to calculate the gap classification:

$$\text{Gap} = (\text{highest score} - \text{lowest score})/\text{number of scales}$$
$$= (4-1)/4$$
$$= 0.75$$

Having computed the gap classification, this study tabulates the classifications in Table 4 based on the 4-point scale. Hence, the *iCAL4LA-Bijak Matematik* is perceived as helpful only if the mean score value is above 3.26.

Table 4. Response Classification

Gap	Classification
1.00 – 1.75	Low
1.76 – 2.51	Fairly low
2.52 – 3.25	Fairly high
3.26 – 4.00	High

Based on the response classification, this study provides the classification for all items that measure the helpful elements of *iCAL4LA-Bijak Matematik* in Table 5. It is found that all items are classified as "High". This indicates that the elements of *iCAL4LA-Bijak Matematik* were perceived as helpful.

Table 5. The Classification of Helpful Aspect of iCAL4LA-Bijak Matematik for Each Item

	Items of Helpful Aspect	Score	
		M	Classification
1	The graphics design helps me understand the lesson content	3.83	High
2	The step-by-step animation helps me understand the lesson content	3.47	High
3	The video presentation helps me to understand the lesson content	3.77	High
4	The text color helps me read well	3.87	High
5	The voice over helps me understand the instructions	3.77	High

6	The on-screen text instruction is clear for me	3.77	High
7	The cue on the button helps me understand the button function	3.93	High
8	The use of graphical button helps me memorize the functions	3.80	High
9	The visual cue feature helps me recognize button	3.80	High
10	The audio cue feature helps me interact with the courseware	3.47	High
11	The button position helps me to navigate the courseware	3.80	High

The above findings justify helpful aspect of *iCAL4LA-Bijak Matematik* as the overall mean score (3.71) also falls as "High". This means that the results positively support the usefulness of *iCAL4LA-Bijak Matematik*. Secondly, this study explores the results of the helpful aspect descriptively based on each item. The items were constructed based on the assistance features embedded in *iCAL4LA-Bijak Matematik*. Table 6 presents the frequencies of each item in percentage based on the scales.

Table 6. Percentage for frequencies of features in Q-iCalH based on scales

Features	N = 30			
	Very unhelpful	Less helpful	Helpful	Very helpful
Graphics	0%	0%	16.7%	83.3%
Animations	0%	6.7%	40.0%	53.3%
Video	0%	3.3%	16.7%	80.0%
Color	0%	0%	13.3%	86.7%
Audio (voice over)	0%	10.0%	3.3%	87.7%
Text of instruction	0%	0%	23.3%	76.7%
Button cues	0%	0%	6.7%	93.3%
Graphical button	0%	3.3%	13.3%	83.3%
Visual cues	0%	0%	20.0%	80.0%
Audio cues	0%	6.7%	40.0%	53.3%
Button position	0%	0%	20.0%	80.0%

The results have shown that the assistance of cues for the button was found to be very helpful as 93.3% of the subjects agree with the element (the rest find it helpful). Also, this study found that at least 80% of the subjects agree that the graphics, video, color of text, graphical button, visual cue, and button position are very helpful for them to explore the content of *iCAL4LA-Bijak Matematik*. Only some of them

(approximately 7%) consider those features as less helpful. Further, the step-by-step animation and audio cues are very helpful for more than half (53%) of the subjects. The other 40% of the subjects agree that those elements are helpful for them. Meanwhile, only a minority (6.7%) think that the audio cue and animation are less helpful. Surprisingly, 10% of the subjects claim that the voice over instruction is less helpful, in which contradicts with the other 90% of the subjects. Overall, it is obviously exhibited that most of the elements of *iCAL4LA-Bijak Matematik* are perceived as very helpful or at least helpful for more than 90% (in combination of helpful and very helpful) of the subjects. It indicates that the embedded elements were useful to assist the LA children to explore the courseware.

Having justified the findings in the user experience testing, this study found that the aspect of helpful is catered successfully in *iCAL4LA-Bijak Matematik*. It means that the components, elements, and design principles of iCAL4LA are useful for the LA children. Specifically, the findings support the achievement of the third objective of this study.

6. Conclusion

This study proposed *iCAL4LA-Bijak Matematik* as an alternative digital learning material to empowering basic mathematical skill among the low achievers in primary school. Thus, to ensure that the courseware is useful, this study went through a three-stage research process: (i) design, (ii) development, and (iii) experimental testing of user experience. The *iCAL4LA-Bijak Matematik* has been designed with suitable components, elements and principles that cater five main segments: general design, navigational design, multimedia design and object interaction design. The design principles focus on the positive interaction learning approach that has been specifically extracted for LA children, which emphasize on the helpful aspect of user experience. The applicability of these features has been supported by specifying in the interaction concept of CAL and provide cueing concept in considering the helpful aspect of *iCAL4LA-Bijak Matematik*. From the perspective of CAL implementation, it enables the LA children to stimulate their reading ability by providing them the suitable audio and visual facilitations. The inclusion of this feature in the "object interaction design" and "navigational design" of design segment amplifies the overall design guideline in designing the user interface and interaction, as they are crucial elements for a CAL. It strengthens the fundamental concept of CAL that mostly found within the mainstream education system. Further, this study proceeds with the development process through prototyping technique. The prototype was successfully delivered to the LA

children, known as *iCAL4LA-Bijak Matematik*. Then, the user experience testing was carried out in school setting to evaluate the usefulness of the model (in a form of *iCAL4LA-Bijak Matematik* prototype) in terms of helpful aspect. The findings of user experience testing through Q-iCalH instrument indicate that *iCAL4LA-Bijak Matematik* is highly helpful in catering the needs of the LA children. However, in future this study requires a shift form standalone application to flexible learning platform to adapt with current online learning environment.

Acknowledgements

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