

Integrating Learning Approach in Interactive Assistive Courseware for Young Low Vision (AC4LV) Learners

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Abstract – This paper proposes an interactive assistive courseware for young low vision learners particularly at primary school level. It was reported in the previous literatures that low vision learners face difficulties in their learning activities since they have to utilize the similar learning materials as general students. As a solution, this study proposes an Interactive Assistive Courseware for Young Low Vision (AC4LV) Learners based on four types of learning approaches. These are: (i) Mastery Learning Approach, (ii) Problem-based Learning (iii) Active Learning (iv) and Self-paced Learning. User Centred Design (UCD) Approach has been applied throughout the development of AC4LV as it is important for this study to ensure the proposed courseware meets the user requirements. Findings of this study report the integrated learning approaches in AC4LV.

Keywords – Human Computer Interaction, Children Computer Interaction, Interaction Design, Assistive Technology, User Centred Design Approach, Low Vision, Learning Approach.

1. Introduction

The number of people with disabilities (PWDs) has been increasing rapidly around the world. The statistics from [1] reveal that 15% of the world's population has some form of disabilities, from which one-third are children younger than 15 years. It is estimated that over 1 million children with disabilities are born each year around the world [2]. Unfortunately, many of them are abandoned by their parents because of insufficient of long-term medical cost, particularly those who live in developing

Table 1. Statistics of disabled people in Malaysia

Types of Disability	Year				
	2012	2013	2014	2016	2018
Visual Impairment	40,510	46,307	50,827	36,692	42,184
Hearing Impairment	53,357	58,706	62,153	31,937	35,273
Physical Impairment	148,461	162,215	174,795	142,600	167,077
Learning Problem	165,281	178,800	188,911	143,334	163,904
Others	20,673	24,455	27,025	54,706	63,790
Total	445,006	470,483	531,962	409,269	472,228

countries [2]. There are different type of disabilities including physical, learning, hearing, and visual. Among the various types of disabilities, visual impairment (VI) is considered the most serious one. [2] reports that 285 million people in the world are visually impaired (VI). Particularly, 246 million of them have low vision and 39 million of them are blind. Approximately 90% of the VI people live in developing countries. Meanwhile, in Malaysia, the Malaysian Social Welfare Department reports that the officially registered disabled people as of July 2018 are 472,228 people [3]. As of December 2012, there were 40,510 registered VI people, and then the number increased to 42,184 in July 2018. Referring to the facts in Table 1., it could be deduced that from the year 2012 until 2018, the number of registered VI people in Malaysia drastically increased and is doubled.

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Learning Technologies for Low Vision Learners

Currently most of developing countries have seriously provides facilities for PWDs in ensuring they are inline with digital era. The technology that is purposely designed for PWDs is called Assistive Technology (AT). It can be categorized into hardware (i.e. thermoform) and software (i.e. screen reader). The advancement of AT has triggered the meaningful impact on the various aspects of PWDs' life. The trend is clear that recent devices are designed to be accessible by PWDs such as smartphones and tablets. In line with that, the field of education is not an exception and has been revolutionary impacted by AT. As evidence, there is increasing interest in the usage of AT with educational technologies to promote education formally and informally to the PWDs. As an example, special education primary schools equip their computer labs and classrooms with Closed Circuit Televisions (CCTVs), large monitors, and screen magnification tools. All these AT are utilized as part of the teaching tools to support and improve the disabled learners' learning activities in the educational environment where they could acquire knowledge and learn. However, most of this technology focuses on the technical aspects of hardware and software which is difficult for low vision learners at the primary school level to operate on their own. This requires them to have instructors most of the time. On the other hand, AT that focus on stimulating them to have active learning experience similar to general students is highly scarce. For that reason, an Interactive Assistive Courseware which is specifically designed for low vision learners' learning needs is urgently needed to be explored.

Prior to developing the intended courseware, appropriate learning approaches need to be reviewed and identified as they are basis in developing the learning materials. The next section reviews and justifies the selected learning approaches of this study.

2. Reviews on Learning Approach

The implication of innovation in learning system and the advancement in technology have revealed several learning approaches that emerge either as totally new theories or mixed with other established theories. The learning approaches that have been selected to be adapted in this study emerged from Multimedia Learning Theory and Multiple Intelligence Theory which are (i) Mastery Learning Approach, (ii) Problem-based Learning, (iii) Active Learning Approach, and (iv) Self-paced Learning Approach. All of them were reviewed and justified in details in the next subsection.

Mastery Learning Approach

The importance of learning through courseware is to what extend the learner could grasp the presented knowledge, not on to what extent the sophistication of the courseware is. It means nothing if the courseware seems to be sophisticated but is unable to provide enough comprehension to the learners. Hence, this study uses the Mastery Learning Approach in attempt to assist the low vision learners' understanding of the learning content as well as providing applicable multimedia elements for them.

The idea of Mastery Learning Approach has been initiated for more than 80 years. Impressed from the idea originated by John Carroll in 1963, Benjamin Bloom then started inaugurating the concept that is known as Mastery Learning in 1968 [4]. [5] claims that all learners have the potential to learn any given subject, but they have to take certain amount of time to complete tasks. The theory hypothesizes that each individual has different intellectual abilities and it can be seen in their achievement outcome [6]. This means that this approach is applicable to be adapted to anyone and it is beneficial for learners at different levels of aptitude. The challenge of this approach is that implementing instructional strategies and providing enough time in making sure all learners are able to achieve similar level of learning [7].

The following are the basic elements of the Mastery Learning Approach as suggested by Bloom and stated in [8]:

- Clearly stated the objective of the course.
- The syllabus is divided into small chapters in which each chapter has its own objective.
- Identify the learning materials and instructional strategies including teaching, practice exercise, formative evaluation, re-teaching, reinforcement, and summative evaluation.
- Each chapter is preceded with a brief diagnostic tests, or formative assessments.
- Utilize the results of formative test as additional instruction, or do correction activity in class in helping the learners to overcome the problem.
- Learning time must be adjusted to fit the level of aptitude, which means no student is allowed to proceed to the new chapter until master the basic pre-requisite chapter.

On top of that, the use of Mastery Learning Approach has been found in works such as the design and development of courseware for slow learners called *Komputer Saya* projected by [9] and the design and development of multimedia courseware, namely Li2D proposed by [10]. Both of them have been discussed in detail in [11].

In relation to this study, Mastery Learning Approach is embedded in AC4LV by applying appropriate instructional strategies and teaching and learning techniques. Also, no specific time is allocated to them in learning and doing activities in AC4LV. This is to ensure they can grasp the knowledge without any pressure and have pleasure in learning.

Problem-based Learning (PBL)

PBL is a student-centered approach, in which students learn through experience and realistic problem solving [12]. It is an instructional method that originates from medical education and has become increasingly popular across disciplines at multiple levels of education [13]. The basic characteristics of PBL are: (i) the use of problem as the starting point of learning process, (ii) small group collaboration, (iii) flexible guidance of instructors, (iv) limited number of lectures, (v) student-initiated learning, and (vi) ample-time for self-study [14].

Meanwhile, the goals of PBL is to help the students to develop their (i) flexible knowledge, (ii) effective problem-solving skills, (iii) self-directed learning skills, (iv) effective collaboration skills, and (v) intrinsic motivation [15]. This implies that instructors or teachers have to act as facilitators rather than providing knowledge to achieve those goals. Through the problem-solving and other characteristics of PBL, it trains the students to become active learners and responsible to their learning. In accordance, it enables the students to understand the subject deeply.

PBL embraces on good principle of teaching and learning, in which it (i) promotes student-directed learning, (ii) promotes active and in-depth learning, (iii) taps into existing knowledge of student, (iii) supports reflection on teaching and learning process, (iv) develops mutually respectful learning skills, (v) involves well-timed feedback, and (vi) supports the self-assessment and peer-assessment of students [16].

In this study, by embedding the PBL approach in AC4LV, it could educate the low vision learners to be more independent, self-motivated, producing interesting work, and become a challenging person.

Active Learning Approach

The term 'active learning' is defined as anything that "involves students in doing things and thinking about what they are doing" [17]. It refers to instructional strategy that encourages students to participate and think actively on what they are doing particularly in learning [18]. This means that students not only listen to formal lecturing or presentation, but also after listening they have to interact with their teachers and peers. This could be achieved through activities such as read, talk, write, discuss, reflects, or

engaged with problem solving. It is a process that compels the students to think and give opinion on the presented knowledge that they gain through listening. Within this context, the students have to: (i) listen carefully, (ii) develop abilities to understand the knowledge, (iii) make analysis and synthesis, and (iv) evaluate the knowledge which can be done through problem solving exercises, informal small group discussions, class game, lab activities, role-playing, or reaction to video [19]. At each step, students are engaged physically and psychologically with activities for them to process the knowledge. The activities prepared by the instructor are named as active learning technique [20]. It provides students to develop higher levels of scientific understanding compared to traditional learning approach. More importantly, the students feel that their study is important when their opinions and involvements have significant value to themselves. This could increase their pleasure and motivation in learning.

On the other hand, with the advancement in technology, various active learning techniques can be applied to force the students to actively participate and enjoy the lesson such as learning through courseware, educational mobile game, and online discussion. Active learning approach educates the learners to be more responsible to the learning process and appreciate the knowledge which benefits for them in sharing with others, think critically in problem solving, and develop various abilities and skills that are demanded by the market today. On top of that, active learning approach also has been applied in works carried out by [21][22][23].

In this study, active learning approach is applied in AC4LV by providing module learning through music and song, interacting using keyboard, and meaningful graphic with friendly sound. These could stimulate and give confidence to low vision learners to interact with AC4LV with or without guidance from the instructor. More importantly, they can learn in pleasurable environment.

Self-paced Learning

Self-paced Learning approach is an instructional method that has become popular since the education world shifted from traditional method (learning in class) to Internet [24]. It is an approach that enables the learners to proceed with the learning process on their own without intermediate response from instructor [25]. This means the learners are able to control the topic that they learn depending on their speed and get instant feedback.

In the context of this study, Self-paced Learning is referred to as an approach that is embedded in e-learning materials, either computer or online learning programs, which contain the learning content and assessment mechanism for self-evaluation [26]. This

means students can learn anywhere (i.e. homes, resident halls, laboratories, or workplaces) and anytime at their own pace. As an example, [27] has set up free online games for students to learn the concepts of economics anytime and anywhere. Another example is the off-the-shelf software programs such as learning languages where the consumers can buy and install them on their own [28]. Also, self-directed e-learning programs are provided by many higher institutions today to facilitate their students to learn at their own initiatives [29]. All these e-learning materials are consistent with contemporary learning theories that highlight on self-paced and self-directed learning. On the other hand, in designing self-paced e-learning materials, a good user interface design is important to increase the learners' motivation and easy for them to use it independently.

In AC4LV, this could be done by providing interesting controls, accessibility information, clear instruction, and attracting sound to catch the attention of low vision learners in ensuring they stay focus to learning content. Over and above, by adapting self-paced approach in AC4LV, it also could educate the low vision learners to decide on their own what to study, where to study, when to study, and how long to study. This aspect has significant implications to the effectiveness of their learning effort and educational achievement.

The next section demonstrates the details of research methodology that has been utilized throughout this study.

3. Methodology

In this study, a series of activities were carried out. The two main phases involved are (i) reviews on previous learning approach and (ii) development of AC4LV based on identified learning approach. There are nine types of learning approaches been reviewed, however this study found that only four of them are appropriate to be adapted in this study which has been reviewed and justified in-depth in the previous section. Having identified the appropriate learning approach, the intended courseware has been developed based on the low vision learners' learning needs and principles in the learning approach as the basis. Also, User Centred Design (UCD) approach has been applied throughout the development phase. It involves low vision learners as the target users and teachers as the experts. This is important in making sure the developed courseware meets the user requirement. Figure 1. illustrates a summary of research activities involved in this study. Meanwhile, Figure 2 demonstrates the development phase of AC4LV which involves three phases. They are (i) pre-production, (ii) production, and (iii) post production.

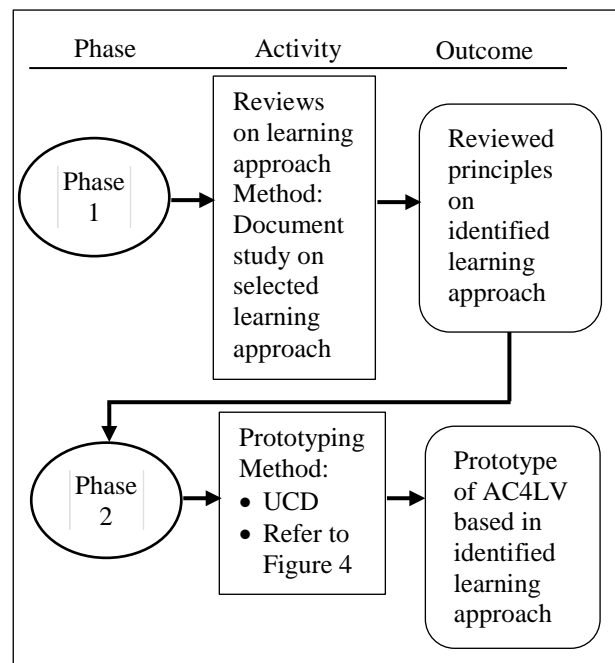


Figure 1. Summary of research activity

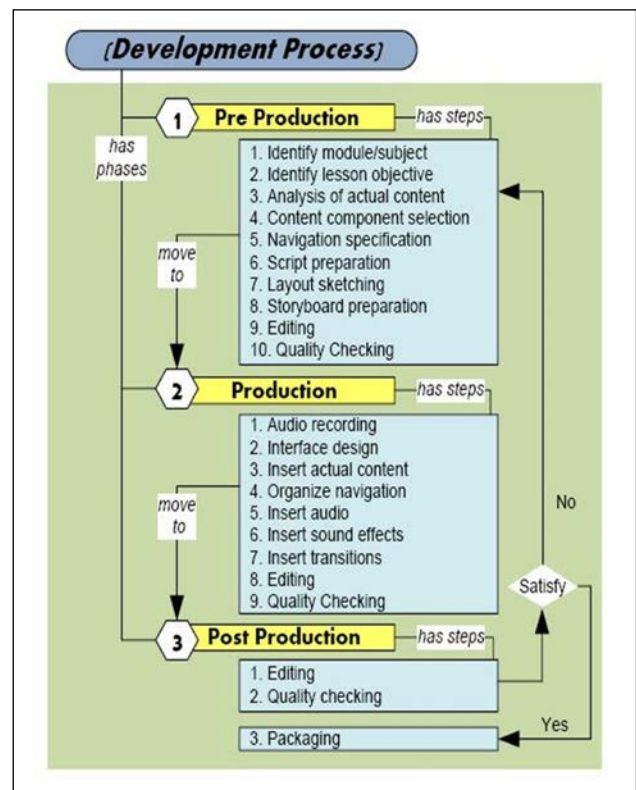


Figure 2. Development phase of AC4LV

Figure 3. and 4. explain the users involved in prototype development.



Figure 3. Low vision learners involve in UCD



Figure 4. Expert involve in UCD

4. Findings and Discussions

This section provides detailed explanation of those approaches in relation to AC4LV.

Integrating Learning Approach in AC4LV

All learning approaches as discussed in previous section are mapped with the AC4LV and explained in Table 2. Then, they are visualized in Figure 5. and Figure 6.

Table 2: Learning Approach in AC4LV

Learning Approaches	AC4LV Characteristic
Mastery Learning	<ul style="list-style-type: none"> • AC4LV clearly states the objective of the course. • The chapters are divided into small topics and each topic has its own objective. • AC4LV applies appropriate instructional strategies through the presentation styles (i.e. Instruction-based and demonstration), and teaching and learning techniques (i.e. through auditory explanation which also involves formative assessment and activities which have summative assessment). Review lesson and reinforcement through instructions are also provided. • Each topic is preceded with activities. • The formative assessment provided in the learning content helps the low vision learners to do correction in activity. • No specific time is allocated to low vision learners in learning and doing activities in AC4LV. • This approach is embedded in AC4LV ensuring that, with the abilities that the low vision learners have, they are able to achieve the similar level of learning among them without having pressure.
PBL	<ul style="list-style-type: none"> • The content in AC4LV uses problem as the starting point to start the learning process (i.e. Topic 1 – with the sound effects and illustration of the paddy field environment, the low vision learners start thinking where the location is, then they have to focus to decide on the desired information and finally get the explanation). • The above example also may involve small group discussion among the low vision learners in order to solve the problem. • Flexible guidance from instructor is provided in navigating the AC4LV as well as doing exercise. • Lecturing is provided in AC4LV only when necessary. • AC4LV give ample-time for the low vision learners to have their self-study which means they have their own initiative when and where to start the learning activities.

<p>Active Learning</p>	<ul style="list-style-type: none"> • AC4LV encouraged the low vision learners to be active during the learning process occurs. • This could be achieved by learning through song, sound effects, keyboard-based interaction, and meaningful learning content offered in AC4LV. • They not only listen to formal lecturing but they have to interact with AC4LV in gathering the inputs. • This explains AC4LV embedded the active learning approach.
<p>Self-paced Learning</p>	<ul style="list-style-type: none"> • AC4LV allows the low vision learners to have the self-paced learning by offering accessibility in content, navigationability in navigating the content, and pleasuring in learning. • This implicates that AC4LV could facilitate the low vision to precede the learning process without intermediate response from instructor. • With the design principles applied in AC4LV, it allows the low vision learners to learn anywhere and anytime at their own pace (i.e. explicit instructions, understandable demonstrations, and clear guidance).

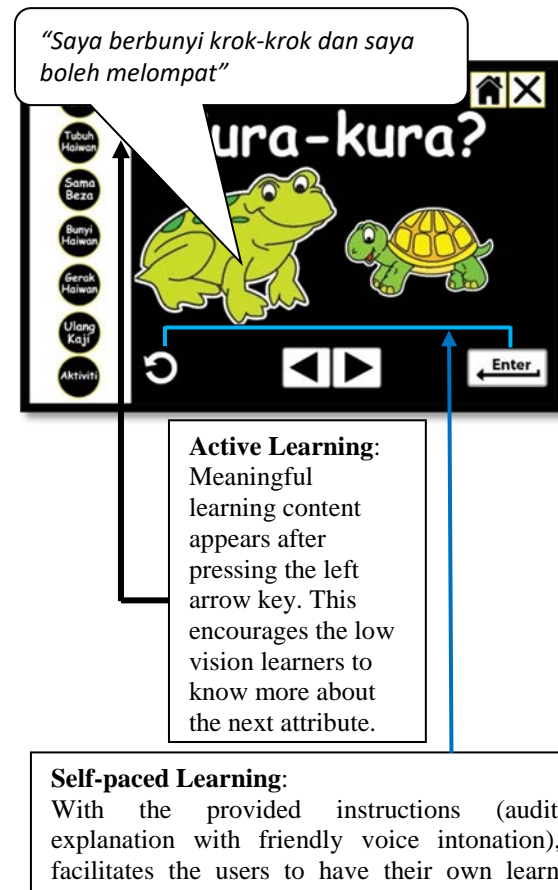


Figure 6. Active learning approach and self-paced learning approach mapped to AC4LV

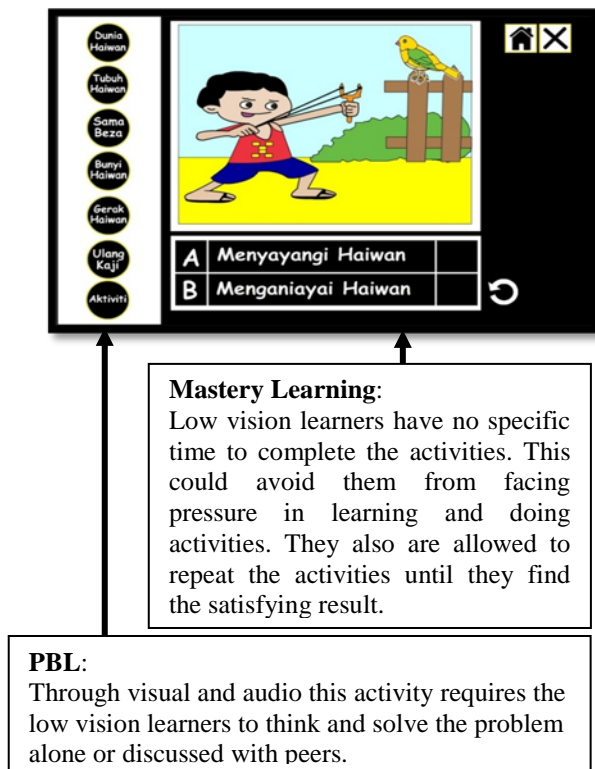


Figure 5. Mastery learning approach and PBL mapped to AC4LV

Having mapped all those learning theories [6] [7] and approaches in the AC4LV, it could be noticed that learning is unable to take place among the low vision learners if the learning content does not address information accessibility, navigationability, and pleurability aspects.

5. Implications of Learning Approach in AC4LV

Other than learning theories, learning approaches were also important in the development of instructional materials. This is to ensure the knowledge is delivered to the learners. Thus, this study involves four learning approaches that were built based on the existing theories. Mastery learning approach and PBL is important to ensure the low vision learners could grasp the knowledge as well as develop their confidence in learning through AC4LV. Meanwhile, active learning approach makes the AC4LV useful in terms of pleurability in learning. Also, self-paced learning approach provides AC4LV with functions that are easy to be used by low vision learners.

6. Conclusion

This study has successfully achieved the main objectives which are: (i) to review the selected learning approaches, and (ii) to develop the AC4LV based on the selected learning approaches. On the other hand, UCD has been utilized throughout the development phases. Having developed the intended prototype it was found that without adapting the learning approaches, AC4LV were useless. The results concluded that providing meaningful learning materials to low vision is important in accelerating their learning activities similar with general students. Future works of this study are to observe the low vision learners' experience in using the AC4LV.

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