International Journal of Conceptions on Management and Social Sciences
Vol. 3, Issue. 2, April' 2015; ISSN: 2357 – 2787

Expert Review on Conceptual Design Model of Assistive Courseware for Low Vision (AC4LV) Learners

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Abstract— **This paper reports an ongoing project regarding the development of Conceptual Design Model of Assistive Courseware for Low Vision (AC4LV) learners. Having developed the intended model, it has to be validated prior to produce it as guidance for the developers to develop an AC4LV. This study requires two phases of validation process which are through expert review and prototyping method. This paper presents a part of the validation process which is findings from experts review on Conceptual Design Model of AC4LV which has been carried out through questionnaire. Results from 12 international and local experts from various respectable fields in Human Computer Interaction (HCI) were discussed and justified. In a nutshell, reviewed Conceptual Design Model of AC4LV was formed. Future works of this study is to validate the reviewed model through prototyping method prior to test it to the targeted users.**

Keywords- Assistive Courseware; conceptual design model; expert review; low vision learners

I. INTRODUCTION

As discussed previously [1], [2], [3] low vision learners need learning contents that are specifically designed for them. Courseware is one of the best learning content applications that could fulfill their needs in learning activities [4]. However, previous studies indicate that most of the available courseware are unable to fulfill their needs in learning activities specifically in terms of information accessibility, navigationability, and pleasurability aspects [2], [3]. Therefore, this study attempts to fulfill their needs by providing a courseware that is specifically designed catering their needs. It is named as Assistive Courseware for Low Vision (AC4LV) learners. Prior to develop the AC4LV that specifically caters their needs; a Conceptual Design Model has to be produced as a guide for the developers to refer to. Having developed the intended model, it has to be validated. Expert review is one of the methods that could be utilized to validate the proposed model [5], [6], [7]. Therefore, the main aim of this study is to validate the Conceptual Design Model of AC4LV learners through expert review. Meanwhile, the specific objectives are (i) to identify the experts of Conceptual Design Model of AC4LV and (ii) to review and validate the Conceptual Design Model of AC4LV. The next section discuss on a series of activities involved in this study to achieve both of the objectives.

II. METHODOLOGY

In this study a series of activities were carried out, as shown illustratively in Fig 1. The figure explains that this study involves two phases of activities which are identify experts, and expert review [8]. The activities involved in the first phase include identifying experts. Experts were selected based on certain criteria as discussed in the next subsection. Having identified them based on the specified criteria, invitation was sent to them through email. Having received their positive feedback, a consent form was sent to them which were also attached through email. From this phase, experts from local and international institutions were identified and the first objective of the study was achieved. They are discussed in detail in the next subsection. The second phase is expert review, in which the Conceptual Design Model of AC4LV was reviewed by the experts identified in phase one. Questionnaire has been used as the instrument for the experts to review the proposed model. At this stage, this study has achieved its second objective. Having finished the second phase, the whole objective of this study is achieved.

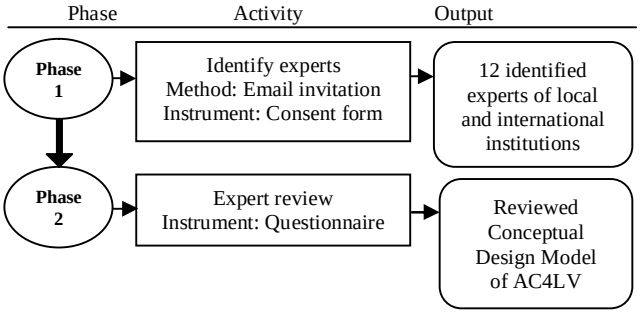

Figure 1.Summary of Activity

A. The Expert Criteria and Profile

Altogether, 22 invitations (11 experts for each local and international) were sent to the identified experts via email. Experts involved in this review process were selected based on the following criteria:

- Have PhD qualification either in AT or Special Educational Technology or Human Computer Interaction (HCI) or Multimedia or Instructional Design Expert or Computer Science (CS) related areas**or/and**
- Have at least five years teaching background either in AT or Special Educational Technology or HCI or Multimedia or Instructional Design Expert or CS related areas**and**
- Have been studying/researching either in AT or Special Educational Technology or HCI or Multimedia or Instructional Design Expert or CS related areas for at least five years.

Out of the 22 experts 12 of them agreed to participate as experts. This number is sufficient as supported by [9] and [10]. Hence, Table I displays the demographic profile of the experts.

TABLE I. DEMOGRAPHIC PROFILES OF THE EXPERTS

Expert	Gender	Field of Expertise	Experience	Affiliations
A	Female	Multimedia	20	UUM
B	Female	Multimedia for Children	10	UUM
C	Male	Learning Application	12	UUM
D	Female	HCI	16	UTP
E	Female	Educational Technology	12	UiTM
F	Female	Multimedia Application Accessibility	15	UKM
G	Male	Computers in Education	30	UTHM
H	Male	Instructional Design	26	UKM
I	Female	Special Educational Technology	28	USM
J	Female	AT and Universal Design	14	University of Auckland
K	Female	HCI Researcher / Software Engineer	5	University of Eastern Finland
L	Male	HCI (Visual Disabled Interface)	30	University of York

B. Instrument and Procedure

Throughout the review process the email was used as the medium of communication. First, an invitation was sent to the identified experts. Having agreed to be appointed as an expert reviewer, a consent form and an official appointment letter was sent to them. Having received the signed and stamped consent form, the illustration of the proposed model [11]together with the instrument was attached also via email. An ample time and opportunity was given to the experts to review the model and complete the questionnaire. Most of them took two to three weeks to complete all the tasks.

As mentioned earlier, the main instrument used for expert review is questionnaire. The format of the questionnaire is adopted from [5]. It contains five questions asking about the (1) relevancy of the proposed elements contained in the components of the AC4LV, (2) understanding of the design principles in each of the AC4LV elements, (3) terms used in the proposed model, (4) connections and flows of all of the components, and (5) readability of the proposed model. Experts were also asked a few demographic questions such as working experience and the highest level of education. Along with that, they were also encouraged to write their further comments in the provided instrument.

A list of the proposed components was provided in the first question in which the experts were required to verify the relevancy of the elements contained by the components (i.e. some are definitely not relevant or some may be not relevant or all are relevant). For the second question, eight elements of the AC4LV were listed: audio, formatting styles and texts, graphics, animations, transitions, navigational button, interface layout, and general interaction. The experts were required to verify their understanding for each of the proposed design principles included in those elements (i.e. needs very detailed explanation or needs some explanation or is easy to understand). For questions three to five, the experts were required to validate the items by answering "yes" if they agree with the statement and "no" otherwise. Finally, based on their expertise, experience, and perception, they were expected to write their further comments from an overall point of view regarding the proposed model. The next subsection discusses the findings of the review.

III. FINDINGS

The gathered data were recorded in frequency and tabulated in Table II based on the questions asked in the instrument. It is also plotted in the clustered column charts (Fig. 2, Fig. 3, and Fig. 4) which provide a straightforward and valuable way to illustrate the different frequency of responses.

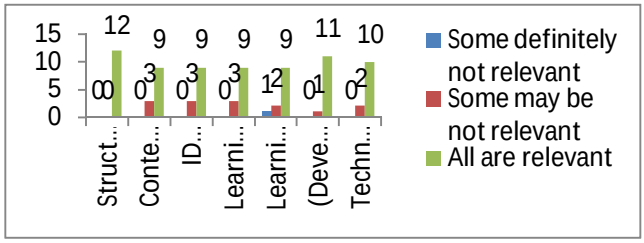

Figure 2. Relevancy of the proposed elements in the components of the AC4LV

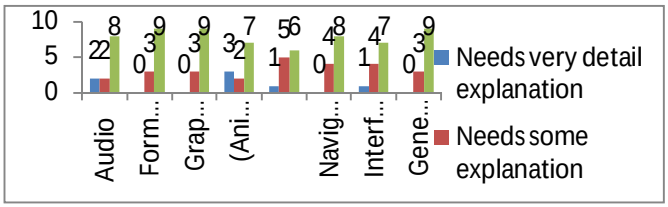

Figure 3. Understanding of the proposed design principles in the elements of the AC4LV

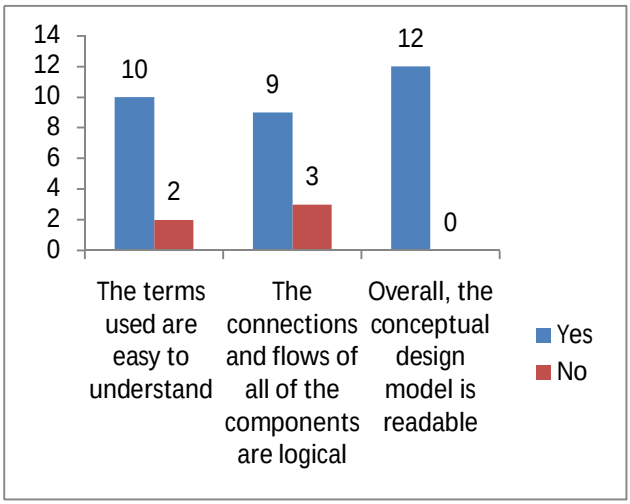

Figure 4. The terms, connections, flows, and readability of the Conceptual Design Model of AC4LV

TABLE II. FREQUENCY OF RESPONSE FROM THE EXPERT

Items		Frequency (n = 12)		
		Some are definitely not relevant	*Some may be not relevant*	*All are relevant*
Q1:	The proposed elements in the following components are relevant			
	a) Structural			12
	b) Content Composition		3	9
	c) ID Models		3	9
	d) Learning Theories		3	9
	e) Learning Approaches	1	2	9
	f) (Development Process)		1	11
	g) Technology		2	10
Q2:	The proposed design principle in the following AC4LV elements are understood	*Need very detail explanation*	*Needs some explanation*	*Is easy to understand*
	Audio	2	2	8
	Formatting styles and texts		3	9
	Graphics		3	9
	Animations	3	2	7
	Transitions	1	5	6
	Navigational button		4	8
	Interface layout	1	4	7
	General interaction		3	9
		Yes	*No*	
Q3:	The terms are easy to understand	10	2	
Q4:	The connections and flows of all the components are logical	9	3	
Q5:	Overall, the conceptual design model is readable	12		

Note: Q = Question

As exhibited in Fig. 3 through 5, majority of the experts agree that the proposed elements contained in each of the components are relevant. Besides, the proposed design principles for each of the elements is understandable except for some of the design principles contained in "animations", "transitions", and "interface layout", in which almost half of the experts need clarification on that. Also, majority of the experts agreed that the proposed conceptual design model contains understandable terms, logical connections and flows, and it is readable. However, the reviews reveal that two of the experts need clarification on the terms "conduction style" and "assistive content".

In addition, further comments from all of the experts are also recorded in this study as depicted in TABLE III In conveying the clearer meaning, some of the comments are rephrased from the original versions.

TABLE III. SOME FURTHER COMMENTS FROM THE EXPERT

Experts	Comments
A	(1) There are specific contents, elements, and technology for low vision learners. (2) What is the difference between elements in Content Composition and Element?
B	(1) Provide close confirmation pop up box. (2) Should provide quiz or summative test.
C	(1) For formatting styles and texts - needs some explanation for design principles no. 2 and 6. (2) Should provide logical flow, to show which component comes first.
D	(1) The proposed design principle box for AC4LV elements should be leveled according to the AC4LV elements in the Content Composition box. You may want to consider (i) Audio (ii) Visual (iii) User Interface Design (iv) General Interaction as in one level. Visual has many subsets that include Graphics, Formatting Styles and Texts, Animations, Transitions, and Navigational Button. (2) How does your model support social interaction? Consider item 7. Tabletop surface interaction as an option to choose to facilitate multi-user interaction when using the courseware.
E	(1) For audio - Provide volume adjustment. (2) For formatting styles and texts – design principles no. 2, the word "biggest" may be changed to "suitable". (3) For graphics – design principles no. 1, the word "clear" may be changed to "high quality". (4) For graphics – design principles no. 2, the word "biggest" may be changed to "suitable size".
F	(1) For content, human interaction, elements – you need to show aspects/elements accessibility which should be the main difference from other models. (2) Technology – download IS NOT a technology but web is.
G	(1) For content please be exact. Recommend the user how to proceed if they got stuck, confuse and lost.
H	(1) For learning theories you may consider adding connection. (2) Otherwise, the model is quite comprehensive.
I	(1) The visual ability of people with low vision is quite diverse.

	Their visual acuity, visual fields and ability to see contrast varies. Therefore, it is suggested that options are provided to change the following elements:(i)Background/foreground contrast: (e.g. yellow text on black background is quite popular; white text on black background, which seems to work better than black text on white background). You can also refer to Windows Accessibility options for the different types of contrasts. (ii) Text size- the biggest may not be the best. When the text is big, then the person has to scan more and that can be tiring for people with low vision. Again, it is better to provide the option to change the font size. You can refer to some websites whereby you can have the option of changing text size by just clicking on the size you want.(iii)Audio- has the option to turn it off/on. (iv) Graphics- graphics is actually a good element to have for low vision. People with low vision should not be deprived of graphics which is rich in information. However you need to make the graphics accessible for low vision. For example (i) graphics used need to be clear and distinct, (ii) avoid unnecessary details, provide only the relevant details to illustrate the intended point, and (iii) have the option to enlarge the graphics (zooming).
J	(1) It looks like a very interesting approach. (2) As indicated in the model, it is important to look at the auditory options - understand audification, sonification, auditory icons, and earcons. (3) Navigational button - must be placed in a location easily accessible - centre of screen, or bottom right are most common.
K	(1) For audio (i) allow users to easily control the audio playback and (ii) speed short and precise. (2) For formatting styles and text (i) text size should be adjustable (not only just large and (ii) predefined and customizable contrast settings. (3) For graphics (i) what is big graphics (define a size, in pixels or byte) and good contrast? (4) Transitions - animated transitions or what? I did not understand.
L	(1) Content composition: Pedagogical approach (i) AC4LV elements – (a) has audio - What does 'audio' refer to here? Audio can take many forms, notably speech and non-speech (and a lot of variation within those categories), so should not this be more specific? (b) has visual - does that include video? (ii) Presentation styles (i) could be (lecturing), instruction-based, demonstration -Is it a deliberate decision to be limited to these styles? What about others, such as problem-solving? (iii) Content delivery strategies - Formatted to Assistive Content - I am not sure what this means in this context (iv) Conduction styles - again, I simply do not understand what is meant here. (2) Elements: (i) Formatting styles and texts – has principles avoid using rollover text - Is that not too prescriptive? *Reliance* on rollover might disadvantage some, but if the information presented is redundant, it should not disadvantage them completely – and may be of assistance to others. I am unclear as to why one section states 'avoid using animated text', while another says, 'only animate the desired information'. The latter comes under the rule, 'follow the same rules as graphics and texts', so that appears to be a contradiction. (ii) Interface layout – (a) place menu area on the left side - why? I know of no interface guideline which prescribes this, (b) having simplicity and consistency - these are good principles – but sometimes hard to achieve, (c) avoid scrolling screen - why? Scrolling is almost inevitable; the information capacity of a single screen is limited. Would you not distinguish vertical and horizontal scrolling? Are you assuming that all presentations will be on large, desktop screens?

IV. Justification On Experts Comments

As for the remarks on the "technology" components this study agrees that "download" is not a technology, so the word "download" is replace to "website". Considering comments from Expert D that AC4LV not only could run on desktop, but also "tabletop surface" also is an option to choose to facilitate multi-user interaction when using the AC4LV. This also could support social interaction among the users. Another suggestion on "technology" is "mobile devices" in which AC4LV also should be run on "laptop", "tablet" or "smartphone". All suggestions on "technology" are put as "recommended to apply". To answer the comments and suggestions regarding flows and connections, this study admits the suggestion from Expert C to provide logical flow by numbering each of the components to avoid confusion and to show which component comes first. Also, connections between "AC4LV elements" in "content composition components" and "AC4LV elements" in "elements" were added. This is as suggested by Experts A, D, and F. Having accepted their ideas, it is established that "assistive content" is the focus of the Conceptual Design Model of AC4LV which should be the main difference from other models. This also answers the question by Expert L regarding "assistive content", which has also been explained in the previous article [2]. About the comments on the connections of "learning theories" and "learning approach" with the proposed design principles and the concerns from Expert G regarding the users' condition while using the AC4LV, they are discussed in detail in prototyping method.

As for the comments concerning "video" and "animations" elements, the justifications are as discussed in the previous article [2]. Also, about the remarks on "presentation styles", "teaching and learning techniques", and "conduction styles". However, to be clearer on "conduction styles" this study decides to reword the word "non-separated" to "non-separated scene" and the word "separated" is changed to "separated scene". This is to explain that "conduction style" is the flow of delivering the content in AC4LV, which is also influenced by the "style of presentation" and the learning content itself. Also, to answer about considering "problem-solving" as one of the "presentation styles", this study has already included it in "activity", which embeds PBL approach. Regarding the comments on "design principles" subject, majority of the experts need some explanation for the design principle "use the biggest font size" and "provide the biggest graphics". Two of the experts also comments that the biggest attribute do not mean the best for low vision learners. As a result, this study decides to change the word "biggest" to "preference". Besides, this study also counters the comments by Experts E and I about their concern on "provide clear graphic" the design principle. So, to be more comprehensible this study rephrases that design principles to "provide clear and distinct graphics" and include "avoid unnecessary details" as suggested by Expert I. Interestingly, Expert L also draws his attentions regarding the "avoid using rollover text", "having simplicity and consistency", "avoid scrolling screen", "avoid using animated text", "only animate the desired information", "follow the same rules as graphics and text", and "place menu area on the left side" principles. Additionally, Expert C and K need some

explanation on "transitions" and Expert J voice out her apprehension on "navigational button" and "interface layout". The answer for these has been justified in the previous article [2]. Thus, those commented design principles are retained. When Expert B recommends "provide close confirmation pop up box" it contradicts with the accessibility guidelines [12]. Captivatingly, one of the experts (from the software engineers' point of view) also pointed out her suggestions "to allow users to easily control the audio playback". This is inline with the design principle proposed in this study which is "provide repeatable function". The explanation also has been provided in the previous article [2] of this study.

This study focuses on content application, which is designed to have assistive features to make sure that learning content is delivered to the low vision learners without forcing them to operate any technical function in acquiring the presented information. This is also in-line with the definition of AT as discussed in [13]. It has to be emphasized that assistive in AC4LV ensures that the low vision learners could stay focus on the learning content without having distress to operate the technical function. Accordingly, suggestion from experts to have "volume adjustment", "turn audio on and off", "customizable texts size and contrast colors", and "customizable graphics size and colors" do not lead to the purpose of this study. As these is very easy for the low vision learners to get lost with the actual content and make them get fatigue easily [12]. This technical function also requires more instructions from the instructor, which actually lead the low vision learners to suffer from ear strain and simply get bored and less interested in learning[12], [14]. However, this study agrees with the suggestions by Expert I to decide the usage of colors for content in AC4LV rather than providing "customizable function" as discussed in detail in. Having understood the concept of "audification", "sonification", "auditory icons and earcons", and "notably speech and non-speech", as regards to the concerns by Experts J and L, it is beyond the scope of this study. "Audio" for this study is as defined in the previous article of this study[11].

V. Revised Conceptual Design Model of AC4LV

In efforts to provide a better impression and enhancing the readability, the Conceptual Design Model of AC4LV has been revised and redesigned based on the comments from the experts as illustrated in Appendix I.

VI. Conclusion and Future Work

Overall, this study presents an ongoing study regarding the development of courseware, which is specifically designed for low vision learners which is called AC4LV. Prior to develop the AC4LV a conceptual design model has to be formed. This is important for the developers who intend to develop an AC4LV to refer to the proposed model as guidance. Previous article of this study has discussed about the steps in developing the proposed model [2][3]. Thus, in this paper the proposed model has been validated through expert review method which involves 12 experts from local and international institutions. Having performed the experts' validation, the proposed model also has to be validated through prototyping method prior to test it to the low vision learners from age nine to 12 years old which will be carried out the future works of this study.

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