Guidelines for Developing an Edutainment Courseware for Visually Impaired People

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Abstract: Visually impaired people have lack access to information disseminated through computers and computer applications including courseware. Most coursewares are developed without addressing visually impaired people as a part of the users. This project proposes and validates the guidelines of an edutainment courseware for visually impaired people in four perspectives: general interaction, text, audio, and graphic and animation. An English edutainment courseware was developed and further tested to validate the proposed guidelines. 30 guidelines were listed, of which five are for the general interaction, eight for the text, eight for the audio, and nine for the graphic and animation. Comments from the participants indicate that the courseware performed accordingly to their expectation and provided guidelines might help the designers to come out with coursewares in the future.

1. INTRODUCTION

Technology advancement and the continuing convergences of computing and telecommunications have made an unprecedented amount of information available to the public. For many people with disabilities, however accessibility issues limit the impact of such widespread availability. There are many types of disabilities such as mobility, hearing, and learning impairments. Visual impairments are the most pervasive in the general population or the functional loss of vision (Liu, et al., 2004). Liu et al. (2004) has also defined the visually impaired people as the people with low vision (that is people for whom ordinary eyeglasses, contact lenses, or intraocular lens implants do not provide clear vision), color blindness and blindness. One of the growing applications to help the disabled in many daily transactions is Assistive Technology (AT).

In general, AT can be defined as a term used to describe all of the tools, products, and devices, from the simplest to the most complex that used to enhance the performance of individuals with disabilities. AT technology provides people with disabilities the means to perform many activities with minimal or no assistance (Cooper, 1998). According to Wikipedia (2005), AT is a generic term that includes assistive, adaptive, and rehabilitative devices and the process used in selecting, locating, and using them (Wikipedia, 2005).

Most AT are designed and developed for web technologies. However, there are also other electronic and computer based technologies including courseware. In fact, courseware is being used in many sectors including manufacturing, education, and training for many purpose (Baloian, et al., 2002). This research is an attempt to develop an English edutainment courseware in order to gather validated guidelines for courseware development for visually impaired people. In the development of courseware for visually impaired people audio is the important element followed by text, animation, and graphic.

This paper first discusses the motivation of this study. After this introduction, the problem statement, objective of the study, and scope of the study are presented. The fields of study are discussed in Section 2, which constitutes the literature review of this paper. Section 3 focuses on the methodology adapted while Section 4 presents the results and findings. The significance of the research is presented in Section 5 and finally Section 6 provides the conclusion.

1.1   Problem Statement

From a preliminary study, visually impaired people have lack access to information disseminated through computers and computer applications including courseware. This statement agrees findings carried out by other researchers (Baloian, et al., 2002; Camacho and Foulds, 2002; Liu, et al., 2004; Watters, 2005). Most coursewares are developed without addressing visually impaired people as part of the users. Guidelines for developing edutainment courseware for visually impaired people might help the designers to come out with the technology. To overcome the above described problems, the objectives as stated in the following were formulated.

1.2   Project's Objective

The objectives of this research are:
  i.   To produce some guidelines for courseware development for visually impaired people.
  ii.   To develop a courseware for visually impaired people.
  iii. To investigate user satisfaction for guidelines validation.

1.3   Scope

In the courseware, researcher focused only on nouns. The development period took two months to include audio, animation, text, and graphics as suggested by respondents in the preliminary interview with the trainers of a care center. The main focus of the courseware is to teach visually impaired children about animal. However, the courseware does not cater all guidelines.

2.   LITERATURE REVIEW

2.1   Computing and Technology

Nowadays, computers can perform many difficult tasks better and quicker than human can. Moreover, many of the current human activities would not be possible without computers. From the beginning of this process, several people started to think that it was possible to help disabled people to enhance their communication capabilities and to facilitate their independent life by means of computers (Abascal, 2002).

2.2   Assistive Technology (AT)

For further detail and related to research to be carried out, Hefzy et al. (2000) stated that AT involves AT devices and/or AT services. Hefzy and his friends also said that the Assistive Technology Act of 1998 (ATA) defines AT devices as any item, piece of equipment or product system, whether acquired commercially off the shelf, modified, or functional capabilities of individuals with disabilities. This is a broad range of devices from low technology to high technology items as well as software. The ATA also defines an AT service as any service that directly assists an individual with a disability in the selection, acquisition, or use of an AT device. The role of AT is to enable individuals with disability to be more independent, productive, self-confident, and integrated into the mainstream of the society. The team members of AT include parents and care givers, individuals with disabilities, and professionals across country (Hefzy et al., 2000).

2.3   Visually Impaired

Visual impairment is the functional loss of vision (Wikipedia, 2005). According to World Wide Web Consortium (W3C) (2004) visual impairment consists of (i) totally blind; (ii) low vision; and (iii) color blindness.
  i.   **Totally blind**- Blindness involves a substantial, uncorrectable loss of vision in both eyes.
  ii.   **Low vision**- There are many types of low vision (also known as "partially sighted" in parts of Europe), for instance poor acuity (vision that is not sharp), tunnel vision (seeing only the middle of the visual field), central field loss (seeing only the edges of the visual field), and clouded vision.
  iii. **Color Blindness-** Color blindness is a lack of sensitivity to certain colors. Common forms of color blindness include difficulty distinguishing between red and green, or between yellow and red. Sometimes color blindness results in the inability to perceive any color.

2.4   Related Works

"Web Content Accessibility Guidelines 1.0" is part of a series of accessibility guidelines published by the Web Accessibility Initiative (WAI) in order to make it easier for people with disabilities to use the web. These guidelines have been reviewed by W3C members and other interested parties. All guidelines are listed below:

Guideline 1: Provide equivalent alternatives to auditory and visual content.
Provide content that when presented to the user, conveys essentially the same function or purpose as auditory or visual content.

Guideline 2: Do not rely on color alone.
Ensure that text and graphics are understandable when viewed without color.

Guideline 3: Use markup and style sheets and do properly.
Mark up documents with the proper structural elements. Control presentation with style sheets rather than with presentation elements and attributes.

Guideline 4: Clarify natural language usage
Use markup that facilities pronunciation or interpretation of abbreviated or foreign text.

Guideline 5: Create table that transform gracefully.
Ensure that tables have necessary markup to be transformed by accessible browsers and other user agents.

Guideline 6: Ensure that pages featuring new technologies transform gracefully.
Ensure that pages are accessible even when newer technologies are not supported or are turned off.

Guideline 7: Ensure user control of time-sensitive content changes.
Ensure that moving, blinking, scrolling, or auto-updating objects or pages may be paused or stopped.

Guideline 8: Ensure direct accessibility to embedded user interfaces.
Ensure that the user interface follows principles of accessible design: device-independent access to functionality, keyboard operability, and self-voicing.

Guideline 9: Design for device –independent
Use features that enable activation of page elements via a variety of input devices.

Guideline 10: Use interim solutions.
Use interim accessibility solutions so that assistive technologies and older browsers will operate correctly.

Guideline 11: Use W3C technologies and guidelines
Use W3C technologies (according to specification) and follow accessibility guidelines. Where it is not possible to use a W3C technology, or doing so results in material that does not transform gracefully, provide an alternative version of the content that is accessible.

Guideline 12: Provide content and orientation information.
Provide context and orientation information to help users understand complex pages or elements.

Guideline 13: Provide clear navigation mechanisms.
Provide clear and consistent navigation mechanism- orientation information, navigation bars, and a site map – to increase the likelihood that a person will find what they are looking for at a site.

Guideline 14: Ensure that documents are clear and simple.
Ensure that documents are clear and simple so they may be more easily understood.

2.5   Population in Malaysia

In Malaysia, the National Eye Survey in 1996 indicates that 2.73% of the population are visually impaired, of whom 2.44% have low vision, and 0.29% are blind. This would put the present number of Malaysians who are visually impaired at close to 700,000; with 74,000 of them blind. Harian Metro (2004), states that in Malaysia there are 132, 655 disabled people were registered and 14,154 among them are visually impaired. According to Orbis (2006) among Malaysia's 24 million people, an estimated 5,000 children are blind and a further 50,000 are visually impaired and at risk of losing their sight.

2.6   Visually Impaired People Access for Knowledge

From the preliminary interviewed that has been done, Community Based Programs Coordinator, Rosidah (2006) states that at St Nicolas Home, visually impaired trainees learn how to use computer in such areas of training including JAWs (Screen reader), Microsoft Words, Microsoft Excel, Microsoft Power Point, MSN Messenger, SKYPE, Internet Explorer, Email, HTML Development, and Web Accessibility. It is because their objectives are to expose and introduce IT to the blind and visually impaired persons, and to ensure that all trainees will effectively utilize the learned skills. Their target groups are focused on lower range school graduates, higher range working blind, and school holiday program for youths. The next section will discuss in detail about the research method of the study and the approaches for developing an edutainment courseware for visually impaired people.

3.   METHODOLOGY

The research methodology is an adaptation from Validation methodology which was introduced by W3C, 1999.The study was conducted in four phases which includes; (1) literature study; (2) guidelines proposal (3) guidelines validation; (4) and documentation. The phases of the study are depicted in Figure 1.
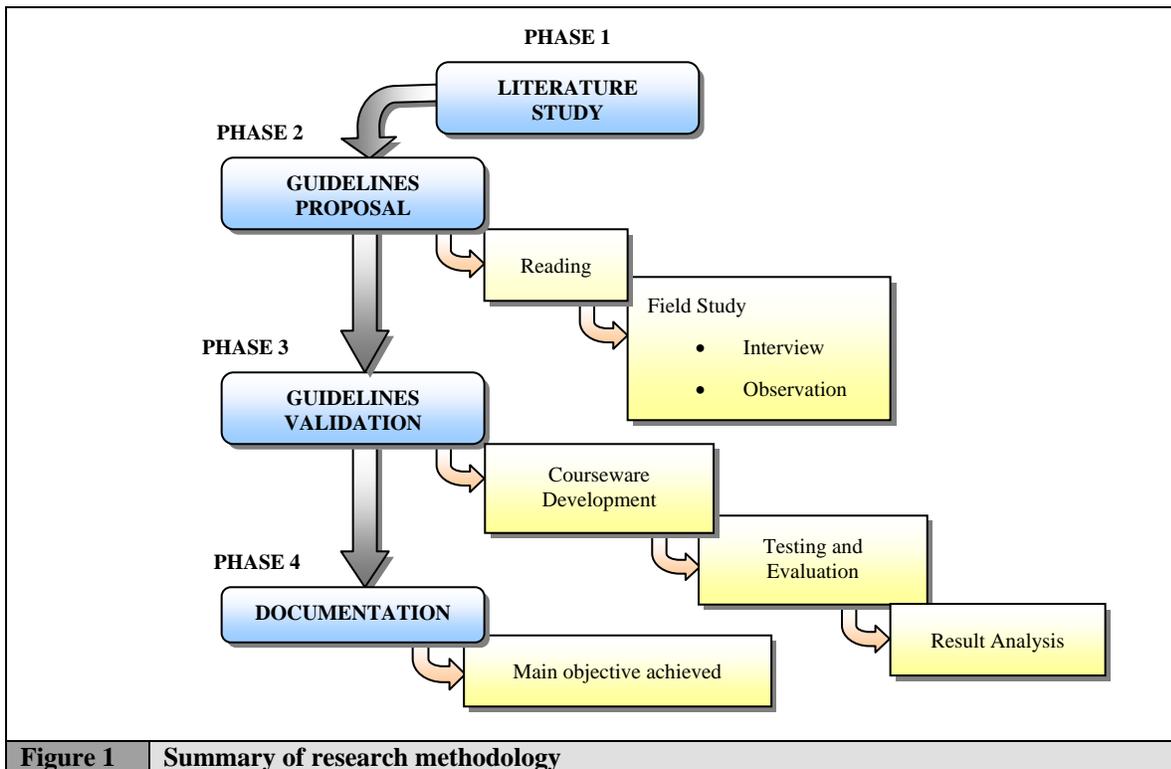

| Figure 1 | Summary of research methodology |

3.1 Literature Study

In Phase 1, literature reviews were conducted to seek and refer findings from prior studies related to the current study. Most of the prior studies referred were from journals, reports, proceedings, and related books. The review provides insightful ideas and questions about problems and ways for the researcher to conduct the study successfully. In this phase the researcher also investigated the most suitable hardware and software to be applied in the project.

3.2 Guidelines Proposal

In phase 2, the researcher carried out some guidelines for courseware development for visually impaired people. In order to gather the information, phase 2 involved the process of reading, and field study. The researcher referred findings from journals, reports, proceedings, unpublished theses, conference papers, and related books in order to gather the valid information. The field study phase involved interviews and observations. Both procedures have been done at St. Nicolas' Home, Penang. The processes of interviewing and observation have been done to the blind and visually impaired trainees, social workers, and instructor which consist of normal people and visually impaired people. The questions were not just limited about the IT area only but encompass vocational training, information and resources, deaf and blind children, and community-based program in order to gather the better understanding of visually impaired people.

3.3 Guidelines Validation

In order to gather validated guidelines, phase 3 involves the process of courseware development, testing and evaluation, and result and analysis. In these phases the researcher develops an English edutainment courseware for visually impaired people according to the guidelines that have been gathered in previous phase. The researcher adapted the courseware development method; an IntView methodology developed by Grutzner et al. (2004). The courseware development involves the process of script preparation, audio recording, screen sketch, design story board, develop courseware, and packaging. It was developing using Flash MX. The courseware has been tested to visually impaired children at Sekolah Rendah Pendidikan Khas Alma, Penang. Each of the guidelines was tested with 11 visually impaired children. During the testing and evaluation phase the researcher use the observation method and practical testing that has been distributed to the target participant in order to investigate user satisfaction for guideline validation. The results that were gathered from the respondents were analyzed. In this phase the researcher come out with ideas on how to produce validated guidelines for courseware development for visually impaired people.

3.3.1 Experimental Design

Experiments have been conducted in order to output this guidelines and to prove that this guidelines might help the designers to come out with the coursewares in the future. The main core items for this experiment are the computer, and courseware. The target group was chosen to be severely visually impaired children. The users were 11 children from Sekolah Rendah Pendidikan Khas Alma, initially of ages six to seven years which consists of seven girls and four boys. Among these children, five of them are totally blind, and six of them are low vision. The experiments took place in the school lab, where there were 15 computers. The researcher installs the courseware into each of the computers.

The experiment can be categorized into 3 main sections. The researcher conducted each of the sessions with two instructors. Firstly is briefing. The researcher gives briefing to the participants to sit next each other at one computer. The participants cannot go out from the lab until they complete the task to ensure the quality of result. Secondly, the researcher plays the courseware on each of the computer. Generally, the kids enjoy the lesson. Finally, the researcher asked users (children and pedagogue) a few questions. These questions concerned their attitudes, their use of computers in general, and their use of courseware specifically. The experiments show positive feedback between the courseware and the users. The characteristic of courseware have direct influence on user willingness to use the courseware in the future.

3.4   Documentation

After analyzing the result, findings were compiled and documented. A set of validated guidelines for courseware development for visually impaired people are presented. Some recommendations with suggestions for further research were suggested. On finishing this phase, the objectives of the study have been achieved.

4.   FINDINGS

In this section, the results from the analysis and experiment have been arranged to get the guidelines for developing an edutainment courseware for visually impaired people. The researcher has proposed 30 guidelines adapted from Web Content Accessibility Guidelines. Some of the guidelines must be followed in developing the courseware for visually impaired people but some of them are not necessary. This guideline has been separated into 4 sections that are:

4.1   General Interaction

Guideline 1: Set up the courseware as autorun CD
Visually impaired users especially children have lack access to information dissemination through computers and computer application including courseware. For them courseware is a new application which they have to explore more if they want to use it. Because of that the designers should set up the courseware as autorun CD, so it easy for them to play it by their ownself without need assistance form instructor.

Guideline 2: Adhere to the principles of good design
When   designing the courseware for visually impaired children, follow the basic good design rules that the designer use when designing the courseware for normal children. Some design components are similar for visually impaired children and normal children. The researcher found the following basic guidelines for normal children are also proven successful for visually impaired children:
   i.   Rich graphics, animation, interaction, friendly narration, cheerful, and entertainment.
   ii.   Learning should be educational and fun.
   iii.   Courseware should provide a simple interface to view information and play recording.
   iv.   On exercises or games session, do not need violence to be fun but finding and destroying things to win points seem to be entertaining.

Guideline 3: Interaction using keyboard
Visually impaired people especially totally blind users must use 100% keyboard to interact with the computer application including courseware. Visually impaired people cannot use the mouse function to point, scroll, or select for moving around the page but instead move by means of keyboard commands such as Tab key, arrow key, and Enter key (Leporini et al., 2004).

Guideline 4: Design for no scrolling
The developers should design the courseware for no scrolling so the users no need to use mouse or keyboard to scroll the screen up and down. Design the courseware fit information on a page viewed at 600 x 800 resolutions and the users can viewed it in full screen.

Guideline 5: Provide explicit directions and instructions
Tell the user exactly what to do, right on the screen. Especially on the exercises session the visually impaired user cannot read the instructions that appear on the screen. Instructions for activities should refer to the visual outcome on the screen.

4.2   Text

Guideline 6: Font size: use large fonts
Text fonts on the screen should be comparable in size at least 50 to 90 point (setting in Flash MX) when viewed on the target users most common screen resolution. Text designs with small fonts were harder to read especially for low vision, and color blindness persons

Guideline 7: Font type: use sans serif fonts

Font type should be in sans serif fonts for example Comic Sans. The designers cannot use serif fonts for example French Script MS. It is because sans serif fonts relatively clear than serif fonts. Based on the preliminary interviewed and testing that has been done the researcher found that the visually impaired people will confuse what type of word if serif fonts appear on the screen. In this case, they cannot compare the shapes of font that appear on the screen. The font should be separate each other. The font cannot be connected each other.

Guideline 8: Font color: must be contrast with the background color

Color is important for visually impaired people, because it is an attribute that is used to distinguish objects and to group properties in illustrations (Rotard, et al. 2005). Font color must be contrast with the background color. Text designs without significant contrast between the letters and their background were harder to read. The designers must provide good contrast between text and background. Contrast is especially important for low vision and color blindness users. Low contrast and using pictures of text can create serious problems for users with visual impairments (Gilutz &Nielsen, 2005).

Guideline 9: Typeface: use regular and bold typefaces.

A good typeface in the development of courseware for visually impaired people is use regular and bold typefaces. From the preliminary testing the researcher found that visually impaired people struggled with the text that look unique by using irregular and fancy typefaces and spend extra time and effort trying to figure out the letters.

Guideline 10: Place text on solid background

In the development of courseware for visually impaired people the text must be place on solid background. Avoid putting text on background images, especially if they are dynamic. The coursewares for normal children often use background images to make the pages appear more exciting. These images make reading text more difficult, especially for pre-school visually impaired children. They need to spend extra time and effort trying to figure out the letters.

Guideline 11: Use animation text

Using animation or other special effects on text can make visually impaired children give more focuses and concentration on the learning session. Based on the preliminary testing the researcher found that, the visually impaired children feel boring and not interested if the text is just static at one place. Instead they are excited when the text comes out with animation and they will be more alert what text that appear on the screen, and where the text comes from.

Guideline 12: Use succinct text only

When designs the courseware for visually impaired children, the designers should minimize the amount of text on screens. From the interview with normal users the researcher knows that reading long pieces of text on a screen is a difficult task. Reading from computer screen is tiring for the eyes and about 25% slower than reading from paper (Gilutz &Nielsen, 2005). This difficulty occurs with visually impaired people also. The testing shows that, when they saw the long text passages, they immediately wanted to do something else and they become gave up with the lesson. The sentences should be straightforward and concise.

Guideline 13: Use easily understandable and terms that non-technical users understand

Because of visually impaired people have lack access of information dissemination through computers; they do not understand technical terms such as *graphic*, and *animation*. Users in this study were unfamiliar with technical terms they encountered when they use computer. Software terms meant nothing to them. When they hear these terms, they usually ignored them. Designers should use easily understandable and terms that non-technical users understand especially on exercises session in order to make the courseware usefulness for the target users.

4.3   Audio

Guideline 14: Audio as background music

Consider using background music for ambience when designing a courseware for visually impaired children. The visually impaired children will take reactions when they hear the sound such as birds singing, wind, or the bees buzzing in the clover and they try to guess where the place is. The designers also should create background music that can make visually impaired children feel entertaining, happy, and cheerful during the learning process. The

background music also should be unobtrusiveness, consistent, but not invasive, and pleasant tunes with reasonable audio quality.

Guideline 15: Use sound to pronounce all texts
In the development of courseware for visually impaired people all the texts that appear on the screen must be pronounced clearly. The sound should refer to the text that is displayed on the screen. It is important for visually impaired users to know what text that appeared on the screen at that time. For the narration part make it friendlier so that visually impaired children feel interesting with the lessons.

Guideline 16: Use sound to tell that there are graphics appear on the screen
Visually impaired people depend very much on their audibility to interact with the computer application including courseware. The sound should be attractive with the graphic that come out on the screen. During the testing phase the visually impaired children try to guess when the animals come out on the screen.

Guideline 17: Use sound effect to supplement and enhance the interaction
Adding sound effects provides an experience enhancement that kids enjoy, especially if the sounds are funny and goofy (Gilutz &Nielsen, 2005). Adding sound effects to button for example created both interactive between users and courseware. The visually impaired children enjoy the exercise part when the researcher tests the courseware to them. They enjoy the exercises and want to do it again because when they select the correct answer, they can hear there are a lot of people clap and applause for them.

Guideline 18: Do not disrupt users with sudden loud sound or music
For some visually impaired users the automatic background sound is startling and unexpected. In some cases users' speakers were not set up at appropriate volume level. Users want to lower the volume of the audio or mute the sounds completely. Audio should start low and increase the volume gradually. During the lesson do not disrupt users with sudden loud sound because they may feel a great shock and automatic want to mute the sounds.

Guideline 19: Use music that is popular and familiar to visually impaired children
Songs are also very important element when developing a courseware for visually impaired children. People know that songs are one of the elements that kids can learn a lot from it. Use music that is popular and familiar to visually impaired children and for this study the researcher use nursery rhymes; *Baa, baa black sheep* and *Old Mac Donald*. Kids get excited when they hear music they know. Obviously, when the songs start, automatically kids smiled and some even tap out the beat with their hands. They react similarly with the courseware. They merrily sing along with the computer.

Guideline 20: Use sound to attract visually impaired children's attention
Visually impaired children find that sounds are extremely engaging. Use sound as a way to focus users' attention on important elements on the screen. Based on the testing on the visually impaired children, they enjoyed listening to background music, paying attention to the lesson, and taking part in the action.

Guideline 21: Depend on the audio to explain everything on the screen
Visually impaired people especially totally blind users depend on the audio to explain everything on the screen when they interact with the computer application. As a result, when developing a courseware for visually impaired people the designer should create audio that explain everything that appear on the screen either text or graphic.

4.4   Graphic and Animation

Guideline 22: Create meaningful graphic and animation to attract users with the lesson
The main benefit of using graphics and animations on visually impaired courseware was that it sparked low vision children's enthusiasm and interest in exploring the courseware. This effect was especially evident with users' first impression of courseware. Scene that presented users interesting, fun looking items when they entered the first scene drew great curiosity (Gilutz &Nielsen, 2005). These low vision children will tell their friends that are totally blind what they have seen on the screen. For example how many apple they have seen on the screen or what the cat is doing. So that, when they go to the shop they can know which one is apple or when they go to the zoo they can know which one is cat and which one is tiger. This is very important for them for preparation for their social life.

Guideline 23: Design characters to attract visually impaired children
Visually impaired children are attracted to characters in general, especially when they are funny. Users were excited about almost any object that appeared to be an animated being. In this courseware the researcher create "*Bibi*" as a character. "*Bibi*" is a bee. When the researcher tests the courseware to visually impaired children they were excited when the character comes out on the screen and say *hi* to them. The children spoke to the character and the entire interface became the background story for this character.

Guideline 24: The color of graphic and animation should be striking
The low vision children will attract more to the graphics and animations that look striking. The graphics and animations that look striking is important because they can easily tell their friends that are totally blind how the graphics or animations look like and they can imagine the situation. However the color of graphics and animations must be match with the background and other images.

Guideline 25: Size of certain graphic and animation must be large
Low vision, and color blind users will attract more to the graphic and animation that looks larger than other graphics or animations that appear on the screen. They also sometimes like to have the graphics or animations pop up on the screen. If the graphic is too small they have to go very close to the screen until the nose touches the screen. This characteristic is important especially to the main graphic and animation that they want to learn.

Guideline 26: The color of graphic and animation must be contrast with the background
Color blindness, and low vision, children cannot compare the difference between two colors that look same such as red and orange or green and blue. The combinations of these colors are not good because for visually impaired users these colors look same. The users will struggle and need more effort trying to figure out the image.

Guideline 27: Create graphic and animation clearly
In the development of courseware for visually impaired people, graphics and animations must be created clearly. It means that the shape and the color of graphics or animations that have been created should look evidently. Low vision, and color blindness users will be confused if the graphic or animation created too ambiguous.

Guideline 28: Do not create too much animation in one scene
To develop an edutainment courseware for visually impaired children the researcher advice other designer do not include too much animation in one scene. The scene may look so crowded and they feel hard to pay attention to the lesson because they may feel confused and cannot concentrate on the lesson. To develop the best courseware for visually impaired people just create one to three animations in one scene.

Guideline 29: Create different environment on every scene
Courseware that has different environment on every scene is better than just has the same environment on every scene. The courseware that has the same environment on every scene will make the visually impaired children feel bored and cannot improve their creativity. Compare to courseware that has different environment every scene it will attract the user to enjoy the lesson without feeling bored.

Guideline 30: Design text button to look pushable
If there is any button on the interface the designer should design the button to extremely look pushable. It is because visually impaired children cannot compare the differences between button and text. Sometimes they try to select the text and press any key on keyboard but nothing happens on the screen and they fell frustrated.

5.   SIGNIFICANCE

The output of this research provides a good set of guidelines for courseware development for visually impaired people that could assist them to have better access to the information. Further more coursewares could be developed for their use to enrich their information acquisition methods.

6.   CONCLUSION

Overall, this study has achieved its objectives. As a result, a set of guidelines for developing an edutainment courseware for visually impaired people has been produced. These guidelines have been tested and validated by the potential users. Findings show that generally interaction, text, audio, color, graphic, and animation have significant roles in developing a usable courseware for visually impaired people. The researcher also found that there are several differences elements of guidelines in developing website and courseware for visually impaired people:

- Make the distinction between clickable and non-clickable items clear.
- Provide clear and consistent navigation mechanisms.
- Do not use more than two navigation levels or schemes because too many navigation systems in one website create confusion.
- Ensure that moving, blinking, scrolling, or auto-updating objects or pages may be paused or stopped.
- Ensure that the user interface follows principles of accessible design: device independent access to functionality, keyboard operability, self-voicing.

Based on the guidelines above, it can be consider that most of the guidelines for developing website for visually impaired people are more focused on accessible design. Hence, in context of this study, it can be assumed that the situation is mature enough for introducing edutainment courseware to visually impaired people.

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