User experience testing on interactive assistive courseware for young low vision learners: Observation approach

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Abstract. This research reports an ongoing project related to user experience testing of interactive assistive courseware which specifically designed to cater the needs of young low vision learners. It is called as AC4LV which has been developed by utilizing User Centered Design (UCD) approach. To ensure the usefulness of AC4LV, it has to be tested to the targeted users. Initial round of user experience testing has been carried out and reported in the previous studies. From the testing, rich and valuable data were gathered through the reactions and behaviours of low vision learners while using the AC4LV. Also, their opinions regarding the AC4LV which gathered through their thought in the interview session has been discussed previously. Thus, to overcome the weaknesses and intrinsic biasness that came from the previous testing and to produce a more comprehensive interpretation, the second round of observation approach is needed. Think aloud protocol has been utilized throughout the testing. The result explains the usefulness of AC4LV in terms of information accessibility, navigability, and pleasurability.

Keywords: Human Computer Interaction, Interaction Design, Assistive Technology, User Centred Design Approach, Low Vision, User Experience

1. Introduction
Learning is one of the most challenging task in disabled peoples’ life. Starting from organizing their personal care until reading, writing, and understanding the learning content; those tasks are very problematic and crucial for them to wade it independently. Usually, they expect assistants from parents in doing normal daily tasks. Nevertheless, there are some parents that have lack of knowledge on how to guide and train their disabled children to learn in organizing their basic routine independently. As a result, the potential of their disabled children are not well-explored perfectly. On the other hand, there are also parents who let schools and teachers to completely assist their disabled children in learning, with the hope that at least their children are able to organize themselves independently in future days.

In school, the disabled children are introduced to rough and fine motor learning skills for their cognitive and physical development. It is very tough to ensure that they can grasp the knowledge efficiently. Knowledge could be delivered in many forms; for children with disabilities. Interactive learning content application is one of the appropriate examples. However, most of the existing conceptual design model particularly for interactive learning content application not catering
specifically to their needs in learning activities [1]. Hence, to overcome the problem this study proposes an interactive assistive courseware for people with disabilities (PWDs).

Among the various types of disabilities, low vision is considered the serious one as the numbers are keep increasing year by year [2]. Currently, as reported in the literature there is no standard learning model specifically designed to cater the needs of young low vision learners in learning activities [3]. The learning materials for low vision learners are similar with general students. Usually, they uses textbook and flash cards with the assistance of Assistive Technology (AT) (i.e. closed circuit television and magnifying glasses). However, the use of AT requires the low vision learners to operate it on their own which is difficult for young low vision learners particularly who grows in developing countries [4]. To overcome that problem, teachers uses their creativity to deliver the knowledge to low vision learners. As an example, they print the learning materials in A3 size paper in which this is not the practical solution for future generations [5].

Therefore, to overcome the problem, conceptual design model of assistive courseware for young low vision learners has been designed and developed in this study. It is called as AC4LV [5]. AC4LV has been developed by utilizing User Centered Design (UCD) as the needs of them is the priority [6]. Figure 1 displays the screen shot of AC4LV. To ensure the usefulness of AC4LV it has to be tested to the targeted users. The initial round of user experience testing has been conducted in the previous study [7]. The results have been reported in terms of information accessibility, navigatability, and pleasurablity based on the components and elements provided in the AC4LV. Thus, to increase the confidence of findings second round of user experience testing were carried out in this study. The next section of this article explains the materials, method and procedure that used to conduct the user experience testing of AC4LV to low vision learners.

2. Materials and method

Since the target users of this study are young low vision learners, so qualitative research method is appropriate to ensure the truthful results [10]. As shown illustratively in Figure 2, a series of activities has been carried out throughout this study. There are two phases involves in this study which are (i) investigating user experience and (ii) result analysis. In the first phase the subjects’ behaviours and reactions while using the AC4LV were observed. They were recorded in the form of note taking, photographs, audio, and video. Next, all the gathered data were transformed into transcripts. Two experts have been appointed to review and validate the transcripts. The reviewed and validated data were then analysed in the second phase. Having finished both phases, the objective of this study is achieved.
2.1. Sampling technique and sample size
In this study the subjects are young low vision learners from standard three to six with the average age nine to ten. They are homogenous subjects, therefore the appropriate sampling technique to be utilized in this study is purposive sampling technique [8].

2.2. The user experience procedure
The user experience testing comprises of three sessions: (i) briefing, (ii) observation, (iii) and closing. Having setup all the materials, the experiment commenced by introducing the researcher and the team members. This session also highlights the purpose of the testing and the matter that the subjects have to do next. In the second session, the subjects were assigned to use the AC4LV for 30 minutes. Having finished the observations, tokens were given to the subjects in the closing session as an appreciation of participating in the testing. Figure 3 illustrates the procedure throughout the testing session.

![Figure 2. Summary of activities](image)

| Phase | Activity | Outcome |
|-------|----------|---------|
| Phase 1 | User experience investigation in terms of: Information accessibility, Navigationability, Pleasurabilty | The behaviours and reactions of low vision learners to AC4LV. |
| Phase 2 | Analyse result in terms of: Information accessibility, Navigationability, Pleasurabilty | Subjective findings in terms of: Information accessibility, Navigationability, Pleasurabilty |

![Figure 3. The testing procedure](image)
2.3. Think aloud protocol
In understanding the subjects inner feelings think-aloud protocol was applied in the observation session. While using the AC4LV, the subjects were encouraged to express their thoughts, feelings, and emotions [9].

3. Result and discussion

3.1. Demographic background of the subject
The final round of user experience was conducted at Special Education Primary School of Alma (Visual impairment) as this school is completed with facilities that are specifically designed for the low vision learners. Table 1 provides detail demographic background of the subjects. Totally 11 subjects involved in the experiment, in which ten of them (90%) were male and only one (10%) was female. The unevenness of male and female subjects are not the main issue, as the main purpose of this study is to investigate to what extend the AC4LV could fulfill the needs of low vision learners in learning. All of them were in the range of nine to 12 years old. Their maximum experience in using computer is three years. Meanwhile, the minimum is three months as seen in Figure 4. Particularly, Subject 7 has experienced using computer since he was in pre-school. In contrast, Subject 10 has only been using computers since the three months after moving into the school from an ordinary primary school. All of them have experienced using online typical courseware as mentioned in the previous testing [7] except for Subject 10, who was still new in exposure of typical courseware. He has been using online typical courseware since the last three months. So, this study concludes that all of the subjects have experienced using typical courseware as illustrated in Figure 5.

Table 1. Demographic background of the subjects

| Subjects    | Age | Gender | Race  | Level of School | Experience of using computer (years) |
|-------------|-----|--------|-------|-----------------|--------------------------------------|
| Subject 1   | 12  | Male   | Malay | Standard 6      | 3 years                              |
| Subject 2   | 12  | Male   | Malay | Standard 6      | 3 years                              |
| Subject 3   | 11  | Male   | Chinese | Standard 5 | 1 year                               |
| Subject 4   | 11  | Male   | Chinese | Standard 5 | 2 years                              |
| Subject 5   | 11  | Male   | Chinese | Standard 5 | 1 year                               |
| Subject 6   | 10  | Male   | Chinese | Standard 4 | 2 years                              |
| Subject 7   | 9   | Male   | Malay | Standard 3      | 3 years                              |
| Subject 8   | 10  | Male   | Malay | Standard 4      | 1 year                               |
| Subject 9   | 10  | Male   | Malay | Standard 4      | 1 year                               |
| Subject 10  | 10  | Male   | Indian | Standard 4   | 3 month                              |
| Subject 11  | 10  | Female | Malay | Standard 4      | 3 years                              |
3.2. Analysis of findings

The analysis of findings is categorized into three themes which are: (i) information accessibility, (ii) navigability, and (iii) pleasurability. They are discussed differently based on the components and elements provided in AC4LV. The AC4LV were played to them and let them use it without assistance or interruption by anyone until the end. Their behaviors while using the prototype was recorded through notes, photographs, and video.

3.3. Theme 1: Information accessibility

Having conducted the observation, their behavioral related to texts, audio, graphics, animations, transitions, and interface layout were found and recorded as in Table 2.

| Codes | Occurrences |
|-------|-------------|
| 1. Texts | • Subjects spoke-aloud by reading the contents appear on the screen. (i.e. “Ikan.., kura-kura”).  
• Subjects spoke-aloud the questions for activities that appear on the screen. |
| 2. Audio | • Subjects followed the instructions carefully and smoothly.  
• Subjects concentrated on auditory explanation.  
• Subjects imitated the auditory explanation by “Smiley”.  
• Subjects imitated the songs.  
• Subjects imitated the animal sounds (i.e. quacking). |
| 3. Graphics | • Subjects named the parts of the animals’ body (i.e. tail, horn, and ears) before the instructor explains it to them.  
• Subjects were able to select the attributes on their own. |
| 4. Animations | • Subjects mimic the “Smiley” movement. |
| 5. Transitions | • Subjects captured the texts or graphics by reading the texts or name the graphics every time they transit on the screen. (i.e. “Topik 4... Bunyi Haiwan”) |
| 6. Interface Layout | • Subjects were able to recognize the location of menu area and content area by pressing the keyboard confidently without guidance from anyone. |
When the AC4LV was started, they followed the instructions carefully and smoothly scene by scene. Sometimes, the subjects were found imitating the songs (Figure 6), the animals sound (i.e. “quack, quack, quack”), and the explanation by the “Smiley” (i.e. “Saya adalah seekor kucing”).

This situation indicates that the audio provided in the AC4LV is useful which means providing meaningful sound effects is really important to the low vision learners. Also, this situation proves that audible instructions and auditory explanation is much more important to the low vision learners in order to make the learning material provide means to them.

Moving on to texts, similar with the findings in initial round of user experience, the subjects were found speaking-aloud the contents on the screen, indicating that they were capable to read the provided texts in the AC4LV without struggling themselves (i.e. “ikan…kura-kura”). They also spoke-aloud the questions for activities that appear on the screen without any difficulties. This helped them to perform the activities smoothly. Having found their reactions on texts in the AC4LV, this study deduces that texts provided in the AC4LV are able to be accessed by the low vision learners as well as the knowledge presented on the screen.

Regarding graphics, this study concerns on whether the subjects could recognize graphical elements or not to ensure knowledge is well-delivered. Through the AC4LV the subjects faced no problem in selecting the attributes while performing the activities (Figure 7). They were also able to recognize the graphics in advanced before the instructor explained it to them (i.e. name the parts of the animals’ body) (Figure 8). These occurrences were also found during the initial round of user experience, which explains that graphics provided in the AC4LV are able to be accessed by the low vision learners without facing any problem.
For the animations provided in the AC4LV, subjects were observed mimicking the “Smiley” movement showing that they were able to capture the provided animations. Result of observing the subjects’ reactions to animations indicating that providing the slow motion animation is more meaningful to the low vision learners compared to animations that are commonly provided in typical courseware for general users. In regards to transition the observation reveals that the subjects were observed able to capture the texts or graphics every time they transit on the screen. This could be seen when they were able to read texts simultaneously with the transition (i.e. “Topik 5...Gerak Haiwan”). This means the transitions in the AC4LV is useful to the low vision learners.

The last but not least, the elements that was also observed in confirming the information accessibility is interface layout. They were observed able to recognize the menu area and content area by pressing the button for the menu confidently without asking anyone throughout their exploration. All the findings indicate that the interface layout in the AC4LV is catering to information accessibility.

3.4. Theme 2: Navigationability

To find out whether the AC4LV could fulfill the needs of low vision learners in navigationability, three codes were observed; navigational button, interface layout, and general interaction. Table 3 exhibits the findings, which are further discussed in the remaining parts of this section.

| Code               | Occurrences                                                                                                                                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Navigational button | • Subjects were able to press all the buttons themselves without assistance from anyone.  
• Subjects recognized how to navigate to other page by counting the button carefully.  
• Subjects were able to navigate the contents and activities themselves without assistance from anyone. |
| 2. Interface Layout  | • Subjects were able to explore throughout the contents and activities logically as expected.                                                   |
| 3. General Interaction | • Subjects interacted with the AC4LV based on the instructions (self-interaction).  
• Subjects sometimes looked at their peers to make sure the content is similar.  
• Subjects were able to press the keys before the instructions completed.  
• Subjects sometimes discussed about the content with their peers (social interaction).  
• Subjects were able to interact with the AC4LV smoothly.  
• Subjects were able to remember most of the keys that they have to press after got the first guidance. |

During the observation, all of the subjects were able to press all the provided navigational buttons themselves without assistance from anyone. Interestingly, they were observed counting the buttons carefully to confirm which keys they have to click to move to another topic. They were also found able to navigate the content and activities in the AC4LV without guidance from anyone (Figure 9). These findings prove that the subjects were able to recognize the navigational buttons provided in the AC4LV that could guide them navigating the AC4LV on their own without make the low vision learners lost in their learning activity.
It was also interesting to notice that how the subjects made use of the interface layout provided in the AC4LV. The subjects were able to explore throughout the contents and activities in the AC4LV logically as expected. It pointed out that the interface layout in the AC4LV caters the navigationability more effectively, that could assist the low vision learners navigating the AC4LV on their own.

Further, this paragraph and the remaining discuss the general interaction provided in the prototype. While using the AC4LV, the subjects were found able to have self-interaction with the AC4LV based on the provided instructions (Figure 10). Interestingly, as found in initial round of user experience, the subjects were able to press the keys in advanced before completing the instructions. They were also sometimes looking at their peers to ensure that the content is similar and they are not lost (Figure 11).

Sometimes, they were also clarifying about the content with their peers which then create social interaction among them. Throughout the testing, the subjects were found facing no difficulty in interacting with the AC4LV, which means they were able to interact sequentially and smoothly. After getting the first guidance, the subjects were found able to remember all the keys that they have to press. This can be seen when they skipped the instructions.

Having tested the prototype, this study found that providing auditory guidance and instructions is important for the low vision learners to interact with the learning material provided for them. This is because the subjects are stuck, lost, and misunderstand without clear guidance.

3.5. Theme 3: Pleasurability
While using the AC4LV, the subjects expressed their pleasurability as noted in Table 4.
### Table 4. Pleasurability codes’ and occurrences on AC4LV

| Codes         | Occurrences on AC4LV                                                                                                                                                                                                 |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Excited    | • Subjects pressed the Enter button trying to start the AC4LV themselves.                                                                                                                                              |
| 2. Enthusiastic | • Some of the subjects already started playing the AC4LV without permission.                                                                                                                                            |
| 3. Curiosity  | • Subjects asked “Teacher, can I start?”                                                                                                                                                                                |
| 4. Interested | • Subjects stayed focused on the content explained to them.                                                                                                                                                              |
| 5. Comfortable | • Subjects followed the contents in relax mode without any pressure.                                                                                                                                                   |
| 6. Enjoyed    | • Subjects sang along with the AC4LV.                                                                                                                                                                                  |
|               | • Most of the times subjects imitated the “Smiley” voice.                                                                                                                                                               |
|               | • Subjects imitated the animals’ sound.                                                                                                                                                                                 |
| 7. Sense of humor | • Subjects laughed when listening to the animal’s sound (i.e. cow mooing)                                                                                                                                              |
|               | • Subjects laugh when they got wrong answer (glee with the “Smiley” response).                                                                                                                                           |
| 8. Amused     | • Subjects smiled when “Smiley” starts introducing herself and the objective of the course.                                                                                                                             |
|               | • Subjects smiled when the instructor explains the content.                                                                                                                                                              |
| 9. Happy      | • Subjects clapped their hands when got 100% marks for the activity.                                                                                                                                                   |
|               | • Subjects raised a hand when got 100% marks for the activity.                                                                                                                                                         |
|               | • Subjects expressed “yeay” when got 100% marks for the activity.                                                                                                                                                     |
| 10. Released  | • Subjects were able to finish all the topics and activities smoothly without any interference.                                                                                                                           |

At the beginning of the AC4LV, Subjects 4, 8, and 9 were found excited, trying to press the Enter button to start the AC4LV themselves. Also, Subject 7 was enthusiastic and started playing the AC4LV without permission. Also, Subjects 8, 9, and 11 were found curious because they requested to start the AC4LV “teacher, can I start?”. They were also found smiling when the “Smiley” start introducing herself and the objective of the course. All these behavior indicate that having seen the first scene, the subjects already feel pleasure in their heart, and makes them excited, enthusiastic, and curious to start the AC4LV. Having started the learning activities, all of them were found staying focused on the content, indicating that they were interested with the content in the AC4LV. This could be seen when they were able to follow all the content in relax mode without any pressure. This means they were comfortable. They were also smiling when the instructor explained the content, indicating that they were attracted to the voice intonation (Figure 12). This means the AC4LV amused them. All of the subjects were observed singing along with the AC4LV and most of the times they imitated the “Smiley” voice and the animals’ sound (Figure 13). They enjoyed the AC4LV. All of the subjects were found laughing for the animals sound (Figure 14), and when they got the wrong answer. For them, it was humorous. Subjects were also happy when they got 100% marks for the activity by clapping their hands, raising a hand, and expressing “yeay” (Figure 15). Because of they have no problem with the information accessibility and navigationability the subjects were found released and able to finish all topics and activities smoothly without any interference.
Having tested the prototype this study found that AC4LV successfully caters to pleasurability aspect. This could be seen obviously through their behavior and reactions while using the prototype.

4. Conclusion

This study achieves the objectives to test the usefulness of AC4LV in terms of information accessibility, navigationability, and pleasurability. At this stage, the user experience testing has been carried out through observation. The results explained that all the components and elements provided in AC4LV is useful to the targeted users. Their reactions and behaviour indicates that more future works to come for them in effort to accelerate their learning activities inline with this digital era. Future works of this study is to gather the expression of low vision leaners using the AC4LV through semi-structured interview.

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