Technology for Visually-Impaired: Identifying Flaws in Assistive Courseware

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***Abstract*—Technologies for visual-impaired people have been widely developed, covering hardware and software. In terms of software, the technology is divided into infrastructure and content. Designing appropriate content technology is very important for the visually-impaired people to support their special constraints. Such content technology, which is called assistive courseware for visually-impaired (AC4VI) has to strategize appropriate elements for efficient information accessibility, navigationability, and pleasurability. This study develops such content technology, based on a systematically and scientifically developed model. Having developed the content technology, it was tested with the real subjects, children of Year 1 in visually-impaired curriculum. To accommodate the needs of the children, this study utilizes qualitative approach. Prior to running the actual testing, a pilot test has been conducted to ensure the actual testing could run smoothly. The initial round of the pilot test reveled that there were problems in terms of the feasibility of the prototype and data collection method. Therefore, to overcome the flaws, the second pilot test was carried out. The test was segmented into four section: (i) briefing, (ii) observation, (iii) interview, and (iv) closing. In the end, it was found that such content technology has to be experienced individually. Also, semi-structured interview has to be conducted individually. The AC4VI, as a content technology for visually-impaired is as important as the infrastructure.**

***Index Terms*—Assistive Technology (AT); Assistive Courseware; Multimedia Technology.**

I. INTRODUCTION

Low vision refers to a person who has a profound visual disability, but still retains some useful eyesight. Low vision is resulted from two possible sources which are reduced visual acuity and restricted field of view [1]. In the context of this study low vision refers to "reduced visual acuity", which means having a limited ability to discriminate visual detail (Figure 1). There are various types of visual impairment. While Figure 1 depicts low vision, others show visual field loss such as central field loss (Figure 2) that is caused by macular degeneration, certain field loss (Figure 3) that is caused by retinopathies diabetes, and reduction of vision field (Figure 4) that is caused by retinitis pigmentation [2]. The rational of focusing to low vision learners has been discussed in [3].

In Malaysia, the number of their population is drastically increasing. As an instance, there were 18,258 reported in 2006 and the latest numbers of them reported in 2014 are 50,827 [2]. The numbers also include children who need quality education similar with normal students because they are also part of the resource for the country.

Figure 1: Low vision

Figure 2: Central Field Loss

Figure 3: Certain Field Loss

Figure 4: Reduction of Vision Field

In Malaysia, the number of their population is drastically increasing. As an instance, there were 18,258 reported in 2006 and the latest numbers of them reported in 2014 are 50,827 [2]. The numbers also include children who need quality education similar with normal students because they are also part of the resource for the country.

Assistive technology (AT) such as screen reader, magnifying glasses, CCTV, and screen magnification could help them a lot in their learning activities as well as in their life routine. Unfortunately, it is too expensive and most of the low vision learners are from developing countries [4]. Additionally, most of the AT are provided in the form of hardware and software which are difficult for the low vision learners particularly children to operate on their own. They usually need help from instructors. Furthermore, using AT such as magnifying glasses making them look different between their sighted peers. This could phsycologically affect their motivation in learning [5].

Due to that, digital learning content is a good alternative as most children in digital age have been well-exposed to technologies. However, this study found that most of the available digital learning content do not support them particularly in terms of information accessibility and navigationability, thus they feel frustrated and have no pleasure in learning [6]. As depicted in Figure 5, the behavior of the subjects indicates that the learners face difficulties in grasping the knowledge delivered through the available typical courseware (TC) [7].

Therefore, this study manage to come out with a conceptual design model that is specifically designed according to the needs of the low vision learners [8]. To validate the designed model, expert review method was conducted [9]. Also, a form of digital learning content, which is called as Assistive

Courseware for Low Vision learners (AC4LV) was developed [3] (Figure 6).

Figure 5: Low vision learners using typical courseware with the help from instructor

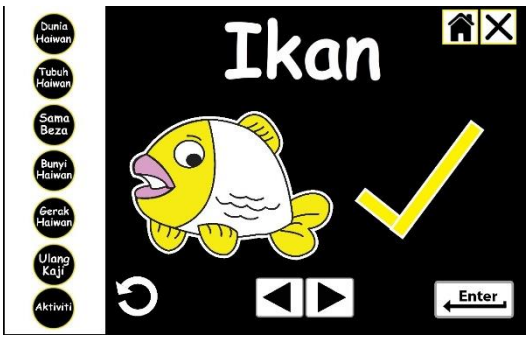

Figure 6: Sample screenshot of AC4LV

Prior to running the AC4LV in the actual learning environment, it is important to ensure that the AC4LV could fulfill the low vision learners' learning needs as well as ensuring that it is useful. So, to investigate the usefulness of AC4LV, this study found that qualitative approach is the most appropriate because the subjects are children with visual impairment [10]. Meanwhile, user experience testing was found as the appropriate method as this study seek for their behavior while interacting with the AC4LV [11] as well as gathered the thruthful results. Thus, before conducting the actual user experience testing, it is important to ensure that there is no flaw occurs during the test. Hence a pilot test is necessary.

An initial round of the pilot test which is called as pilot test I, has been conducted, in which it revealed that there are problems in terms of the feasibility of the prototype (AC4LV) and data collection method. Therefore, to overcome the results gathered in the pilot test I, this study conduct the pilot test II of AC4LV, which is called as final round. It was carried out based on the methods discussed in the next section

II. METHODOLOGY

The main method utilized are observation and interview. Figure 7 illustrates the summary of activities involved in the test.

A. Pilot Test with Low Vision Learners

In this study, pilot test was carried out with the main objective to investigate the wellness and consistency of user experience testing. Meanwhile, the specific objectives are (i) to determine the feasibility of the proposed model (prototype of AC4LV) and (ii) to identify any problems with the equipment and data collection methods [12]. This investigative work is important in determining if there are flaws, limitations, or other weaknesses in the prototype of AC4LV, equipment, or data collection methods which allow this study to make necessary revisions prior to commencing the main study of user experience testing as suggested by Turner (2010) and [14]. Both of the objective are used to conduct pilot test I and pilot test II.

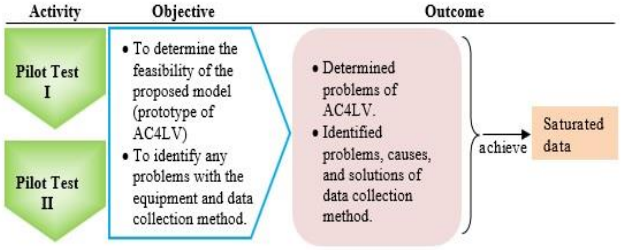

Figure 7: Summary of activities

B. Pilot Test I

The initial round of pilot test was carried out at one of the Integration Primary School (Visually-impaired) in Malaysia. Seven low vision children between nine and 12 years old involved in this test. Four of them were males while the remaining were females. However, one of the girls has to be excluded, because she was standard two, which is beyond the scope of this study. So, the total of the subjects considered in the test is six (Figure 8).

Figure 8: Sample of subject involves in pilot test 1

C. Pilot Test II

Having gone through the experience in the pilot test I, the strategy was changed in the pilot test II. It was conducted at one of the Special Primary School of Visual Impairment in Malaysia. This school is facilitated with a computer lab that is specifically designed for VI learners including low vision. There were nine low vision learners participated in the test, ranging between nine and 12 years old. Seven of them were boys while the remaining two were girls. However, one of the boys has to be excluded from the analysis because he was totally blind, which is beyond the scope of this study. So, the total subjects involved in the pilot test II are eight (Figure 9). Next subsection discusses the detailed procedure of the pilot test.

Figure 9: Subjects involved in pilot test II

D. Procedure of Pilot Test

In this pilot test, two research assistants were employed to assist the researcher in setting up the testing. Having setup the AC4LV on the desktop as well as other equipment for observation as mentioned in the pilot test I, the subjects were asked to sit next to each other as comfortable as they prefer. It has to be emphasized that getting natural setting of learning environments is important for this study to obtain the truthful results. Each of the subjects was attached to one desktop that was equipped with headset individually as exhibited in Figure 10. Getting familiar scenario is important for qualitative study to obtain the valuable and truthful data. Figure 10 also shows the similar scenario of the learning environment that the subjects go through in their routine learning activities. This is highly important in avoiding the subjects feeling weird, afraid, or stressed during the testing.

Figure 10: Sample of subjects involve in pilot test II

Similar to pilot test I, the testing was segmented into four. By utilizing the complete equipments, the subjects were shortly briefed about the researcher and the team members as well as the purpose of the testing. Having finished the first session, session two started by recording the observation through notes, video, and photographs using think-aloud protocol. The time allocated for them is 30 minutes, which was sufficient for them to explore all the topics and activities contained in the AC4LV. After that, focus group interview was conducted in a relaxed environment to encourage them to talk as much as they desired. The last but not least, tokens were given to each of the student as appreciation of their involvement in the testing.

III. Result and Discussion

A. Flaws Found in Pilot Test 1

It is important for this study to attach one computer for one subject in order for them to get the experience of using AC4LV individually. This is due to the results obtained from the observation, that one of the subjects of Group 1 showed uninterested to join the testing as he faced restricted access to the laptop. Furthermore, it was found that audio is not applicable to be played through loud speaker, which could disturb each of the group. Even this procedure has not affected the whole results but the experience of using the AC4LV is important to each of the subject. Due to the detected problems, the second round of pilot test has to be conducted in future works of this study.

B. Findings of Pilot Test II

After encountered all the problems addressed in the previous pilot test, the final round of pilot test found no problem with the prototype itself. Each of the subject has experienced the AC4LV smoothly. The observation in the test has given rich data in terms of the subjects' behavior and their reactions while using the AC4LV. The data are really important for this study to interpret the experience of the low vision learners in going through the AC4LV. Meanwhile, in terms of data collection methods, focus group was found quite challenging, especially in handling the subjects. At this stage, it was very hard for the researcher to get their own opinion in regards to answering the similar set of semi-structured interview questions. However, with the existing communication and psychological skills, this study successfully gathered the intended data. As to compliment the data, the subjects were interviewed individually face-to-face.

C. Interview and Observation of Pilot Test

By utilizing non-participant and structured observation with think-aloud protocol, rich and valuable data of subjects' behavior while using AC4LV were gathered from both of the pilot tests. Eventhough the operationalizing the activities in pilot test I were quite challenging for the researcher, to observe the two groups simultaneously due to their position, the session was backed-up with the video recording for observation. Due to that, in the final cycle of the pilot test, this study managed to set the position of the subjects in two lines, which was easy for the researcher to observe and record their behavior in the recording sheets as well as annotating their comments alive. Also, video recording is important as the backup for any missing data.

Table 1
Types of interview questions

Types of interview questions No.	Types of questions	Information Collected	Example
1.	Background or demographic	About the background or characteristics of the subject such as name, age, and level of school.	How old are you?
2.	Experience or behavior	About what the subjects do or have done.	Have you ever used a courseware before? If so, which course/title?
3.	Opinion or values	About what the subjects think regarding their experience and interpretive process or believe to be important.	What are the strengths of this courseware?
4.	Feeling	About the subjects' emotional reactions to their experiences and thoughts.	What are some of the things you really like about this courseware?
5.	Sensory	About what the subjects experience through their five senses (seen, heard, touched, tasted, and smelled).	What have you seen in this courseware?
6.	Knowledge	About the factual information that the subjects know or have.	Since when have you used computer?

To consolidate the information gained from the observation and to provide corroboration of the data, interviews were conducted with the low vision learners in both of the pilot studies. Interview questions were conducted in semi-structured format. Patton (2002) discussed different types of interview questions as exhibited in Table 1.

Interview would provide means in obtaining genuine information from children because children even as young as three years old are able to give graphic representations and are able to recall their experience excellently [16]. However, to ensure that the children could recall and convey their experience completely, accurately, and consistently, the content, timing, number, and structure of interviews have to be set in a proper way [16]. So, it is particularly important that the interview questions are piloted to guarantee that the structure, language, and length of the interview questions are acceptable [10].

It was found that majority of VI learners in Malaysia, face difficulties in understanding English, so mother tongue language was decided as the most appropriate medium [17]. The interview was started with informal chats with the subjects to build-up the harmonized environment [18].

IV. CONCLUSION

Based on the two cycles of the pilot test, rich experience were collected as guidance for this study to conduct the actual study of user experience testing. As Kim (2010) points out, a pilot study may not be intended to produce results. Thus, this study aims to investigate the wellness and consistency of user experience testing. Thus, both of the pilot studies have achieved the objectives. It was found that, the AC4LV has to be experienced individually. This means that one computer is attached to one subject because testing the AC4LV in groups was found not practical for this study. Also, semi-structured interview has to be conducted individually not as focus group interview for the reason as discussed previously. Future works of this study will reports on actual user experience testing which possibly involves treatment and control group.

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REFERENCES

[1] J. Fraser and C. Gutwin, "A framework of assistive pointers for low vision users," *Proc. Fourth Int. ACM Conf. Assist. Technol. - Assets '00*, pp. 9–16, 2000.

[2] Malaysian Department of Social Welfare, "Laporan Statistik," 2016.

[3] A. Nurulnadwan, M A. Ariffin, and S. Siti Mahfuzah, "The design principles of assistive courseware for low vision (AC4LV) learners," *ARPN J. Eng. Appl. Sci.*, vol. 10, no. 3, pp. 1447–1456, 2015.

[4] World Health Organization, "Visual impairment and blindness," 2016.

[5] J. Khadka, B. Ryan, T. H. Margrain, J. M. Woodhouse, and N. Davies, "Listening to voices of children with a visual impairment: A focus group study," *Br. J. Vis. Impair.*, vol. 30, no. 3, pp. 182–196, Sep. 2012.

[6] A. Nurulnadwan, M A. Ariffin, and S. Siti Mahfuzah, J. Mohd Saifullizam, "Preliminary investigation on creative educational content for visually-impaired (VI) learners," in *Advances in Visual Informatics*, 3rd ed., H. Badioze Zaman, P. Robinson, O. Patrick, T. K.Shih, and S. Velastin, Eds. Switzerland: Springer International Publishing, 2013, pp. 408–417.

[7] A. Nurulnadwan, M A. Ariffin, and S. Siti Mahfuzah, "Integrating multimedia learning theory in assistive courseware for low vision learners," *J. Teknol.*, vol. 78, no. 2–2, pp. 49–56, 2016.

[8] A. Nurulnadwan, M A. Ariffin, and S. Siti Mahfuzah, "Conceptual design model of assistive courseware for low vision (AC4LV) learners," *Proc. Int. Conf. Adv. Educ. Technol. (ICAET '14)*, pp. 1–12, 2014.

[9] A. Nurulnadwan, M A. Ariffin, and S. Siti Mahfuzah, "Expert review conceptual design and development model of assistive courseware for young low vision (AC4LV) learners," *Int. J. Conceptions Manag. Soc. Sci.*, vol. 3, no. 2, pp. 35–39, 2015

[10] C. Shaw, L. Brady, and C. Davey, *Guidelines for research with children and young people*. NCB Research Centre, London., 2011.

[11] R. Hartson and P. Pyle, *The UX book, process and guidelines for ensuring a quality user experience*. London: Elsevier, 2012.

[12] J. Herrington, "Authentic learning in interactive multimedia environments," (Doctoral Dissertation, Cowan University Faculty of Science, Technology and Engineering, 1997), 1997.

[13] D. W. Turner, "Qualitative interview design : A practical guide for novice investigators," *Qual. Rep.*, vol. 15, no. 3, pp. 754–760, 2010.

[14] Y. Kim, "The pilot study in qualitative inquiry: Identifying issues and learning lessons for culturally competent research," *Qual. Soc. Work*, vol. 10, no. 2, pp. 190–206, May 2010.

[15] M. Q. Patton, *Qualitative research and evaluation method*. Thousand Oaks: SAGE Publication Ltd, 2002.

[16] S. Docherty and M. Sandelowski, "Focus on qualitative methods: Interviewing children," *Res. Nurs. Health*, vol. 22, no. 2, pp. 177–185, Apr. 1999.

[17] N. Aziz, N. Roseli, E. E. Eshak, and A. A. Mutalib, "Assistive courseware for the visually impaired based on theory of multiple intelligence and SECI model," *Am. J. Econ. Bus. Adm.*, vol. 3, no. 1, pp. 150–156, 2011.

[18] S. Patomäki, R. Raisamo, J. Salo, V. Pasto, and A. Hippula, "Experiences on haptic interfaces for visually impaired young children," *Proc. 6th Int. Conf. Multimodal Interfaces*, pp. 281–288, 2004.