VIRTUAL ENVIRONMENT OF ATOM AND MOLECULE FOR LEARNING CHEMISTRY

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DEDICATION

To my beloved parents, brother, sisters and friends...

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ABSTRACT

This research is developed as to provide a new learning method for Chemistry subject dedicated to Form 4. This method is using high technology approach which is *Virtual Reality* (VR) in collaboration with three dimensional models (3D). The used of such technology is hoped to help students learn and increase level of understanding of atoms and molecules as Chemistry subject is an abstract subject and full with concept. This research is based on the constructivism concepts which help students learning process based on experiences. The experience gained is not from the manual method but through the visualization and user can immerse into the virtual environment. Detail analysis has been made in few secondary schools in Melaka to further analyze the current method of learning atom and molecule to gain some useful sight of what is the problems faced by the student in order to understand the topics. Few analysis techniques have been adapted while the research is made. The technique used for this research is interview and questionnaires. Based on the analysis that has been done, an early prototype has been developed to fulfil the need of research. The learning application built focused the two main topics in the syllabus which are Atom Structure and Chemical Bond. Student can interactively interact with the model of atom and molecule in virtual environment. The prototype is built using ADDIE model methodology which is suitable for building learning application in order to ensure the output is high in quality and able to help the learning process effectively. 3D authoring tool software which is 3D Studio Max is integrated with EON Studio software is used as the platform in developing the virtual environment for the system. The prototype and the final output of the research are presented as semi – immersive system using goggle, *Crystal Eyes*.

Keywords: Chemistry, Education, Virtual Reality, Three Dimensional, Semi – Immersive, Interactive, EON Studio, CrystalEyes.

ABSTRAK

Kajian ini dibangunkan atas dasar menyediakan satu kaedah pembelajaran baru bagi subjek Kimia kepada pelajar Tingkatan 4 khususnya. Kaedah ini menggunakan pendekatan teknologi terkini iaitu realiti maya ataupun *Virtual Reality (VR)* dan model 3 dimensi (3D). Penggunaan teknologi ini diharap dapat membantu pelajar untuk lebih memahami tentang atom dan molekul memandangkan Kimia merupakan satu subjek yang abstrak dan berasaskan konsep. Kajian ini berasaskan konsep konstruktivisme di mana pelajar memperolehi pemahaman berdasarkan pengalaman dan pengalaman tersebut bukan melalui kaedah manual tetapi secara visualisasi dan dapat imersif ke dalam persekitaran maya. Analisis terperinci telah dilakukan di beberapa buah sekolah menengah di sekitar Bandaraya Melaka terhadap sistem semasa yang digunakan bagi mendapatkan gambaran apakah masalah yang dihadapi oleh pelajar dalam memahami topik ini. Beberapa teknik analisis telah diadaptasikan semasa kajian dilakukan. Antara contoh analisis yang telah dijalankan ialah temuramah dan soal selidik. Hasil daripada analisis yang telah dijalankan, satu rekabentuk awalan ataupun prototaip telah dibangunkan untuk memenuhi keperluan kajian. Aplikasi pembelajaran yang dibangunkan menfokuskan kepada dua topik utama iaitu Struktur Atom dan Ikatan Kimia. Pelajar dapat berinteraksi secara interaktif dengan model atom dan molekul dalam persekitaran maya. Prototaip kajian ini dibangunkan berasaskan metodologi model ADDIE untuk memastikan output yang dikeluarkan berkualiti dan mampu membantu proses pembelajaran dengan berkesan. Perisian permodelan 3D iaitu 3D StudioMAX diintegrasikan bersama perisian EON Studio digunakan sebagai platform dalam membina persekitaran maya ini. Prototaip dan output akhir kajian ini akan dipersembahkan secara separa imersif menggunakan kacamata gogel, *CrystalEyes*.

Kata Kunci: Kimia, Pendidikan, Realiti Maya, Tiga Dimensi, Separa Imersif, Interaktif, EON Studio, CrystalEyes.

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LIST OF ABBREVIATIONS

KUTKM	Kolej Unversiti Teknikal Kebangsaan Malaysia
FTMK	Faculty Information and Communication Technology
PSM 1	Projek Sarjana Muda 1
PSM 2	Projek Sarjana Muda 2
2D	Two Dimensional
3D	Three Dimensional
KBSM	Kurrikulum Bersepadu Sekolah Menengah
SMKAK	Sekolah Menengah Kebangsaan Ayer Keroh
VR	Virtual Reality
VE	Virtual Environment
VRML	Virtual Reality Modelling Language
SME	Subject Matter Expert
CD	Compact Disc
VGP	Von Glasersfeld's Philosophy
ADDIE	Analysis Design Development Implementation Evaluation
ID	Instructional Design
IT	Information Technology
PC	Personal Computer
CD ROM	Compact Disc Read Only Memory
CDR – W	Compact Disc Re - Writable
MOE	Ministry Of Education
GUI	Graphical User Interface
MB RAM	Mega Bait Random Access Memory

CPU	Central Processing Unit
GHz	Giga Hertz
MHz	Mega Hertz
GB	Giga Byte
USB	Universal Serial Bus
LCD	Liquid Crystal Display
HCI	Human – Computer Interaction
DPI	Dots per Inch
JPEG	Joint Photographic Experts Group
BMP	Bitmap
MPEG	Motion Pictures Experts Group
GIF	Graphics Interchange Format
MIDI	Musical Instrument Digital Interface
MP3	MPEG Audio Layer 3
NASA	National Aeronautic and Space Administration
HMD	Head Mounted Display
VDT	Video Display Terminal
SWF	Shock Wave Flash
VGA	Video Graphic Accelerator
LAN	Local Area Network

CHAPTER I

INTRODUCTION

1.1 Preamble

As technology in the computer field matures, computers have been one of the most important aspects in our everyday life. Almost every applicable task is currently operating on computer-based applications. The ever increasing need in this field influence the emergent of the computer science discipline.

Over the past decades, Virtual Reality (VR), sometimes called Virtual Environments (VE) the third era in the Human – Computer Interaction (HCI) has experienced a tremendous growth in serving a paradigm for much of the current activity in virtual environment and education. Virtual reality is able to display elements of three – dimensional (3D) in terms of sight, hearing and the sense of touch (hap tic) (Mandel, 1994). Instead of just using two – dimensional (2D) images, the used of 3D object is much more suitable to represent the visualization of the content for much more understandable information.

As referred to the title of the project, which is Virtual Environment of Atom and Molecule for Learning Chemistry, this education program is tended to be used by the Form 4 student. This is a new approach to present an education program for Form 4 student where students can improve their learning process of atom and molecule from using the conventional way, which is from 3D model in 2D environment to 3D model in virtual environment. The program will contain two major modules that are taken from Form 4 syllabus from *Kurikulum Bersepadu Sekolah Menengah* (KBSM) textbook provided by Ministry of Education (MOE).

The use of 3D model in conjunction with virtual environment will creates a unique vantages point for learning. The purpose of develop this education program is to enhance the way of learning Chemistry from the ordinary approach to a new and systematic approach.

This project is taken up to improve and increases the developments of numerous existing science education (especially chemistry) applications with intensify effort in moving towards better method of teaching and learning chemistry.

1.2 Project Background

Virtual Environment of Atom and Molecule for Learning Chemistry is a virtual classroom for learning atom and molecule. This project is derived from the constructivism concept which is we learn by reflecting on our experiences according to Jacqueline and Martin Brooks (2004). In easier terms is learning by doing. Constructivism calls for the elimination of a standardized curriculum. Instead, it promotes using curricula customized to the students' prior knowledge. In addition, it emphasizes hands-on problem solving as said by Jacqueline and Martin Brooks (2004). According to Ernst Von Glasersfeld (2004), cognitive science has undertaken the study of the mental processes used to acquire, store, process, and use knowledge. Essential to any such study is a theory of learning and cognition. As a theory of epistemology, constructivism plays a central role in cognitive science. By using the will be develop project, student can learn the atom and molecule by doing which is the constructivism concept, have unlimited access to the chemical substances and facilities and immerse into the virtual environment of atom world.

1.3 Problem Statements

Few shortcomings in the available current systems, which results to its impractical usage, are described as follows:

a. **Lack of learning tools for chemistry subject in the school.**
   One of the main problems in science education is experienced by students when faced with abstractions. Computer visualization tools are particularly effective to overcome this problem as said by Trindade et al. (2001). For example, when learning the atomic and molecular structure of matter, the progressive familiarization with scientific models benefits from static and dynamic representations of the building blocks of matter. Nowadays, the application for learning chemistry only exists in the form of 3D. By developing the 3D plus virtual environment application for learning chemistry, user can interact with the application, feel the virtual environment as if they are 'immersed' in the real environment, touch the 3D model, sense and do the activity instead of using just interact with the 3D application.

b. **Limited access to chemical facilities and substances.**
   The laboratory that is provided in school has its own rules where it limits the number of student per session to use it and very often that the facilities in the laboratory is insufficient with the total of student per class. Nevertheless, by using this virtual application, it can save cost to provide so many laboratory in the school as student can just use this virtual application and still can perform the experiment related to the Atom and Molecule topic in chemistry subject.

c. **The ineffective way of teaching and learning Chemistry**
   Using conventional method to tech and learn Chemistry is no longer suitable these day as so many new technologies has grown up. Learning by only referring to textbook will not help in the learning process, students might get bored and obviously, it is hard to understand so many concepts in Chemistry if student just use the textbook. Interactive multimedia education program is

the perfect solution to provide a very convenient way of learning chemistry especially when learning Atom and Molecule.

1.4 Objectives

This project is developed with intention as described below:

a. To apply VR as an educational tool, in order to determine which aspects of VR provide the most effective educational benefits, and to learn the strengths and weaknesses of this technology in an educational setting.
b. To learn Atom and Molecule in Chemistry using VR approach/visualization.
c. To enable user to visit virtual attractive and enjoyable sceneries where they can learn the constitution and properties of atom and molecule.
d. To provide a highly sensuous experience, surrounding the user with sight, sound, color, motion and can immerse user into real world environment of the same location.
e. As a new learning tools that suit the need for this modern technology time.

1.5 Scopes

Virtual Environment of Atom and Molecule for Learning Chemistry helps Form 4 students and anyone learn about atom and molecule while playing the role of substance builder. The participant builds their way through the periodic table of elements using the fundamental types of atoms and its characteristic. The interactive aspects of the project will highly engaging and significantly enhanced learning, especially amongst low – achieving students. The project will focus on the forming of the molecule from different atom. It will also clarify the meaning and give clear example of the term atom and molecule using the 3D visualization instead of just 2D images. It will also focus on the explanation of each atom and molecule itself such as the characteristic of each compound. User can interact with the 3D model in the activity section where user can form their own molecule and substance according to

what they have learned earlier. This project is develop to everyone who wants to use the CD or to learn about atom and molecule, not limited only to students and teachers but still focusing on Form 4 students as the content of the project is derived from Chemistry Form 4 syllabus. The development of this project is the construction of 3D model of atom, molecule depends on the syllabus using 3D Max Studio, and EON Reality Software will be used as the platform to create the virtual environment. A high powerful desktop computer will be needed to develop the project completed with the 3D accelerator. The last finished product will be viewed using VR goggle as this is a semi immersive VR.

1.6 Project Significance

The Virtual Environment of Atom and Molecule for Learning Chemistry development is taken up to satisfy the following major requirements:

a. To help learning activity more fun and understandable.
b. To help create a new environment of chemistry learning.
c. To help build knowledge of VR techniques and tools this can later be applied to other problems.

1.7 Expected Output

Few results are expected from this project, which are:

a. A 3D model of atom and molecules in virtual environment.
b. An educational environment for students to explore some microscopic and abstract concepts, which they are teached in class but are far away from daily experience.
c. Complete report of how the project will be implemented, the features of the program, the methodology chosen to be implemented while developing the project, the design created for the user interface and the 3D model etc.