PROTOTYPE OF MOLECULAR BIOLOGY COURSEWARE FOR INCLUSIVE EDUCATION SYSTEM: AN INSTRUCTIONAL INTERFACE

***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

This paper provides a research approach in developing an e-learning environment for inclusive learners. By capturing and modelling the multimedia 3-D knowledge into an instructional interface for teaching and assessing Molecular Biology Courseware for student in inclusive learning environment. The research proposed and developed a Conceptual Design Model for Courseware for Inclusive Education System, called C4IES. The experimental result conducted from the subject experts using the proposed prototype has demonstrated a great potential. Where, out of 10 experts 90% agreed that the proposed Multimedia environment has demonstrated a high usability in enhancing molecular concept (DNA) and practical skills of student in self learning practicing the laboratory task while away from on-campus environment. This could also be as guidance for the developer or anyone who intent to develop courseware for inclusive environment.

Keywords: Usability, Instructional, Courseware, Inclusive Learners, Strategies, Molecular Biology.

1.0 INTRODUCTION

Learning materials to ease the learning acquisition needs to design for every learner, including both disabled and non-disabled. However, for the inclusive, learning instructional learning materials are quite demanding. With the setback facing those with impaired, various challenges in the learning instructional material 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 material in order to maximize their potential and self-sufficiency learning attributes. Among many types of the disabilities, visual and hearing impairment are considered as non-mentally disorder that has ability to learn with non-disabled learners in an inclusive environment. In terms of definition, Inclusive Education is where learners with specific needs or learning disabilities learn alongside learners with no disabilities in the same environment (Slee, 2001). This is to place suitable special needs learners in tertiary institutions either part-time or full-time, and in-school or distance learning according to their capabilities. The effort of inclusive education system has being undertaken by both developed and developing countries. For instance, Malaysia Education Blueprint (MEB) 3013 – 2025 ensures to have students whose circumstances or needs are learning alongside with non disabled student in mainstream that are likely to fall through the gaps in education are specially catered for, while this will help them reach their full potential. 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 million

disabled people in December 2012 (Rashid, 2010). The report mentioned the total number of disabled people in Malaysia is 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 remains that the number of disable keeps on increasing drastically. Therefore, exposing them to the inclusive education system 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 for inclusive users. This is because the main learning styles that are used for normal learning for disabled students are followed by text reading or kinesthetic (Aziz, Rasli & Ramli, 2010).

This indicates that inclusive learners need typical learning materials that specifically could fulfill their needs in learning without facing anymore difficulties, particularly in terms of content acquisition, navigation accessibility, and usability strategies aspects. Instructional interface with multimedia could be a better way that can enhance the understanding and content acquisition in learning materials for inclusive environment, this occurs when the user can control 'what', 'when' and 'how' of such elements, which includes text, audio, video, graphics and animations (Haroon & Abdulrauf, 2015). It has the capacity to deliver learning materials in multiple forms, which can motivate any form of learners with limiting in the specific learning difficulties. In response to that, this study attempts to develop a prototype of courseware, which specifically caters for the needs of inclusive learners in learning, which is named Courseware for Inclusive Education System (C4IES). Prior to developing the C4IES, a set of specific design principles have to be determined in making sure C4IES could fulfill the needs of both impaired and non-impaired learners. Hence, with the support of comparative analysis carried out (Abdulrauf, Ariffin,& Sobihatun, 2015), this study comes out with two specific objectives as i) to determine the design principles of C4IES, and ii) to develop a prototype of C4IES based on the gathered design principles. Thus, in achieving both objectives, two phases of activities were performed as discussed in the next section.

2.0 PHASES OF ACTIVITIES AND METHODS

This study involves two phases of activities which are identification of elements specification that result to conceptual design for C4IES model, and prototype development through IntView methodology as shown in the Figure 1. This methodology is supported by Ariffin and Faizah (2010) and Nurulnadwan, Ariffin, and Siti Mahfuzah (2014). In the first phase, the activities involved include literature study and preliminary study (Abdulrauf, Ariffin & Sobihatun, 2014). This technique is known as User Centered Design (UCD) approach. From this phase, data regarding the design concepts of C4IES model were gathered and the first objective of the study was achieved.

Phase 1 Phase 2

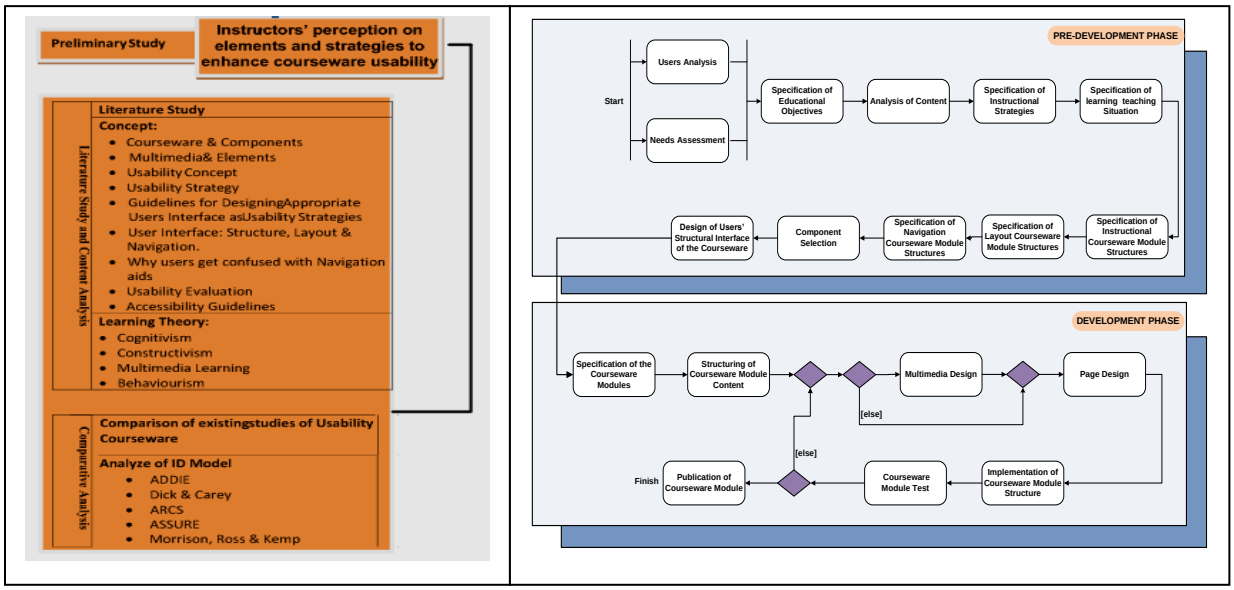


Figure 1 Summary of activities

3.0 C4IES PROTOTYPE DEVELOPMENT

In the development process of C4IES prototype, **IntView** methodology was adopted. It involves two phases, which are pre-production, and production. In the first phase, 11 steps were implemented. In developing C4IES it is important to involve users and experts before the development of C4IES begins. The development of C4IES prototype takes up the challenge to ensure opportunities of multimedia interactive courseware presentation to cater for content acquisition and accessibility to all learners, including those with various impairments. The learners learning materials for different target were used to gather the input and comments in terms of the design of C4IES prototyping. All this input are important in preparing the script and storyboard of C4IES. Therefore, the subject area of learning content in C4IES is Molecular Biology. This is based on the finding from preliminary study (Abdulrauf, Ariffin & Sobihatun, 2014) on subject taken has shown that students have problems in learning biological course. According to Abdulrauf, Ariffin and Subihatun (2014), students having problem in visualizing the concept of Molecular Biological Cell in abstract reading, in un-interactive environment and the images are represented in 2-Dimensional in the textbook. Hence, the prototyping of interactive courseware with multimedia elements was developed for this topic.

In the development phase, all the identified elements and design from the previous stage were referred for developing the working prototype. The early step before commencing the development process is to identify the required tools. In this research, the development tool being chosen is Adobe Photoshop CS6 which plays different roles for the development process of the prototyping. Apart from the technological tools, the development process of "Learning Content" module highly relies on the learning material on the PDF lesson material, which as the main source of content development and design based on the identified instructional strategies that proposed for the C4IES model (Abdurauf, Ariffin & Subihatun, 2015). Cross reference was also made by referring to several available reference books. This is to make sure that the multimedia courseware prototype is rich in contents and informative for the students. The modules for C4IES are divided into different units, which are a shown in Figure 2.

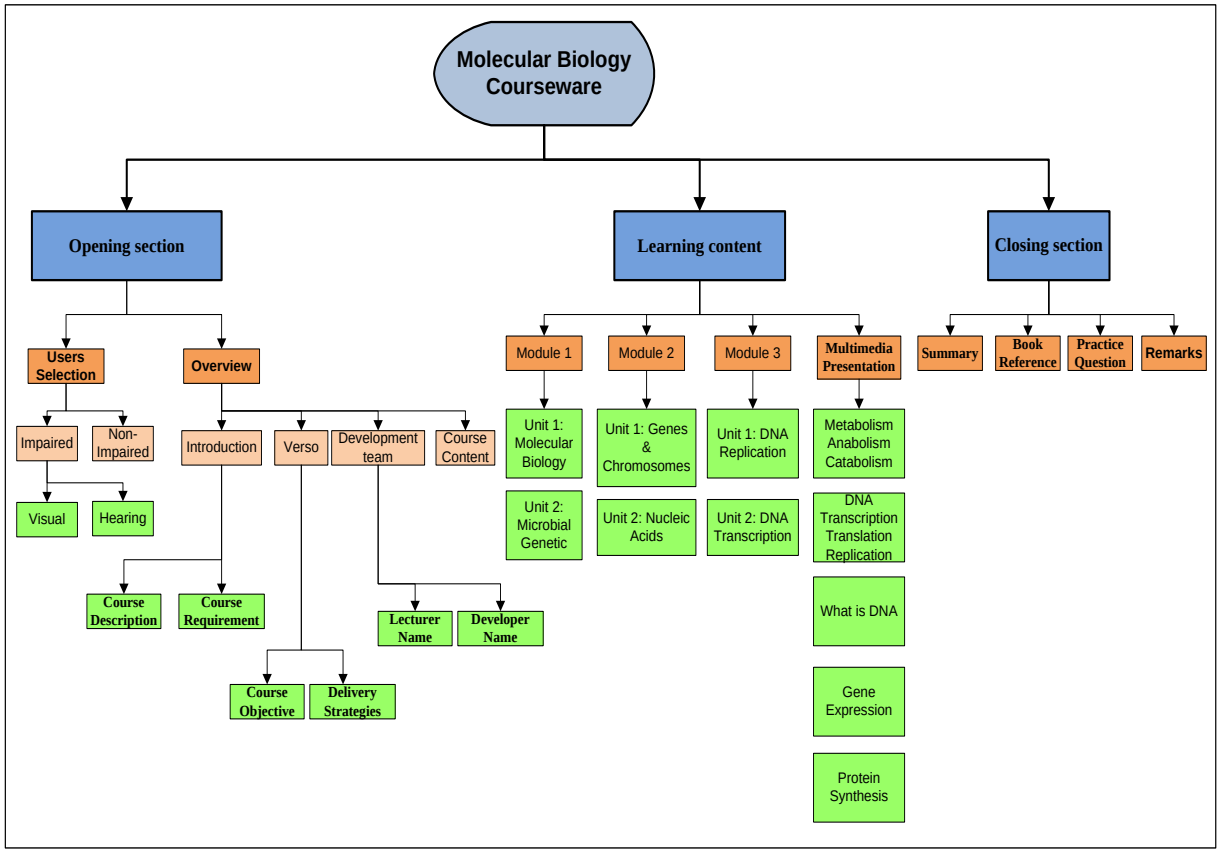


Figure 2 Courseware modules

Based on the determined usability strategies for the proposed conceptual model of C4IES, this study come up with specific instructional elements that serve as usability strategies design principles that has been enhanced the content accessibility and consider the needs of different abilities in the learning content (inclusive user). Theses make the courseware usable for particular disability groups; and they come in the form of implementing assistive technologies or retrofitting the courseware. Table 1 shows the lists of instructional strategies principle for particular user groups. However, Namatame, Kobayashi and Harada (2012) have been supposing that non-impaired people and hearing-impaired people have little difference in interface use, except for sounds in the contents design. Therefore, the study provides equivalent alternatives to auditory and visual content for hearing-impaired learners. Specifically, these guidelines have been considered with the sound of auditory content and provide non-text equivalents of text.

Table 1 Instructional elements for usability strategies for different abilities (design principles)

Non-impaired	Low Vision 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. ✓ Provide role-over on navigation button key.	✓ Provide enough contrast between text and background color. ✓ Text -to- speech system. ✓ Provide an auditory equivalent. ✓ 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. ✓ Closed captions. ✓ Screen/image-enlargement utility. ✓ Provide role-over on button key. ✓ Object magnification. ✓ Avoid blinking, flickering, or moving elements. ✓ Do not design something differently from user expectations just to be different. ✓ Eliminate unnecessary complexity.	✓ 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 "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. ✓ Provide role-over on navigation button key.

(Source: Abdulrauf, 2015)

4.0 FINDINGS

Data gathered from the expert review are tabulated in Table 2. The data were documented as in frequency of responses of the expert review to the questions asked in the instrument.

Table 2 Frequency of responses from expert review focus group

Q1.	The Prototype	Frequency (n=10)		
		Is easy to understand	Need some explanation	Not relevant
	a) Structural Components	10	0	0
	b) Layout Components	10	0	0
	c) Navigation Components	10	0	0
	d) Structural Instructional Elements	10	0	0
	e) Layout Instructional Elements	10	0	0
	f) Navigation Instructional Elements	10	0	0

	Question	Strongly Agree	Agree	Disagree	Strongly Disagree
Q2.	I found the connections and flows of all elements are logically appropriate	4	5	1	0
Q3.	I found that proposed elements as part of usability strategies were used in prototype development.	3	7	0	0
Q4.	Generally, I found that the proposed Multimedia learning material has demonstrated a high usability in enhancing molecular concept (DNA)	3	6	1	0

As shown in Table 2, majority of the experts agreed that the prototype instructional interface elements as part of usability strategies contain relevant elements, exhibit logical flows, usable to the development of courseware and the elements are readable. In addition, 90% agreed that the proposed Multimedia environment has demonstrated a high usability in enhancing molecular concept (DNA). Further comments from the experts were also documented during the reviews. Table 3 lists the comments from all of the experts. Some of the comments were rephrased in the original versions to express clearer meaning.

Table 3 Further comments from the expert reviews

Experts	Comments
Expert 1	1. Overall, the items are easily understood but need to demonstrate with prototype.
Expert 2	1. Appropriate colours combination should be well considered in the usability strategies
	2. The proposed elements design should be user's friendly as much as possible
	3. The e-mail and phone number of lecture/instruction in charge of the course could be included in the development team section.
Expert 3	1. The proposed items for instructional interface are essential for improving courseware design
	2. The element may incorporate some features of adaptive and intelligent web-based education systems to make the courseware to be more adaptive.
Expert 4	No comment
Expert 5	No comment
Expert 6	1. The supportive guidance should cater for all strategies
	2. The figure should be consistent in terms of terminologies used
	3. The title of the model should be consistent with terminology of usability strategies and instructional interface.

Expert 7	No comment
Expert 8	1. Adding semantic features to search engine module to enhance the degree of courseware relevance
Expert 9	1. The proposed item should review as enhancement of usability strategies for courseware. 2. e-learning technology has been adjudge to be mature technology. 3. Remove the item of usability strategies to separate content.
Expert 10	No comment

Furthermore, Figures 3 through 6 show some interface samples of the C4IES prototyping snapshots that developed for low vision, hearing impaired and non-impaired as inclusion learners based on the courseware modules design and instructional strategies principles as determined in the previous phase. This is done to evaluate the proposed designed principle, which is transformed into working prototype. Figure 3 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.

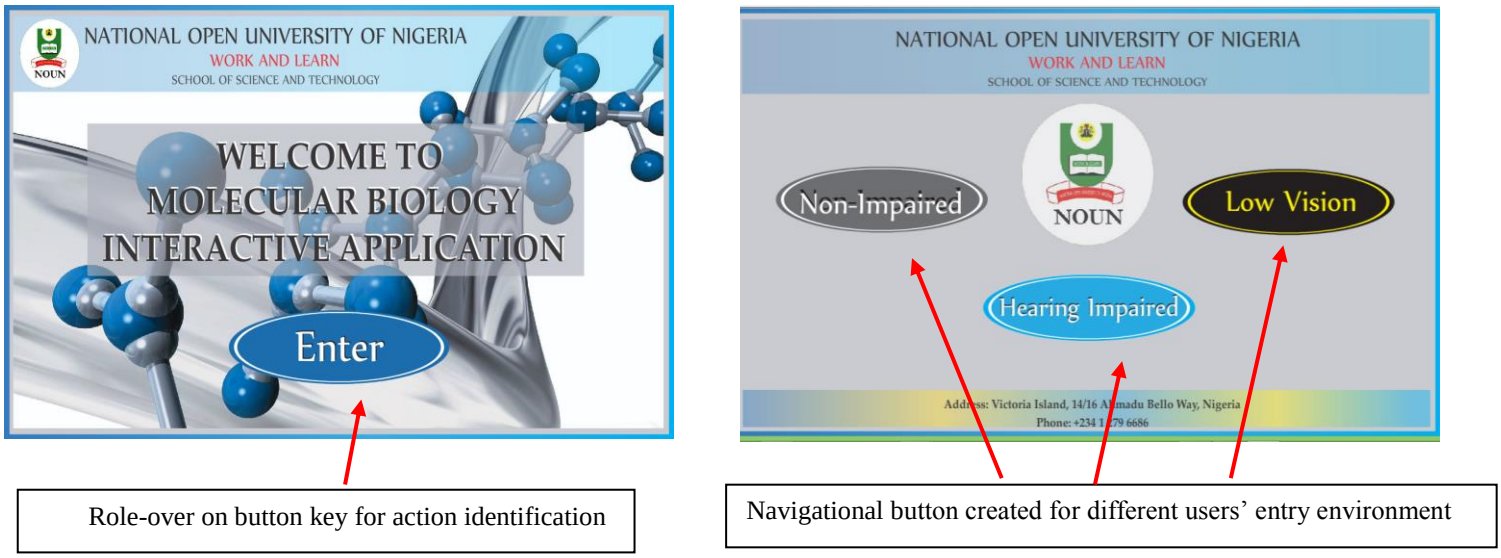
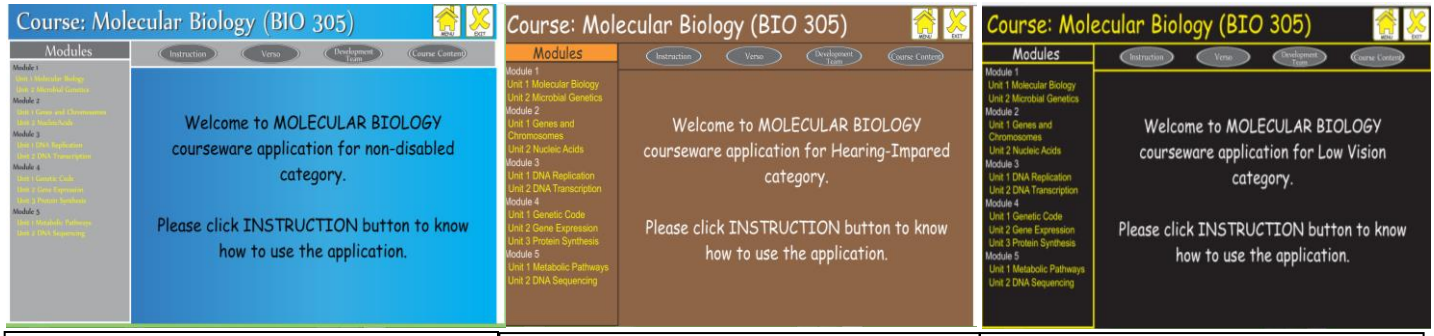


Figure 3 Structural (Opening section in C4IES)

Figure 4 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.

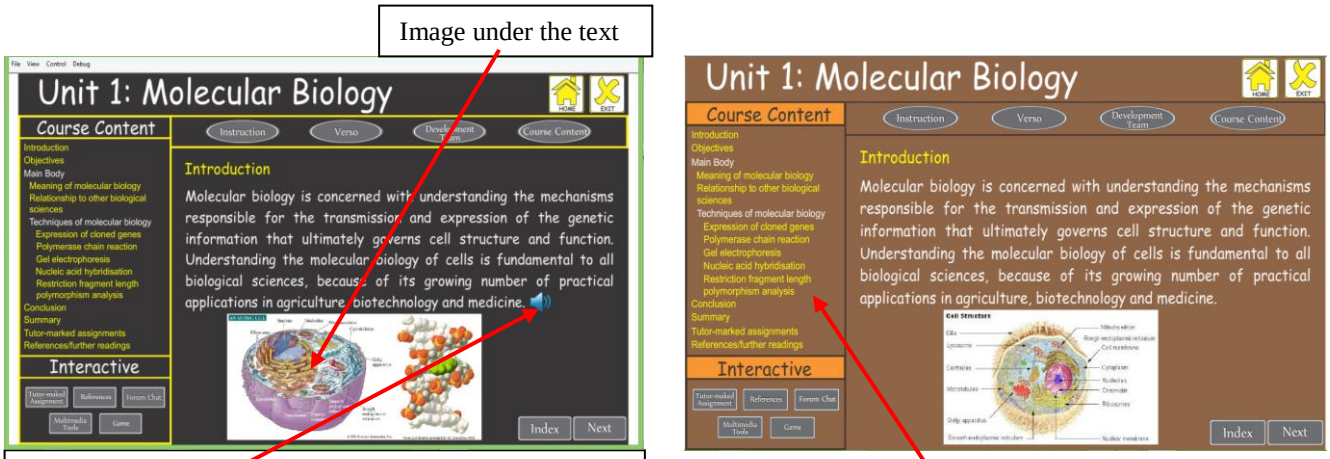
Non-impaired interface | Hearing impaired interface | Low Visual Interface



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 4 Interface design (Layout section in C4IES)

The Courseware for Molecular Biology composes visual elements including texts, graphics and images. Figure 5 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.



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 5 Content presentation in C4IES

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, as seen in Figure 6.

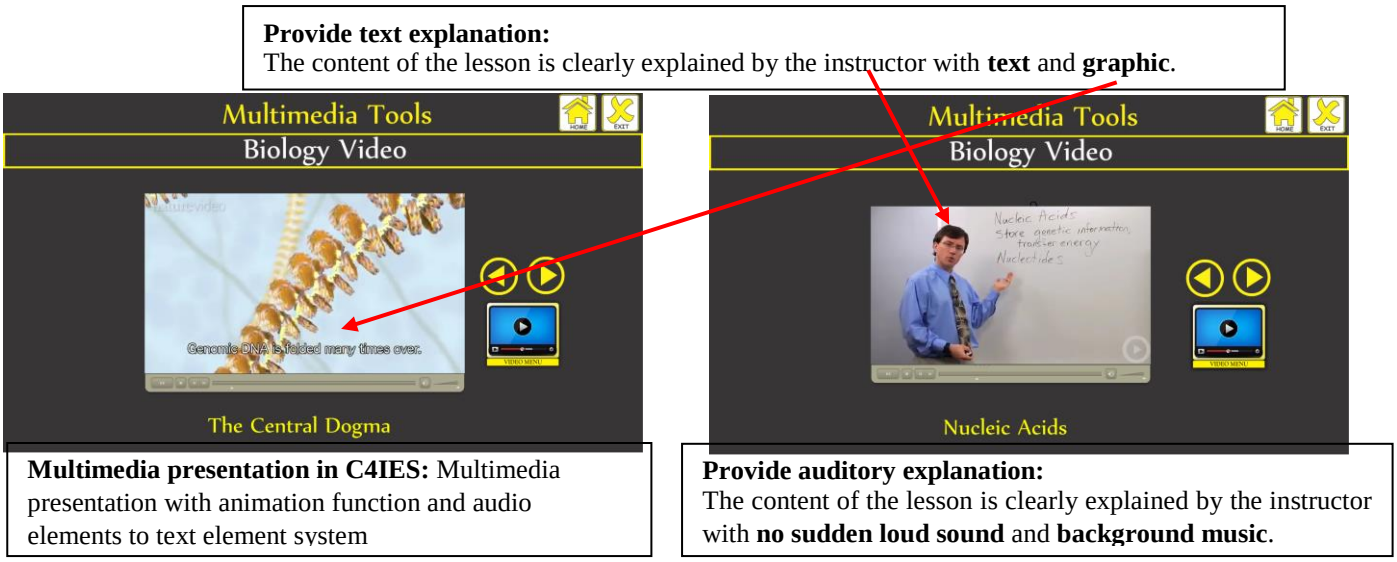


Figure 6 Multimedia interactive instructive section in C4IES

5.0 CONCLUSION AND FUTURE WORKS

Summarily, this study reports an ongoing project regarding the development of C4IES prototype. C4IES was developed based on the identified instructional strategies principles in attempt to fulfill the needs of inclusive learners in learning activities. Content acquisition, navigation accessibility, and motivation are applied in C4IES through the identified instructional elements and strategies design principles. Future works of this study is to investigate the user experience of using C4IES in terms of motivation to use courseware again net time, efficient in shorting the time to accomplishing a task, and effective for inclusive learning environment.

References

Abdollah, N., Ahmad, W. F. W., & Akhir, E. A. P. (2010). Multimedia design and development in "Komputer Saya" courseware for slow learners. *Second International Conference on Computer Research and Development*, 354-358

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). Preschool multimedia interactive courseware: Classifying object (mengelaskan objek) PMICMO. *Second WRI World Congress on Software Engineering*, *2*, 318-322.

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*, *95*(5), doi: 10.1136/bjo.2010.182386

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

Lyashenko, T.V. (2010). Multimedia information technologies in education: basic concepts, essence, and typology (review), *Automatic Documentation and Mathematical Linguistics*, *44*(4), 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*, 355–360.

Quan, Y.S. (2002). Network curriculum design and development. Retrieved from http://etc.elec.Bnu.Edu.Cn.

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

Shakirat O. H. & Tosho, A. (2015). A Virtual reality prototype for learning maize Planting. *Communications on Applied Electronics 2*(1), 10-14.

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., Ariffin A., & Sobihatun N. A. S., (2015). Designing usability strategies: Implications for instructional interface towards courseware for inclusive education system *(C4IES). Research Journal of Applied Sciences, Engineering and Technology*. doi: 10.19026/rjaset.11.2034

Vodanovich, S., Rohde, M., Dong, C., & Sundaram, D. (2013). Youth web spaces: Designing interfaces as if youth mattered. *Human IT: Journal of Information Technology Studies as a Human Science 11(3),* 21-56. doi: http://hdl.handle.net/2292/11526

Weihong, Z., & Chunying, Z. (2013). Using multimedia to create a scientific English teaching model of human computer interaction. *Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering*, 1040-1043. doi: 10.2991/iccsee.2013.261

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*, 2.

Zhang, Y. J. (2011). A net courseware for image processing. *The Sixth International Multi-Conference on Computing in the Global Information Technology*, 143-147. Retrieved from: https://www.thinkmind.org/download.php?articleid=iccgi_2011_7_20_10132