INSTRUCTIONAL DESIGN PRINCIPLES FOR DEVELOPING A COURSEWARE FOR LOW VISION AND HEARING IMPAIRMENT

***Abdulrauf Tosho[1], Ariffin Abdul Mutalib[2], Sobihatun Nur Abdul-Salam[2]**

[1]Department of Physical Science, College of Natural Science,
Al-Hikmah University, Ilorin, Kwara State, Nigeria

[2]School of Multimedia Technology and Communication, Universiti Utara Malaysia (UUM),
06010 Sintok Kedah, Malaysia

*Corresponding author's email: abdtosh@gmail.com

Abstract

Instructional based on coursewares' interface face serious usability problem due to ineffective design towards content delivery. With restrictions in the interface design for diverse users, the conventional teaching and learning approaches requires people with disability to struggle more compared to their non-disabled counterpart learners. Meanwhile, the pedagogical applications that are specifically designed for the universality are highly scarce. This could be seen when most of the existing content applications that available in the market are designed for particular target user. This study presents an ongoing project, with the main objective to develop an instructional interface design principles in an attempt to cater for the needs of low vision and hearing impairment learners in their learning activities; called Courseware for Low Vision and Hearing Impairment (C4LVHI). Thus, to achieve the main objectives, this study comes up with specific objectives, which are: to determine the appropriate instructional interface elements and design principles of courseware design for low vision and hearing impairment learning. This could be as guidance for the developer or anyone who intend to develop courseware for low vision and hearing impairment. The recommended future works is to investigate the user experience of using C4LVHI among the low vision and hearing impairment learners in Learning Centres. The target participant would be low vision, hearing impaired and non-impaired learners from tertiary level.

Keywords: Usability; instructional; strategies, interface design; design principle

1.0 INTRODUCTION

Every child has equal rights to quality learning activities. Therefore, technique to ease the learning acquisition needs to design for every user that indicates universal approach of learners aids. However, for diversity learners, the learning instructional is quite demanding. With the setback facing those with low vision and hearing problem, various challenges in the learning instructional interface are higher, which finally could result to learning difficulty. Those with special needs have their own setback that makes them incapable to learn at the same pace with normal persons (Abdollah, Ahmad & Akhir, 2010). They require specialized learning instructional tools in order to maximize their potential and self-sufficiency learning attributes. Among many types of the special needs, visual and hearing impairment are considered as non-mentally disorder that has ability to learn with other counterpart learners. World Health Organization (2012) reports that WHO and World Bank (2011) anticipated that there are 15% of the world population has some form of disabilities. Department of Social Welfare has registered the total number of 359,203 of people with disabilities in December 2012 (Rashid, 2010). The report mentioned the total number of people with disabilities in Malaysia has 305,640. However, these data are incomplete as registration of

persons with disabilities in Malaysia is not compulsory, and is done only on a voluntary basis. In addition, the data are not up to date, as the names of those who have died are not deleted from the main record (Tiun, Lee & Khoo, 2011)

The facts still remain that the numbers of people with disabilities keep on increasing drastically. Therefore, exposing them to learn with others is important because they should together be respected as part of the resources for the country. Unfortunately, study has reveals that 80% of learning materials such as textbook and courseware are provided for different target learners (Chadha & Subramanian, 2010) but are not designed towards universality. This is because the main learning styles that uses for normal, low vision, and hearing impared students are followed by text reading or kinesthetic or auditory (Aziz, Rasli & Ramli, (2010). The effort of universality in learning material has being undertaken by both developed and developing countries. For instance, Malaysia Education Blueprint (MEB) 2013 – 2025 ensures to have students whose circumstances or needs are learning alongside with people without deformity in mainstream, this will help them reach their full potential.

Presently, there are several problems in the area of courseware instruction interface design for learning purpose. For instance, the interface design is vague or complex for the users, and the content lacks universal motivational elements to serve as usability strategies (Lyashenko, 2010). In the area of instructional, learners have difficulties in using instructional interface tool to guide their learning (Maj et al., 2007), and content acquisition methods are often not that effective for self leaning (Quan, 2002). Consequently, usability problems regarding instruction interface are often reported in literatures. For instance, the level of awareness of usability remains low among the developers and incorporating multimedia elements on the instructional interface to consider as strategies to be used for improving the courseware interface design is lacking (Zhang, 2011; Weihong & Chunying, 2013); the difficulty in user instructional interface that learners face when exploring courseware is indeed the greatest concern (Kabari & Ukpong 2012); students' learning interest with courseware is often low, then available coursewares are not utilized repetitively by users after the first viewing and when they do read courseware, they do so strategically: skimming, skipping, and scanning (Abdulrauf, Ariffin & Subihatun, 2014); and developers unintentionally put little concern into the instructional interface on layout, structure and navigation design that takes care of the content acquisition and accessibility for all diverse learners. This problem related to the poor user interface and inappropriate structure of instructional elements to present information (Vodanovich et al., 2013). As a result, the learning mode and means are rigid (Zhang, 2002).

This indicates that merging the gap between low vision, hearing impaired and people without deformity need typical learning materials that specifically could fulfill their needs in learning without facing anymore difficulties in terms of content acquisition, and navigation accessibility. Currently, most of the content composition and learning styles in courseware are developed for target students, which totally are not appropriate universally. They are known as typical courseware (TC) either it provided in the form of CD-ROM or available online. Low vision and hearing impaired are also exposed to TC. Usually, when using TC, they have to face problems in the instructional interface design, such as blinking button, crowded pages, inappropriate font and background design, mouse-based interaction and inappropriate images design. Those problems restrict their ability to acquire the provided content, navigate around the contents and finally prompting to frustration in their learning activities (Abdulrauf, Ariffin, Subihatun 2014).

Universal instructional interface with multimedia elements could be better way that can enhance the understanding and content acquisition in learning materials for low vision and hearing impaired, this occurs when the user can control 'what', 'when' and 'how' of such elements, which includes text, audio, video, graphics and animations. It has the capacity to deliver learning materials in multiple forms which can motivate any form of learners with specific learning difficulties (Haroon & Abdulrauf, 2015).

In addition, it is established that learners' benefit from highly instructional elements, but the interactive in courseware is not feasible for most low vision and hearing impaired. In order to accommodate this emerging instruction medium, we are drawing design principles and models from the research literature on educational instructional strategies and courseware. Moreover, we provide a comprehensive approach to the design of universal content. Finally, we suggest that learning organizations and instructors should invest additional effort in developing interactive learning systems that support an integrated approach to low vision and hearing impaired, information sharing, and self-controlling of learning tools.

In response to that, this study attempts to determine design principles for instructional interface, which specifically caters for the needs of low vision and hearing impaired in the same learning environment. The courseware is named Courseware for Low Vision and Hearing Impaired (C4LVHI). Prior to developing the C4LVHI, a set of specific instructional design principles has to be determined in making sure C4LVHI fulfill the needs of universality. Hence, with the support of content analysis carried out, this study comes out with two specific objectives as pointed below:

i) to determine the instructional element as design principles for C4LVHI
ii) to develop a prototype of C4LVHI based on the gathered instructional design principles.
Thus, in achieving both objectives, some activities were performed as discussed in the next section.

2.0 PHASE OF ACTIVITIES AND METHODS

This study involves of activities for the identification of elements' specification that result to instructional design principle. The activities involved preliminary study and comparative analysis. From this phase, data regarding the design concepts of Instructional principles were gathered and the first objective of the study was achieved.

Analysis of user's need is necessary in order to develop appropriate usability strategies elements that can motivate learners in utilizing courseware accordingly. A preliminary analysis was carried out at early stage of this research, using interview as instruments for the evaluations. This analysis was carried out to determine the limitation in existing learning material and identifying the instructional elements that are applicable to low vision and hearing impaired before determine a suitable model of instructional interface design principles for courseware. This will serves as learning tool that can suite the abilities and learning styles for low vision and hearing impaired learners.

An interview with lecturers has been conducted at university level. This university has resulted on the learning characteristics for both low visual and hearing impaired learners. Limitations with existing learning materials and suggestion on improvement in the instructional interface were gathered. The results indicate that general impression was that the multimedia design principles were appreciated on the instructional interface design. Therefore, data obtained from the analyzed interview on instructional interface design and as well as comparative analysis on multimedia learning theories and courseware has been very useful. Based on the approaches, the focus of the instructional design principle is to ensure the strategies that will enhance the usage of courseware and most adhere to content accessibility and acquisition. Table 1 shows the criteria and justification in determining appropriate components for instructional design principles.

Table 1 Criteria and justification to determine appropriate components for instructional design principles for C4LVHI

Users	Criteria	Justification
People with no disability	They are higher institution level of distance learning centre (inclusive education) with average age range 18 to 35 years old (undergraduate and post-graduate)	Non-disabled learners are the target users of design principle. They are introduced to Molecular Biology. It involves them to find how helpful to the content accessibility and content navigation in terms of structure, layout and navigation design of the proposed model which could help them realize their needs in learning activities
Low Vision	They are higher institution level of inclusive learning system with partial disability of low vision (undergraduate and post-graduate)	Low vision learners are the target users of design principle. They are introduced to Molecular Biology. It involves them to find how helpful to the content accessibility and content navigation in terms of interface design which could help them realize their needs in learning activities
Hearing impaired	They are higher institution level of inclusive learning system with disability of hearing (undergraduate and post-graduate)	Hearing impaired learners are the target users of design principle. They are introduced to Molecular Biology. It involves them to find how helpful to the content accessibility and content navigation in terms of interface design which could help them realize their needs in learning activities

In supporting the findings gathered from the UCD approach, a comparative analysis was carried out as detailed in the next subsection.

2.1 Comparative Analysis

Prior to proposing the instructional design principles for C4LVHI, a comparative analysis on the existing studies on design principle of courseware was conducted. 14 existing coursewares (i.e. typical courseware) from previous studies were selected. To simplify the discussion, all of them are named as sample model. The selected studies have been discussed and analyzed deeply with their limitations. Consequently, this section compares them with the objective to identify their generic components and elements to serve as part of instructional design principle strategies for courseware. They were selected to be compared based on justifications detailed in Table 2.

Table 2 Justifications detailed

S/No	Studies	Justifications
1.	The Development and Usability of Malaysian Sexuality Education (MSE) Courseware (Chan & Jaafar, 2010)	This study is chosen because of its clarification in implementing instructional design and learning theories. Hence, it is most perfect for the prototype design phase.
2.	Usability on Appropriate basic design layout for Courseware: Research Based Design Models (Khlaisang, 2010)	It was chosen for the reason that it highlights the details regarding the design approaches that could be attractive strategies to the learners.
3.	Usability Satisfaction of Open Source e-Leaming Courseware (GhalibAI-Masoudi, 2010).	This study is selected because it stresses on learning activities and details on multimedia elements guidelines to motivate the users to learn.
4.	Effectiveness and Usability for	This study is chosen because it details in terms of structural interface

	Li2D development (Zuraini & Wan Fatimah, 2011).	design and learning theories to support learning approach.
5.	Usability of Design Recommendations for Small Screens Key Concepts and Issues: base on learning objective model (Churchill, 2011).	This study is chosen because it recommends some specific guidelines to be considered in designing interface and the recommendation is good for this study.
6.	Usability of "Image Processing" in a net courseware design (Zhang, 2011).	It discusses the usability approaches in terms of content arrangement clearly (layout design) and it considers some principles that are useful for this study.
7.	Usability of Affective Impact of Navigational and Signaling Aids to e-Learning Material (Sung & Mayer, 2012)	This study implements the cognitive theory to motivate the learning processing and provides some instruction elements in the interface design, which is appropriate to adopt in this study.
8.	Usability, in relation to e-learning projects (Jeffels, 2011)	This study is chosen because it focuses on usable and accessibility of the learning materials. The usability factors that are considered are interface issues, pedagogical issue, information architecture, accessibility and delivery issues and multimedia issues.
9.	Usability Design for Video Lectures (Chorianopoulos & Giannakos 2013)	This study is chosen because it implements an online educational video lectures with virtual reality and the system enhance the usage with the navigation (such as pause, play, and random seek), sharing and editing.
10.	Usability of Multiple Intelligence in Ensures of Digital Storytelling for Preschool Children (Cut et al., 2011)	This study is chosen because it incorporates multimedia digital content strategy components to improve the usability concepts of courseware. The concepts of courseware and digital storytelling are combined to deliver learning contents. Also, Multiple Intelligence is mapped into the development of learning material and the multimedia elements used are animation, imagery, text, and voiceover that enable the students to stimulate for reading activity.
11.	Assistive Courseware for the Visually Impaired based on Theory of Multiple Intelligence (Nurulnadwan, Ariffin, & Siti Mahfuzah, 2014)	The study is selected because it develops an Assistive Courseware for visual impaired learners based on multiples intelligence theory. It discussed eight types of intelligences, in which different users may have good skills at different types.
12	Guidelines of assistive courseware (AC) for hearing impaired students (Ariffin & Faizah, 2010).	This study is chosen based on the IntView methodology employed in developing the courseware and it comprises some characteristics to design assistive courseware for hearing impaired learner that it will part of the element to consider in inclusive education system.
13	Malay Sign Language Courseware for Hearing-Impaired Children in Malaysia (Savita & Athirah, 2011).	The study uses colors and design, simple and easy navigation method and inclusion of 3D images with video capability and animated rotational view to design courseware with sign language, which are the part of content learning element to enhance learning for hearing impaired learners.
14	Interactive multimedia courseware of vowel training for the hearing impaired. (Chaisanit, Suksakulchai & Nimnual. 2010).	This study is chosen because it implements contents and the knowledge structure to the interactive multimedia courseware for the hearing impaired students. The courseware was used the technique of dynamic computer graphics to establish an animation display system to assist the hearing impaired learner.

(Source: Abdulrauf, Ariffin, & Sobihatun, 2014 & 2015)

The features of all compared studies are tabulated in separated columns. The similarities and the differences of the features contain in the studies are then plotted. With that, information for all models for certain features is seen on the same line, so that the decision is easy to form. This technique is supported by Ariffin and Faizah (2010) and Nurulnadwan, Ariffin, and Siti Mahfuzah (2014). The results of the comparative study are compiled and used as the input for determining the instructional interface elements as part of usability strategies for C4LVHI and lastly the elements are merged together to form the design principles for C4LVHI. Having done with the UCD approach and comparative analysis, the component,

elements, and content composition for design principles of C4LVHI have derived as detailed in the next section.

3.0 INSTRUCTIONAL INTERFACE DESIGN PRINCIPLE FOR C4LVHI

The instructional interface design principles for C4LVHI, which consist of the content composition of structural, layout and navigation elements. These were gathered through multimedia components design using integration of learning theory approach of suitable pedagogy technique. In addition, data collection from early analysis is also used as reference in determining the approach and strategy incorporated in the design principles. This ensures that all expected educational objectives for low vision and hearing impaired learners are achieved.

3.1 Specification of Instructional Principles

The instructional strategies are the major aspect in the design principle for **C4LVHI**. Instructional strategy refers to the content that this study intends to use to deliver the instructions to the users. These are included in the description sheets and are described below:

- The variation of content, that are in text and pictorial information
- The variation of styles in information display.
- To show operations by using multimedia element in a step-by-step
- The implementing of demonstration items
- Using of narration and storytelling in the courseware design.

Based on the analyzed usability strategies for the instructional components of C4LVHI as detailed in previous paragraph, this study comes up with specific instructional strategies as design principles that will enhance the content accessibility and applicable for the low vision and hearing impaired. This makes the courseware usable for particular groups. It comes in the form of implementing assistive technologies or retrofitting the courseware. Table 3 displays the lists of instructional design principles for particular user groups. However, Namatame, Kobayashi and Harada (2012) have related that non-impaired people and hearing-impaired people have little difference in interface usage, except for sounds in the contents design. Therefore, provisions of equivalent alternatives to auditory and visual content for hearing-impaired learners that are required have been considered. Specifically, this guideline has stated as follows: "Describe the sound of auditory content" and "Provide non-text equivalents of text".

Table 3 Instructional strategies for specific target (design principles)

Non-impaired	Low Visual impaired	Hearing impaired
✓ Avoiding large graphics. ✓ Avoiding numerous graphics. ✓ Avoiding lengthy pages of content presentation. ✓ Offering navigation support. ✓ Simplifying user interface. ✓ Avoiding complexity design. ✓ Making content succinct and relevant. ✓ Using text to label images. ✓ Provide users' control on sounds. ✓ Provide a text equivalent. ✓ Provide feedback. ✓ Eliminate unnecessary complexity. ✓ Design nothing differently from	✓ Provide enough contrast between text and background color. ✓ Text -to- speech system. ✓ Provide an auditory equivalent. ✓ Provide colors Mindful for action Items. ✓ Provide closed captions for all audio content that contains useful information. ✓ Use the largest font size. ✓ Auditory feedback. ✓ Tactile interface. ✓ Screen/image-enlargement utility.	✓ Speech-to-text system. ✓ Closed captions. ✓ Provide a text equivalent. ✓ Conform to current interface design standards. ✓ Provide transcripts for all audio content. ✓ Provide captions and descriptions of multimedia used. ✓ Using text to label images. ✓ Turn off graphics. ✓ Turn off sounds. ✓ Provide enough contrast between text and background color. ✓ Use descriptive links rather than

user expectations.	✓ Provide role-over on button key. ✓ Object magnification. ✓ Avoid blinking, flickering, or moving elements. ✓ Design nothing differently from user expectations. ✓ Eliminate unnecessary complexity.	"click here. ✓ Use the largest font size. ✓ Provide feedback. ✓ Avoid blinking, flickering, or moving elements. ✓ Do not design something differently from user expectations just to be different. ✓ Eliminate unnecessary complexity

(Source: Abdulrauf, Ariffi, & Sobihatun, 2015 & 2016)

Furthermore, Figures 1 through 3 show some interface samples of the C4LVHI prototyping snapshots developed for this study. This is done to evaluate the proposed designed principle, which is transformed into working prototype. Figure 1 exhibits that the title of the Courseware for Molecular Biology incorporate text with some graphics, particularly to attract users and give clearer of the course title. Further, it visualizes the multiple entry form to support the universal usage for three different users.

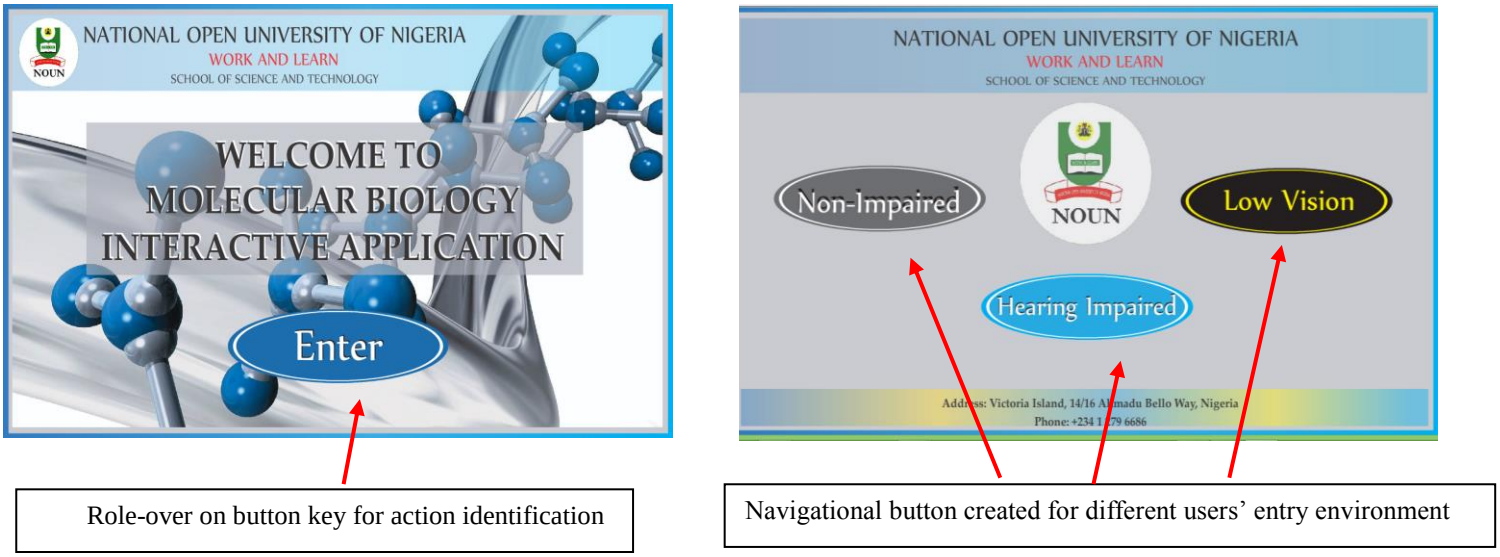


Figure 1 Structural (Opening section in C4IES)

Figure 2 exhibits various users' interface with appropriate color for background and text. The display of the multimedia elements exhibits the incorporated instructional design as usability strategies on each instructional interface. Combination of attributes and background were highly contrasted for low vision learners to unable the users comparing the combination of colors. Black is a good example for background while white and yellow is for the attributes. Hearing impaired has a clear interface in terms of shapes and combination of colors. For example deep brown color for background and white and yellow is for the attributes. Non-impaired learners have the same characteristics of interface design for hearing impaired, only that the color blue was used to differentiate the background design.

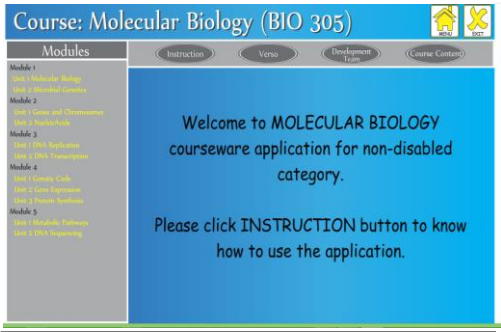
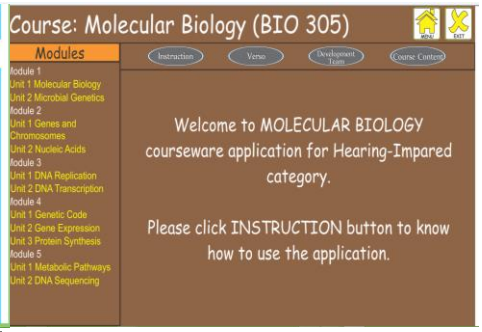
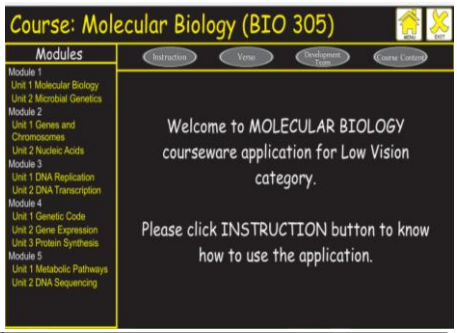
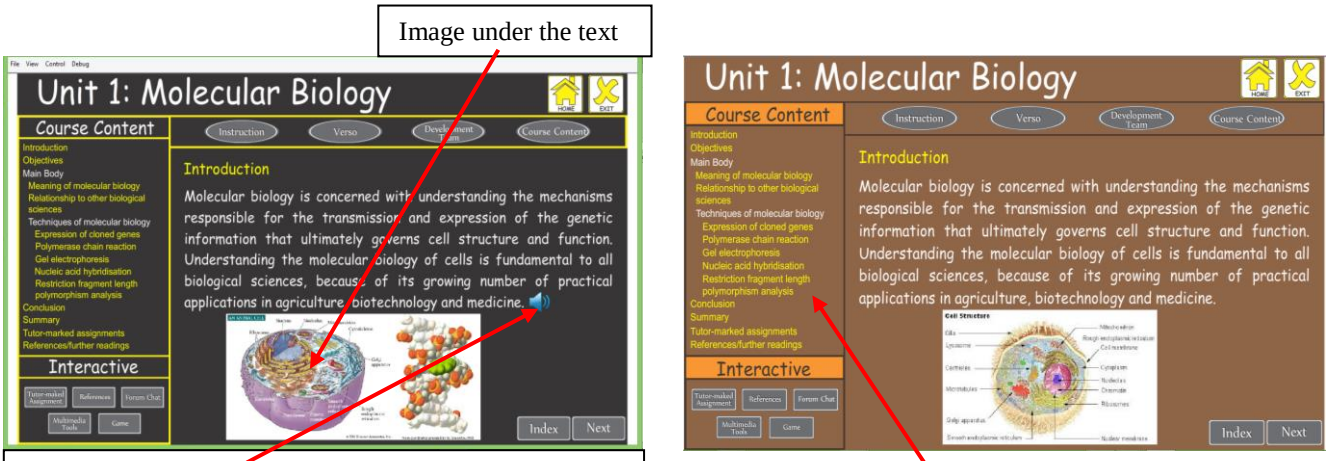
Non-impaired interface	Hearing impaired interface	Low Visual Interface
		
Create good contrast color between background and foreground: As example use either black or deep color for text and bright color for background	**Create good contrast color between background and foreground:** As example use either yellow/ white for text and deep brown color for background	**Create good contrast color between background and foreground:** As example use either yellow or white for text and black for background

Figure 2 Interface design (Layout section in C4IES)

The Courseware for Molecular Biology composes visual elements including texts, graphics and images. Figure 3 shows a page in which text is used, combined with a graphic. Also, the prototype displays most text, graphics, and images on the real objects. The use of images and graphics to explain the content fasters the rate of understanding and enables the learners to visualizes every action in the lesson. The use of images and real objects can support learners' recognition. This factor reflects a manifestation of recommendation in cognitive theory. Courseware for Molecular Biology ensures to use audio as a supportive element in both static content and motion. It inherits the video metaphor. Audio is a required element and is embedded along the Courseware for Molecular Biology for low vision users from the start to finish. It enables different preferences regarding sound volume; users could be self-control using DVD player control mechanism.

Interface Layout in C4IES



Supply sound effects & Create good object magnification: Sound effects are supplied in this scene to enhance the learners understanding (Text -to- speech system), in addition to roll over to enlarge the object

Learning content interface for hearing impaired with navigation bar at left side.

Figure 3 Content presentation in C4IES

4.0 CONCLUSION AND FUTURE WORKS

Summarily, this study reports an ongoing project regarding the development of C4LVHI. The objective has been achieved, which are the identification of elements specification that results to instructional interface principles for C4LVHI. C4LVHI prototyping was developed based on the identified instructional strategies principles in attempt to fulfill the needs of learners in learning activities. Content acquisition, navigation accessibility, and motivation are applied in C4LVHI through the identified instructional strategies design principles. Future works of this study is to investigate the user experience of using C4LVHI in terms of motivation to use courseware again next time, and effectiveness for low vision and hearing impaired learners.

References

Abdollah, N., Ahmad, W. F. W., & Akhir, E. A. P. (2010, May). Multimedia Design and Development in" Komputer Saya'Courseware for Slow Learners. In*Computer Research and Development, 2010 Second International Conference on* (pp. 354-358). IEEE.

Abdulrauf T. (2015). Usability Strategies of Instructional Interface Design Courseware for Inclusive Education System. Unpublished PhD Thesis, Universiti Utara Malaysia. Retrieved from http://etd.uum.edu.my/1521/2/21.Abdulrauf_Tosho.pdf

Aziz, N. A. A., Rasli, R. M., & Ramli, K. (2010, December). Preschool multimedia interactive courseware: Classifying object (mengelaskan objek) PMICMO. In *Software Engineering (WCSE), 2010 Second World Congress on*(Vol. 2, pp. 318-322). IEEE.

Aziz, N., Mutalib, A. A., & Sarif, S. M. The Prototype of Assistive Courseware for Low Vision (AC4LV) Learners.

Chadha, R. K., & Subramanian, A. (2010). The effect of visual impairment on quality of life of children aged 3–16 years. *British Journal of Ophthalmology*, bjo-2010.

Kabari, L., & Ukpong, U. (2012). *Creating an effective E-learning environment for Nigerian Polytechnic Educational System.* Paper presented at the Adaptive Science & Technology (ICAST), 2012 IEEE 4th International Conference on.

Lyashenko, T.V. (2010) 'Multimedia information technologies in education: basic concepts, essence, and typology (review)', *Automatic Documentation and Mathematical Linguistics*, Vol. 44, No. 4, pp.206–217.

Maj, S.P., Tran, B. and Veal, D. (2007) 'State model diagrams – a systems tool for teaching network technologies and network management', *Innovations in E-Learning, Instruction Technology, Assessment, and Engineering Education*, pp.355–360.

Namatame, M., Kobayashi, M., & Harada, A., (2012). A preparatory Study of Forming Web Accessibility Guidelines for the Hearing-Impaired.

Quan, Y.S. (2002) 'Network curriculum design and development' [online] http://etc.elec.Bnu.Edu.Cn.

Rashid, M. Z. (2010). "Empowering persons with disabilities in Malaysia," *10th BJM of teh East Asia Pacific Regional Council of Cheshire Home*, pp. 8-11,

Shakirat Oluwatosin Haroon & Tosho Abdulrauf. (2015). A Virtual Reality Prototype for Learning Maize Planting. *Communications on Applied Electronics* 2(1):10-14. Published by Foundation of Computer Science, New York, USA.

Slee, R. (2001). Social justice and the changing directions in educational research: The case of inclusive education. *International journal of inclusive education*, *5*(2-3), 167-177.

Tiun, L. T., Lee, L. W., & Khoo, S. L. (2011). Employment of people with disabilities in the Northern State of Peninsular Malaysia: Employers' perspective. *Disability, CBR and Inclusive Development Journal*, *22*, 79-94.

Tosho, A., Abdul Mutalib, A., & Nur Abdul Salam, S. (2014). Usability of Instructional Interface: Accessibility Strategies of Courseware Design for Distance Learning, Nigeria. *International Journal of Computer Applications*,*106*(18), 32-36.

Tosho, A., Mutalib, A. A., & Abdul-Salam, S. N. (2016). Conceptual Design Model of Instructional Interfaces: Courseware for Inclusive Education System (IID4C) Distance Learning. *International Journal of Distance Education Technologies (IJDET)*, *14*(4), 68-82. Athabasca University, IGI Publication.

Tosho, A., Mutalib, A. A., & Abdul-Salam, S. N. (2016). Conceptual Design Model of Instructional Interfaces: Courseware for Inclusive Education System (IID4C) Distance Learning. *International Journal of Distance Education Technologies (IJDET)*, *14*(4), 68-82. Athabasca University, IGI Publication.

Vodanovich, S., Rohde, M., Dong, C.-s., & Sundaram, D. (2013). Youth Web Spaces: Designing Interfaces as if Youth Mattered. *Human IT: tidskrift för studier av IT ur ett humanvetenskapligt perspektiv*, *11*(3).

Weihong, Z., & Chunying, Z. (2013). Using Multimedia to Create a Scientific English Teaching Model of Human-Computer Interaction.

World Health Organization. (2012). *World report on Disability*. Retrieved from http://www.who.int/disabilities/world_report/2011/report.pdf

Zhang, T. (2002) 'Super sports multimedia WCAI web-based teaching courseware development design and application', *Sichuan Sports Science*, No. 2

Zhang, Y. J. (2011). A Net Courseware for "Image Processing". ICCGI 2011, The Sixth International Multi-Conference on Computing in the Global Information Technology.