Faculty of Information and Communication Technology

LEARNING CHEMISTRY USING 3D APPROACH: 3D ATOMIC CUBIC

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LEARNING CHEMISTRY USING 3D APPROACH: 3D ATOMIC CUBIC

NURAZIERA BINTI MOHD HATTA

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DECLARATION

I declare that this thesis entitle “Learning Chemistry Using 3D Approach: 3D-Atomic Cubic” is the result my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……...

Name : NURAZIERA BINTI MOHD HATTA

Date : ……...

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality as a partial fulfilment of Master of Science in Information and Communication Technology.

Signature : ……..

Supervisor Name : DR. HJH. NORASIKEN BAKAR

Date : ……..

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DEDICATION

To my beloved father and mother,

En. Mohd Hatta Bin Md Lani and Pn. Norizah Binti Musa

Brother and Sisters,

Nor Shella, Nor Ihdayu, Muhammad Arif and Mohd Fauzi

For my supervisors,

Dr. Hjh. Norasiken Bakar and co-supervisor Prof Dr Faaizah Shahbodin

(UTeM)

Lastly to my beloved friends who are encouraged, guided and inspired me. Without their patience, understanding, support and most of love, the completion of this work would not have been possible.

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ABSTRACT

This research is about the development of the 3D courseware named as 3D-Atomic Cubic as a tool for teaching and learning Chemistry subject. This 3D-Atomic Cubic courseware contains all multimedia elements used to attract students' attention for learning the contents. This courseware is specifically developed for a topic in Chemistry subject for student of Mechanical Engineering in Universiti Teknikal Malaysia Melaka (UTeM). The questionnaire is the instrument used in this research to determine the problem statement. Based on the questionnaires, Properties of Matter topic is identify as the most difficult topic, because students need to understand and visualize the arrangement of the atom in Cubic Cell. One of their problems faced when learning this topic is student enable to imagine the arrangement of the atom easily. By using traditional approach, the visualization of the model is using two dimensional (2D) models, as a result student hard to imagine the real scenario. This research is focusing on delivery approach of learning by using three dimensional (3D) approaches in studying Chemistry subject. The advantages gained from this research can benefit the students, lecturers, education industry, high institution and also the public. The development methodology of 3D Atomic Cubic courseware was developed using life cycle of 3D Atomic Cubic that based on the ADDIE model. This methodology consist five phase represents a series of task that help to ensure the development efforts stay on tract, on time and on target. Completing each phase is an important element for the instructional design process. For the preliminary analysis, 52 students from the whole Mechanical Engineering students who already took Chemistry subject are involved in determining the difficult topic in Chemistry subject. For evaluation on the effectiveness of 3D-Atomic Cubic Courseware, 52 of Mechanical Engineering students from UTeM is involved and they are divided by two which are Conventional and Experimental Group. From the analysis of the result, both of conventional and experiment group showed an improvement but the student who use 3D-Atomic Cubic courseware get higher mark. This shows that 3D-Atomic Cubic courseware can be used as teaching aid material in classroom since it shows those students who use the courseware get better result. This research found that a 3D element is very useful in helping students to understand chemistry subject especially in visualizing the arrangement of the atom.

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ABSTRAK

Kajian ini adalah tentang pembangunan perisian 3D yang dinamakan sebagai 3D-Atomic Cubic sebagai alat untuk pengajaran dan pembelajaran mata pelajaran Kimia . Perisian 3D-Atomic Cubic ini mengandungi semua unsur-unsur multimedia yang digunakan untuk menarik perhatian pelajar untuk mempelajari kandungan pembelajaran. Perisian ini dibangunkan khusus untuk salah satu tajuk yang terdapat dalam mata pelajaran Kimia bagi pelajar Kejuruteraan Mekanikal di Universiti Teknikal Malaysia Melaka (UTeM). Soal selidik adalah instrumen yang digunakan dalam kajian ini untuk menentukan pernyataan masalah. Berdasarkan soal selidik, tajuk Properties of Matter adalah dikenalpasti sebagai tajuk yang paling sukar kerana tajuk ini memerlukan pelajar untuk menggambarkan susunan atom dalam sel padu. Salah satu masalah yang dihadapi oleh mereka apabila belajar tajuk ini adalah pelajar tidak dapat membayangkan susunan atom dengan mudah. Melalui pembelajaran mengunakan pendekatan tradisional, visualisasi model itu menggunakan model dua dimensi (2D) sahaja, dan adalah sukar untuk pelajar membayangkan keadaan sebenar susunan atom di dalam sel padu. Justeru, kajian ini menumpukan kepada pendekatan penyampaian pembelajaran yang lebih baik iaitu dengan menggunakan pendekatan tiga dimensional (3D) dalam subjek Kimia untuk tajuk Properties of Matter. Kelebihan penyelidikan ini memberikan manfaat kepada pelajar-pelajar , pensyarah, industri pendidikan, Institusi tinggi dan juga kepada orang ramai. Metodologi Pembangunan untuk perisian 3D Atomic Cubic ini dibangunkan menggunakan Model Kitar Hayat 3D Atomic Cubic yang berasaskan kepada model ADDIE. Metodologi ini mengandungi lima fasa di mana setiap fasanya adalah untuk memastikan pembangunan perisian ini berjalan mengikut waktu yang ditetapkan dan sasaran yang dikehendaki. Melengkapkan setiap fasa juga adalah elemen penting untuk proses reka bentuk pengajaran. Untuk analisis awal , 52 orang pelajar dari Fakulti Kejuruteraan Mekanikal yang telah mengambil mata pelajaran Kimia terlibat dalam menentukan topik yang paling sukar di dalam subjek kimia. Untuk penilaian mengenai keberkesanan perisian 3D-Atomic Cubic ini, 52 orang pelajar Fakulti Kejuruteraan Mekanikal dari UTeM telah terlibat dan mereka dibahagikan dengan dua kumpulan iaitu kumpulan konvensional dan kumpulan kajian. Daripada analisis keputusan, kedua-dua kumpulan konvensional dan kumpulan kajian, telah menunjukkan perbezaan peningkatan dalam markah ujian yang diberikan, tetapi pelajar yang menggunakan perisian 3D-Atomic Cubic mendapatkan markah keputusan yang lebih tinggi. Ini menunjukkan bahawa perisian 3D-Atomic Cubic ini boleh digunakan sebagai bahan bantuan mengajar di dalam kelas kerana ia mampu menunjukkan kepada pelajar bahawa dengan menggunakan perisian 3D-Atomic Cubic tersebut mendapat hasil markah yang lebih baik. Kajian ini mendapati bahawa unsur-unsur 3D adalah sangat berguna dalam membantu pelajar untuk memahami mata pelajaran kimia terutamanya dalam menggambarkan penyusunan sesuatu atom.

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation, Evaluation
ICT	Information & Communication Technology
SPSS	Statistical Package for Social Science
2D	2- Dimensional
3D	3- Dimensional
CD	Compact Disc
FKM	Faculty of Mechanical Engineering
UTeM	Universiti Teknikal Malaysia Melaka
CAL	Computer Aided Learning

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LIST OF APPENDICES

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LIST OF PUBLICATIONS

Hatta N.M., Bakar N. (2010).“Development and effectiveness of 3D Visualization Courseware” Proceeding of Kolokium Universiti Teknikal Malaysia Melaka 2010, UTeM, Malaysia, 10 November 2010.

Hatta N.M., Bakar N. (2011). “3D Design of Chemistry Subject in UTeM: The Cubic Atom” Proceeding of National Conference on Active Learning 2011 (NCAL 2011), UTeM, Malaysia, 10-11 November 2011.

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Hatta N.M., Bakar N., Salam S., Shahbodin F. (2012). “3D Approach in the Development of Chemistry Subject at UTeM: Atom Cubic” Proceeding of International Conference on Active Learning 2012 (ICAL 2012), UTeM, Malaysia, 18-20 September 2012.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Chemistry is one of the compulsory subjects for all undergraduate students in science related fields. There are a number of methods to deliver chemistry lessons especially in classes of basic molecular formation theories. Throughout the years, various teaching methods have been adopted to assist student to better understand in learning. Computer based learning has become popular in Malaysia and the usage of Information Communication Technology (ICT) tools in Malaysian education system are meant to support the learning and teaching process in class (Honarmand, 2011; Hamidi, 2011; Ghavifekr 2012).

In educational field, information technology can be use to collect, save, process, and convey information quickly and correctly like internet, or multimedia or hypermedia in teaching and learning process (Nusir, Alsmadi, Al-kabi, & Sharadgah, 2012). The use of computer technology in teaching and learning process is not to replace the function of teacher but to create an interesting, effective, and meaningful teaching and learning atmosphere to student (Sanga, Africa, & Venter, 2006). Teaching and learning style in the 21st century still based on student but the teacher play the most important role to let student actively involved in learning activities (Tarmizi, Zah, Ali, Yunus, & Bayat, 2012).

Teaching and learning based on computer had grown and the latest innovation is multimedia field (Mukti, Zaman, Mohd, & Sembok, n.d., 1999). Multimedia technology has expended the usage of computer from information processing tools to teaching tools. According to Halimah (1999), multimedia technology has ability in delivering text, video, sound, animation and high resolution graphic. An information delivery effect created by combination of images, texts, and sounds has shown the significance everlasting compared to listened or read (Trindade, 2003). Combination of these elements will create an interesting presentation and make the information conveying more meaningful. Teaching media that using multimedia technology are able to get the student's attention, get the idea, and gain the complex information and help to prevent lack of time, size and space. Computer-based

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teaching media that has interactive or linear movement can able the user to access the information from one segment to another without following the flow.

The growing number of “multimedia study” classroom exemplifies the trend towards Multimedia technology in Education (Sanga et al., 2006). Besides using the conventional computer-based training techniques, courseware has included multimedia capabilities, such as graphics, sounds, animation, and video clips. This paper illustrates the development of such multimedia courseware. Additionally, this courseware employs sound instructional and learning strategies, thereby making the courseware not only educational, but also captivating. The other unique feature of the courseware is its adaptability. Teachers who are not computer experts can use the “Lecturer” module to modify and add content to the courseware. By selecting the predefined objects, and or filling in a form, the teachers can create simple animation by using the module.

1.2 Research Background

This research highlights the development of 3D approach in learning chemistry subject. This research is trying to use the learning based on computer for 3D concept in chemistry subject. Learning in conventional approach often use the whiteboard and textbook that only shows text and graphic to show the arrangement of the atoms in cubic cells (Oke & Alam, 2010). The arrangement of the atoms in the cubic cells are required learners’ knowledge and metal image, so by using 3D technology approach is possible to applied to assist learners in the topic. This research addresses the impact of using 3D approach in teaching and its advantages over current approach. Besides, 3D model can be rotated around any axis, panned or zoomed in any direction (Li-hong & Xia-mei, 2009). By using the approach of 3D viewing, students are able to position and recognize the object with relation to others scene, enabling a better and more complete visualization and interactive learning process (Bingimlas, 2009). This research is trying to use the learning based on computer for 3D concept in chemistry subject. This research will increase students and lecturer in visualizing the topic much more better. In other word, educational level will be increase parallel with the information technology (Pan, Han, Wu, & Zhang, 2010). Therefore, learning based computer is build to increase the efficiency the student ability of visualization with the aid of multimedia elements (Hasana & Ishak, 2012). Beside, 3D model atom assists learners to gain more understanding in molecular structure.

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Computer based multimedia material offers different means of supporting 3D information representations (Honarmand, 2011; Noordin, Fatimah, Ahmad, & Hooi, 2011; Osman, Azan, & Mat, 2010). Viewing dynamic and 3D animations is assumed to be a possible way of changing and improving students' incomplete mental models (Sulaiman & Iskandar, 2008). Nevertheless, based on various researchers (Dafoulas & Loomes, 2012), it is found that 3D models may lead to cognitive overload problems in hypermedia-learning environments in particular, as such environments are assumed to generate a heavy cognitive load. On the other hand, the findings of Ferk (2003), research revealed that some representations of molecular 3D structure are better understood and can be more readily used by students in solving tasks of different complexity. To all students the concrete representations seem to be more useful than abstract representations.

There has been interest expressed in science education reform which emphasis the need for integrating computer technologies into learning and teaching. Computer also may be effective in other areas as a general pedagogical aid that complements regular teaching methods. ICT can serve as a tool for designing new learning environments, integrating virtual models and creating learning communities. Learning courseware offers an effective tool for education since it involves all the senses, giving a modifiable three dimensional (3D) environment emulating and overcoming reality (Hasana & Ishak, 2012). Multimedia courseware is believed as the most appropriate way to encounter student's problem in visualization. In Malaysia context, the use of multimedia courseware in classroom is actually taking the concept and advantages provided by the computer aided learning (Hasana & Ishak, 2012; Noordin, Fatimah, Ahmad, & Hooi, 2010).

The term teaching refers to the methodology or strategies chosen in arranging the information, activities, approaches or media in order to help the students achieve the objective stated earlier (Korakakis, Pavlatou, Palyvos, & Spyrellis, 2009). Learning is the change in behavior in the students that occurs because of their interaction with the surrounding (Yahya & Latif, 2008). So by using computer enhance the learning environment making the learning more practical, improving the learner's access to learning, increasing the focus of higher order skills. Other than is to make possible to adapt learning programme more nearly to the needs of individual. One way of teaching for understanding is to have students engage in information processing and problem solving activities that focus on real-world experience, and daily-life chemistry.

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1.3 Research Problem Statement

The research problems was identified according to result from the preliminary analysis. From the result analysis, found that one of the problems when student learn chemistry is students do not understand the topic well because it needs students to imagine the formation of the structure of the atoms and their arrangement (Hasana & Ishak, 2012; Mbendera & Sun, 2010). Each people have a different ability to learn and capture the information and it is related to their learning style which is defined as the way a person takes and process the knowledge. By including 3D element in this courseware, it is use to stimulate student's interest in some content of the learning and as a supplement to classroom teaching, the graphics and animation make the subject come alive, so that learning the subject is much easier, animation, voice and video clips are used to implement various teaching strategies such as tutorials, activities and games. The ability to visualize has enable the student to understand the topic better (Bingimlas, 2009). Besides that, the simple animation can be use in this courseware to make the learning of content in the class more interactive. The development of computer technology multimedia methods are been increasingly used in teaching practice. A multimedia courseware are able to combine sound and pictures with knowledge (Dafoulas & Loomes, 2012; Hasana & Ishak, 2012). This reinforces the fact that students retain 50% of what they see and hear, as the use of multimedia technology gives students more information than just writing on the blackboard and increase the chance of active learning (Chou & Liu, 2005).

Most students find the traditional way of studying is boring and uninteractive. When there are useless, the teacher gives information or if when the learning is teaching by using projector, the light in the classroom is too dim. To avoid these disadvantages the teacher can combine it with other strategies and gives students more opportunity to think and ask questions. According to Lagowski, students retain 10% of what they read, 26% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say and 90% of something they say as they do something. So if the teacher shows as many demonstrations as they can in this interactive courseware to the student as well as letting the student do the demonstration by them, the student will learn more actively and effectively.

1.4 Research Questions

This study investigates the use of the 3D-Atomic Cubic Courseware as an alternative tool in the learning process. Besides that, this research examines the student's satisfaction and

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their acceptance on the use of 3D approach for the Chemistry subject. In order to achieve the research objectives, several questions have been formulated:

RQ1: What is the suitable elements of multimedia that will give better visualizing for student to learning chemistry subject?

RQ2: What is the suitable method on developing courseware that will give better visualizing for student to learning chemistry subject?

RQ3: How does the 3D approach will affect the imagination of the students about the structure of the atoms in cubic cell on chemistry subject?

RQ4: Is there any effective in terms of student perception when using interactive 3D-Atomic Cubic in subject of Chemistry visualization?

1.5 Research Objectives

The main purpose of this research is to measure the effectiveness of 3D approach in the learning process of 3D-Atomic Cubic subject in Chemistry. There are four objectives to be accomplished in this research:

i) To identify the various elements of multimedia to support 3D-Atomic Cubic.
Elements of multimedia acting as delivery methods to present 3D-Atomic Cubic courseware for help learner to a deeper understanding through supporting conceptualization and contextualization of the new material being presented.

ii) To develop interactive 3D element.
As an assisting teaching and learning tool for lecturer and student because will be provided with interactive 3D element in the module for help student easy to visualize the structure of the atom in each type of cubic cell.

iii) To evaluate the effectiveness of teaching by using 3D element approach in learning of Chemistry subject through a case study with Mechanical Engineering students of Universiti Teknikal Malaysia Melaka (UTeM).
The current style of study is still using traditional method which is using text and book. This research is to show the effectiveness of using new approach in studying Chemistry subject for FKM students in UTeM.

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