LECTURE NOTES IN GEOINFORMATION AND CARTOGRAPHY

LNG&C

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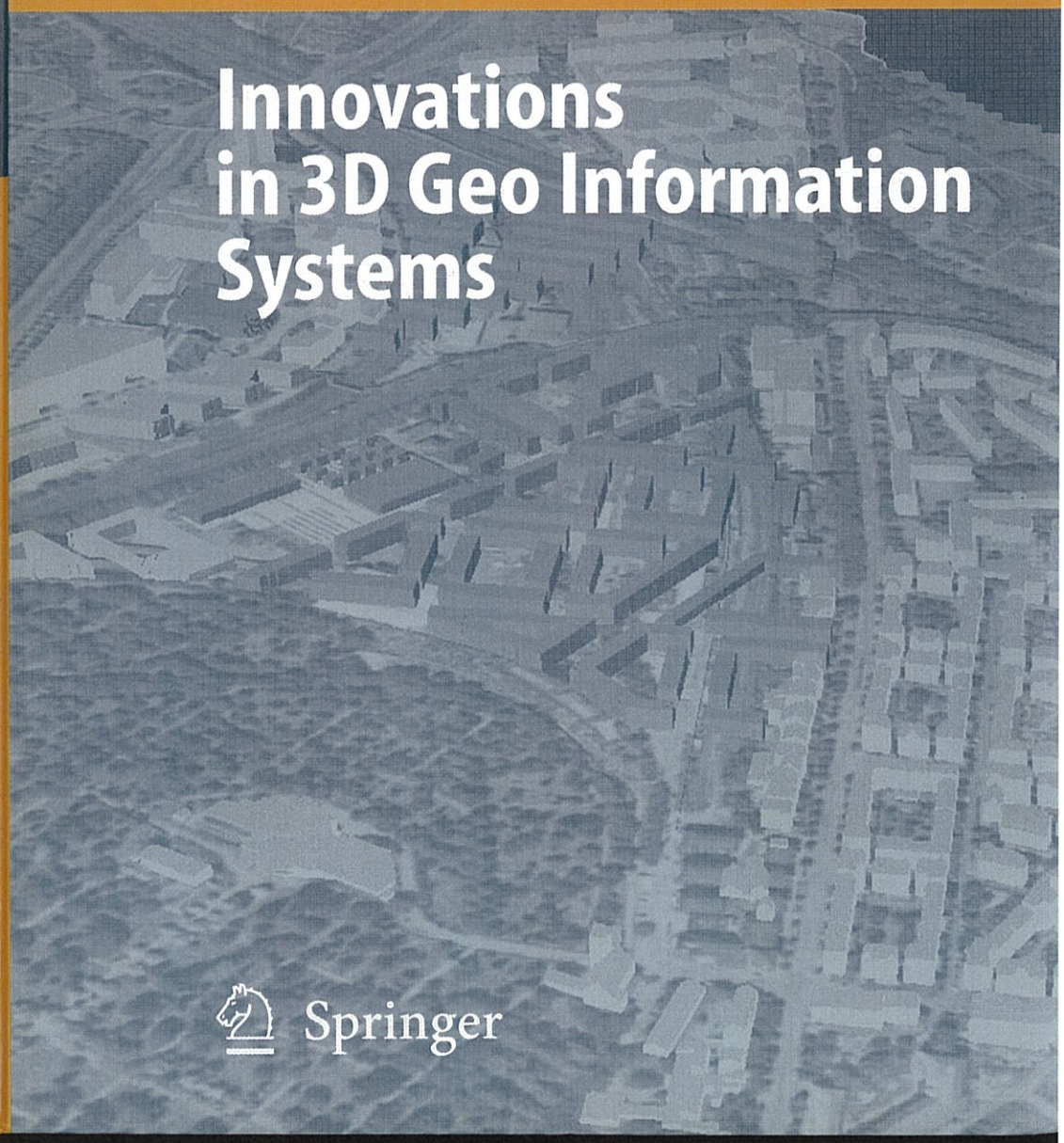
Editors

Innovations in 3D Geo Information Systems



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Editors:

Dr. Alias Abdul-Rahman
Department of Geoinformatics,
Faculty of Geoinformation
Science and Engineering
Universiti Teknologi Malaysia
81310 Skudai, Johor, Malaysia
Email: alias@fksg.utm.my

Dr. Sisi Zlatanova
Section GISt, OTB
Delft University of Technology
Postbus 5030
2600 GA Delft, The Netherlands
Email: s.zlatanova@otb.tudelft.nl

Dr. Volker Coors
Geoinformatics
Faculty Geomatics, Mathematics
and Computer Science
University of Applied Sciences
Schellingstr. 24
70174 Stuttgart, Germany
Email: volker.coors@hft-stuttgart.de

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3D Visualization

Oral Contributions

Development and Design of 3D Virtual Laboratory for Chemistry Subject Based on Constructivism-Cognitivism-Contextual Approach

Norasiken Bakar [a,*], Halimah Badioze Zaman[b]

[a]Jabatan Media Interaktif, Fakulti Teknologi Maklumat Dan Komunikasi, Kolej Universiti Teknikal Kebangsaan Malaysia, 75450 Ayer Keroh, Melaka, E:mail: norasiken@kutkm.edu.my,
[b]Jabatan Sains Maklumat, Fakulti Teknologi Dan Sains Maklumat, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor Darul Ehsan, E-mail: hbz@ftsm.ukm.my.

Abstract

This paper addresses about designing virtual laboratory for chemistry subject, acid, base and salt (VLab-CHEM) in three dimensions (3D). Discussion involved on theoretical framework modelling where it divided into two parts that is analysis, design, development and evaluation. For the second objective, researcher was view on constructivism- cognitivism - contextual lifecycle model where it used for 3D VLab-CHEM. This model defined about education media, how to measure content, authoring program and systematic instructional design. For the third objective, researcher also explained the 3D laboratory architecture and story board for the early state of development VLab-CHEM. Others objective are defining Instructional Design (ID) model (VLab-CHEM) where it include 3D virtual laboratory modules. ID model focused on learning and teaching aspects and science education, education process and by using multimedia interactive module. While designing the development of VLab-CHEM, researcher has used approach in learning theory such as constructivism-cognitivism-contextual. Concept through learning-by-doing, contextual education, simulation, 3D animation and real time animation to create 3D virtual based on reality, added in the VLab-CHEM.

KEY WORDS: 3D, Virtual Laboratory, Experiment, Learning by Doing, Chemistry, Education Theory.

1 Introduction

The development of computer technology especially multimedia technology has been a major factor in education world. By that reason, the using of computer in learning and education has been increased. Ahmad Fauzi Mohd Ayub et al. (2005).

Research on virtual laboratory in chemistry subject, acid, base and salt (VLab-CHEM) is the main research based on problem found by the student and teacher in conventional chemistry education especially in understanding on the experiment process that is not easy to prove in real world. Norasiken & Halimah. (2005)

VLab-CHEM is developed as a new value in chemistry education. Besides that, VLab-CHEM that will be developed can get more attention by the student in their new way learning. Activity in the VLab-CHEM is based on interactive laboratory in order to ensure the understanding student in chemistry material process and also to do experiment. By that, VLab-CHEM will reduce cost such as time in lab, material and component used in the experiment where it differs in conventional lab.

In other way, student and teacher can do the experiment as long as they want and it will avoid the student from using the dangerous material. Norasiken and Halimah. (2005)

2 Educational Theories

2.1 Constructivism Theory

Student can be defining as an active individual in developing their knowledge. Education involved creating and arrangement student knowledge through experience and environment around them and their interaction within software. Mohd Arif et al (2005).

Through constructivism educational theory, students have their own mind that has been created by interaction with the environment. Concepts that own by each student are differing and mistake will be occurred if the concept created opposite with the concept accepted in the classroom.

Through constructivism approach in classroom, student will actively involved in educational process and they have the chance to create their own knowledge based on their background. Roziah Abdullah (2004).

Jonassen (1994), constructivism members found that student should learn in order to create construct, define and make their understanding in many ways based on experience and on-line relation with environment. Education is one of activity that been done by student by their self, Shapiro (1994).

By helping student in their integration with experience and new knowledge they already have, the activity should be in the context of needed requirement and in different perspective. Jonassen 1994, Oliver 2000.

2.2 Cognitivism Theory

Cognitivism theory refers to the process of thinking that happened to someone while in the process of learning. It relate with short time and long-time memory.

While in learning, student created a cognitive structure in their memory. Every time student learn, they will used all its experience in learning and store all the experience in their memory until they want to used it, in order to help him in the learning process.

One of the cognitivism theories is information processing in learning computer. This theory offer active learning where student actively to get, restructure and define knowledge in order to make learning more fun. It is because student needs a transformation in learning and knowledge. The theory focused on new knowledge and past knowledge.

To help student in learning, software designing should be in terms of symbol and other channel so that learning more accurate and easy to get. Based on previous research, in designing learning activity, cognitive structure of student should be taken. Alessi and Trollip 2001; Simonson and Thomson 1990.

Cognitive theories figures, Brunner, Piaget and Papert focused on main concept that is (Simonson and Thomson 1990) :

(a) How knowledge can be arranged and structured.
(b) The willingness of student to study.
(c) Give value upon intuition and intellectual approach to achieve conclusion without following analytical steps.
(d) The important of motivation to study or having positive attitude in learning.

Based on cognitive theory, some guidelines have been used in creating and evaluate learning based on computer. Simonson and Thomson 1990. The guidelines as below:

(a) The willingness to study is important to start, maintain and ensure the objective of learning.
(b) Structure and types of knowledge to teach. It is based on opinion, that student start to understand concrete operation, graphic display from reality and abstract expression and number system.
(c) The sequences of learning material are important to define the type of student in processing the information they get. Knowledge of cognitive children style through parts of dominant brain and processing level are important to know style of learning.
(d) Type and style given depend on time and place.
(e) Learning in terms of exploration and discovery is the important approach. LOGO language by Papert (1980) is one example learning based on computer, one way of problem solving by student.

2.3 Learning Approach Based On Contextual

Scars (1999) found that teaching and learning approach based on contextual is one concepts for helping teacher to explain content of learning in real situation and also as a motivation for student to relate the knowledge gain with real life time.

Ketter and Arnold (2003), research in case study of using teaching and learning approach based on contextual, found student can relate concept with real lifetime much better.

Hardy (2003) found student more successful in gaining knowledge and increase their performance. Approach also focused on practical approach to give student more experience using material and hands-on concept.

3 Research Purpose

The purpose of the research can be divided into two components:

(i) Developing virtual lab for chemistry subject, acid, base and salt topic for form 4 science students.
   (a) Define methodology for virtual lab content for chemistry equation, acid topic, base and salt.
   (b) Creating Instructional Design Model (ID Model) for virtual reality content of chemistry subject.

(c) Develop prototyping the content virtual lab based on constructivism-cognitive-contextual approach.

(ii) Do a research on the successfulness of virtual lab among chemistry student at school in Alor Gajah district, Melaka in one case study.
(a) Testing the ability of virtual lab in chemistry subject, acid, base and salt.
(b) Testing the effect of using virtual lab in the science process in the chemistry subject.
(c) Test the effect of the achieving student used the virtual lab based on pre test and post test.

4 Research Objective

Result will give input to teachers and software design in the aspects; the suitable teaching for science software, technique or using software with the constructivism-cognitivism-contextual approach in learning and teaching.

Result also will input the school execution towards the virtual lab in the readiness of teacher requirement and the willingness of student to use the knowledge based on ICT.

Besides that, research will give a chance to Education Legislation Principle to legislate the ICT in education and give the suitable accommodation for student in upper level and also to curriculum legislation to make the virtual lab and ICT in teaching and learning in lab.

Overall, research will give the input as below:

(a) Developing a methodology of virtual lab in chemistry education.
(b) Designing an instruction model of virtual lab with constructivism-cognitivism-contextual approach in chemistry course.
(c) Developing a virtual lab modules for constructivism-cognitivism-contextual approach
(d) Developing virtual lab prototyping
(e) Defining methodology for partial experiment to ensure the successfulness of using a virtual lab.
(f) Design and produce software evaluation checklist by using the Statistical Package for the Social Sciences (SPSS).
(g) Design questionnaire for student and teacher of chemistry course to ensure the difficult topic in chemistry subject.
(h) Produce the successfulness data of virtual lab using constructivism-cognitivism-contextual approach.
(i) Produce the data of using virtual lab differ with conventional chemistry laboratory.

5 Theoretical Framework Model

Theoretical framework model showed the structured profile that is Analysis and Design (I), Development (II) and Evaluation (III) for VLab-CHEM. The development model can be seen in figures 1.1, research on theoretical framework model. It's including research questioning and research hypothesis. To achieve the purpose of research, some main question and research hypothesis is designed as below:

(a) What is the methodology used in developing virtual lab for the chemistry subject (acid, base and salt)?

(b) What is the instructional model design suitable in order to increase the cognitive skills based on virtual lab for chemistry subject (acid, base and salt)?

(c) What is the chemistry virtual lab that is suitable for instructional design?

(d) Is there any differ in terms of achieving cognitive skills between students using virtual lab with student using conventional lab?

i. Hypothesis Mol 1 (Ho 1): No difference marks in pre test and post test for the experiment group in acid, base and salt topic.

ii. Hypothesis Mol 2 (Ho 2): No difference marks in pre test and post test for the control group in acid, base and salt topic.

iii. Hypothesis Mol 3 (Ho 3): No difference in achieving between students from experiment group using virtual lab based on constructivism - cognitivism - contextual approach and control group that using conventional lab.

(e) Is there any difference in overall achieving between students using virtual lab for chemistry subject (acid, base and salt) with student using conventional lab?

iv. Hypothesis Mol 4 (Ho 4): No significant different between marks in pre test and post test within student in experiment group for the topic acid, base and salt.

v. Hypothesis Mol 5 (Ho 5): No significant different between marks in pre test and post test within student in control group for the topic acid, base and salt.

vi. Hypothesis Mol 6 (Ho 6): No significant different in overall achieving between students learning through chemistry virtual lab with student learns through conventional lab.

(f) Is virtual lab for chemistry education (acid, base and salt) can improve the science skills process?

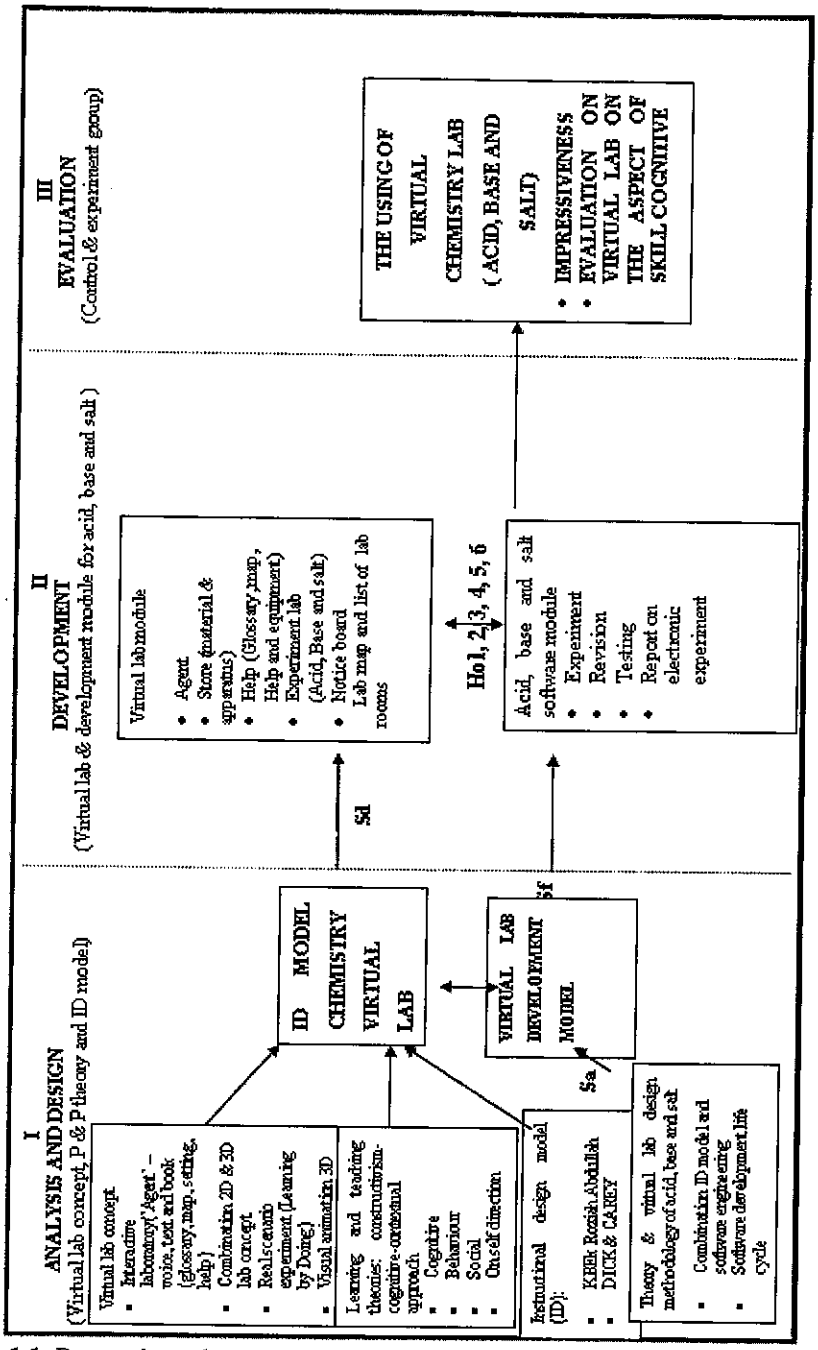

Fig. 1.1. Research on theoretical framework model

6 Constructivism-Cognitivism-Contextual Model Life Cycle (LCC^3) VLAB-CHEM

The development of VLab-CHEM is designed in a form of cycle to show the whole package. Adaptation from KHGK2 model, Roziah Abdullah, based on waterfall model, will give the inner and outer entity for the education needed so that there is an expanded in terms of cognitive, affective and psychomotor. 5 phases involved in the model that are: analysis, design, development, implementation and evaluation. Therefore this model is called constructivism-cognitivism-contextual model life cycle.

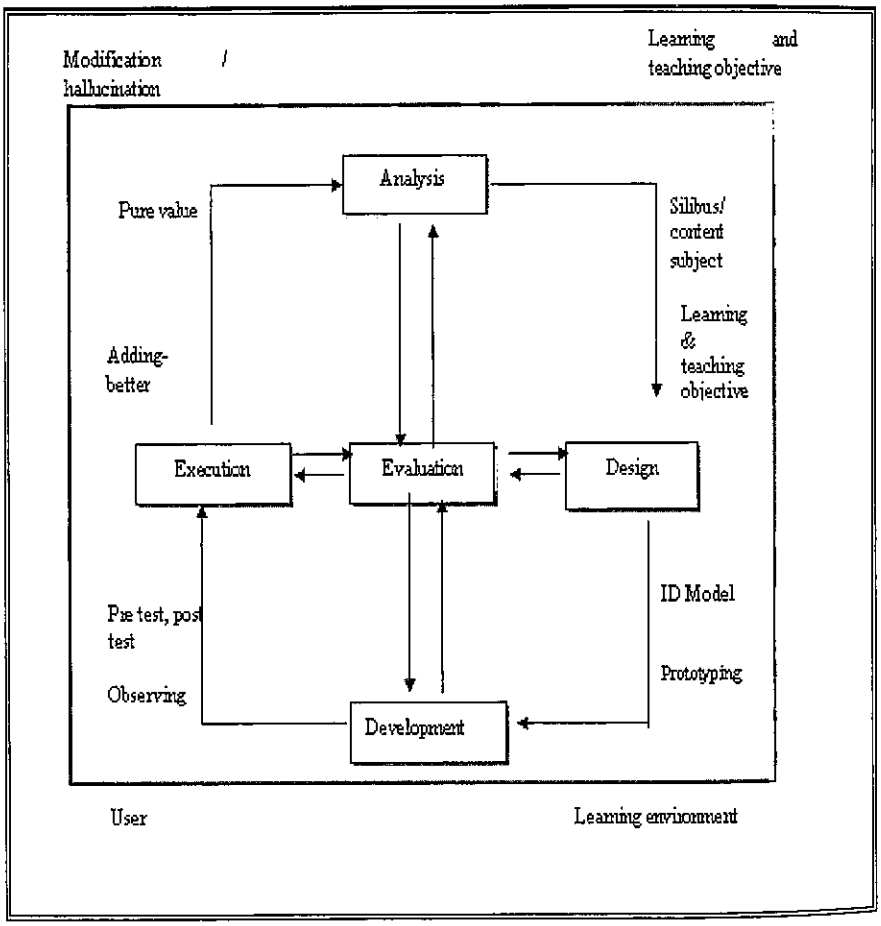

Fig. 1.2. Constructivism-Cognitivism-Contextual Model Life Cycle (LCC^3) for VLab-CHEM

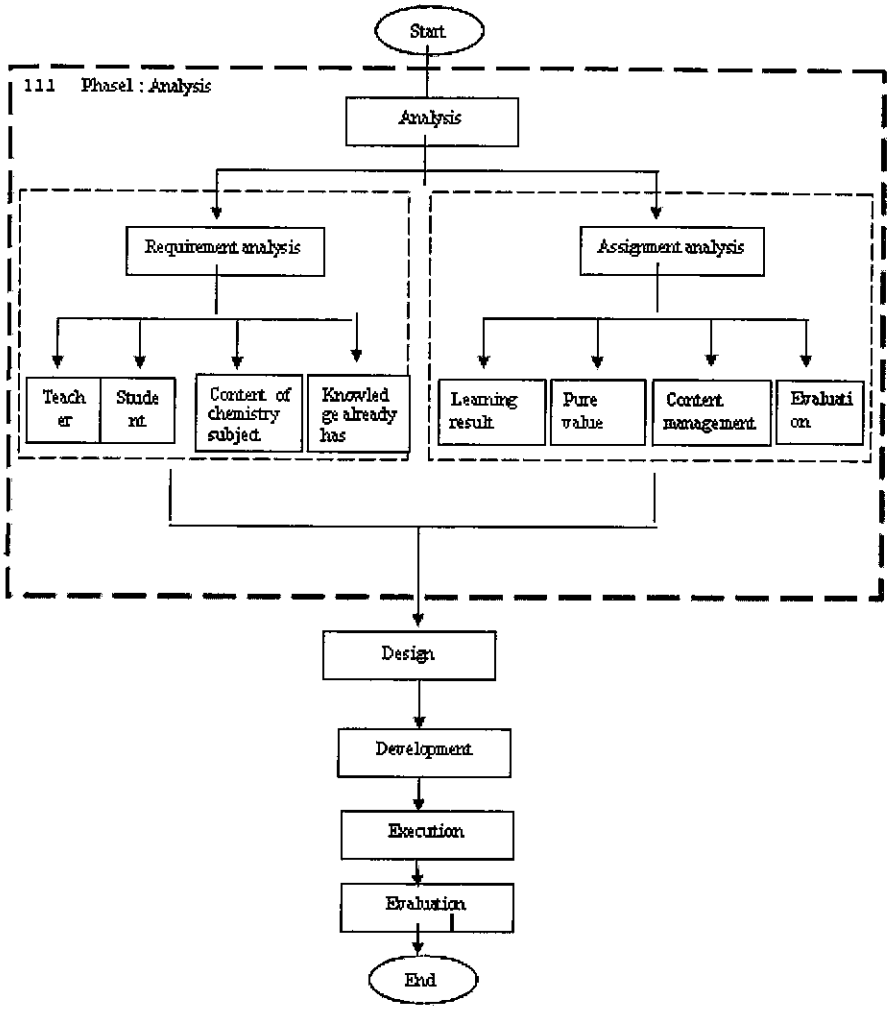

Fig. 1.3. Constructivism-Cognitivism-Contextual Life Cycle (LCC^3) for VLab-CHEM : Analysis

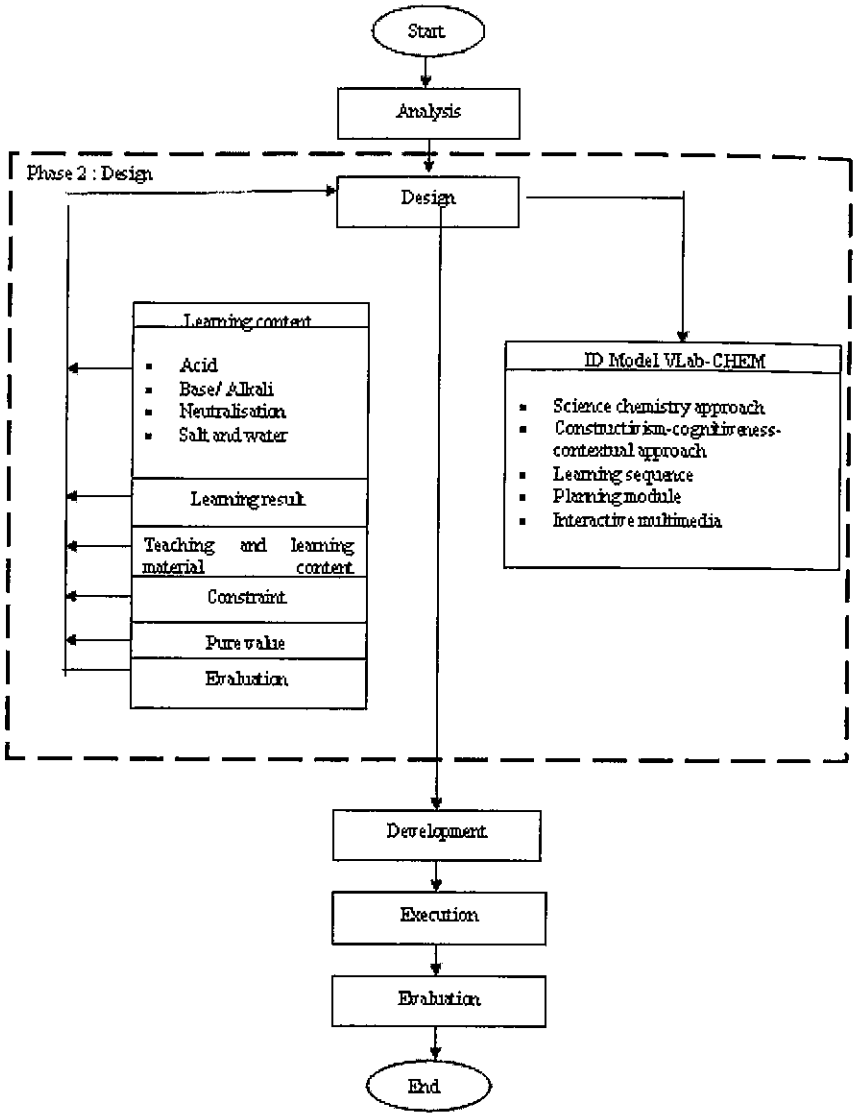

Fig. 1.4. Constructivism-Cognitivism-Contextual Life Cycle (LCC^3) for VLab-CHEM: Design phase

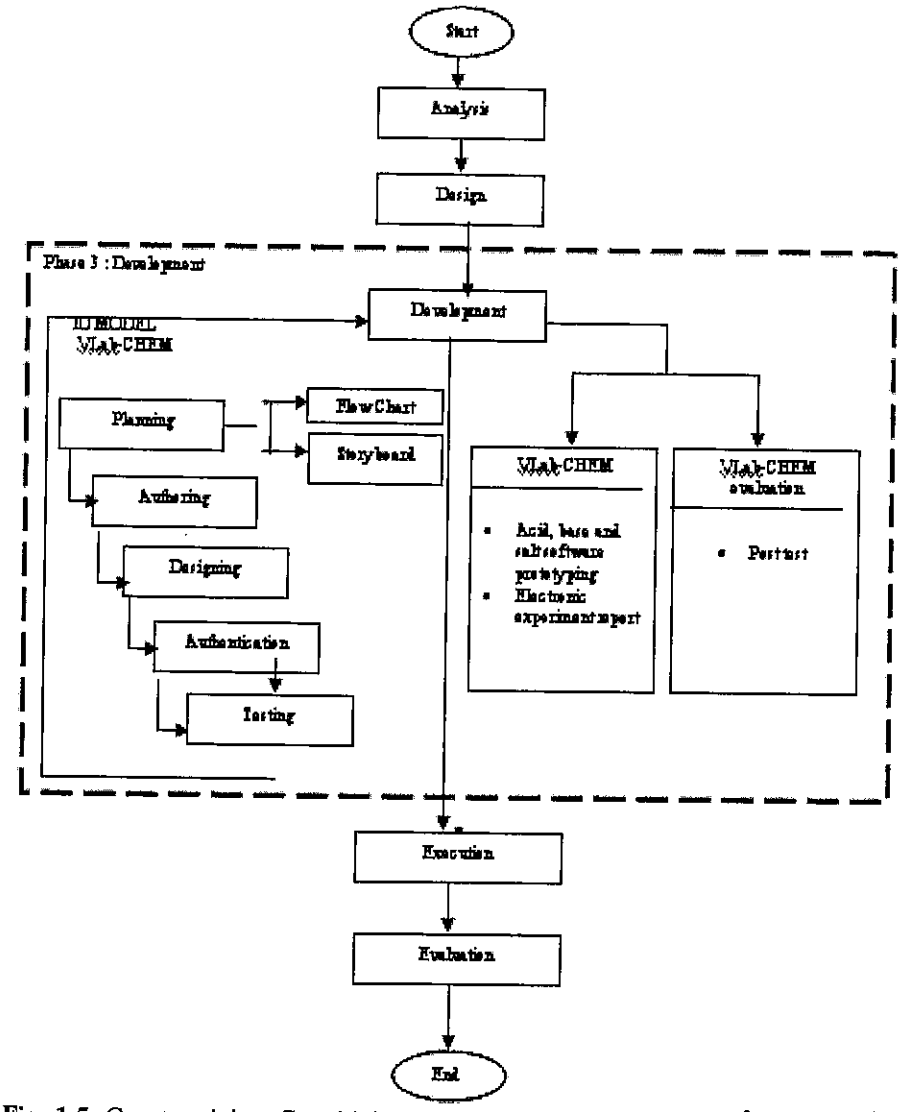

Fig. 1.5. Constructivism-Cognitivism-Contextual Life Cycle (LCC^3) for VLab-CHEM: Development phase

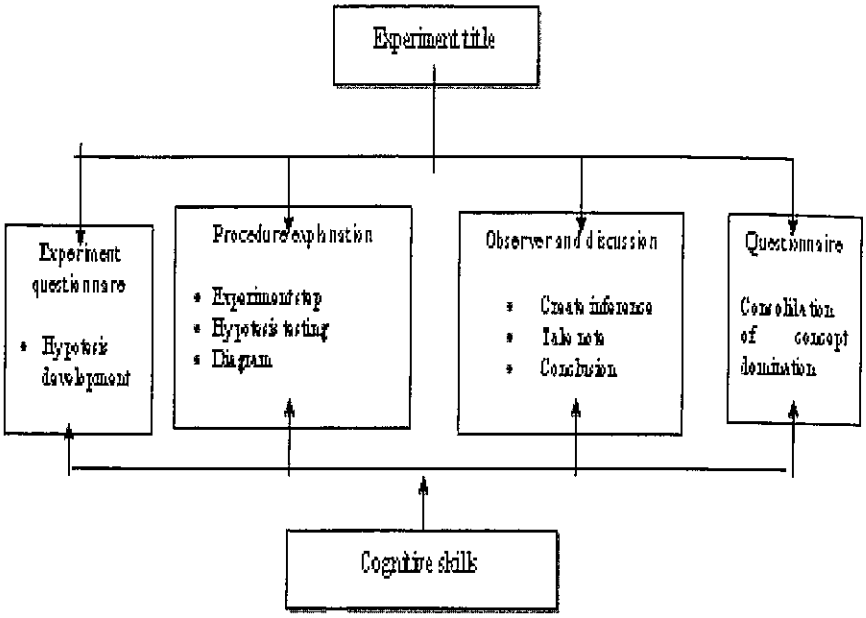

Fig. 1.6. The design of electronic experiment report

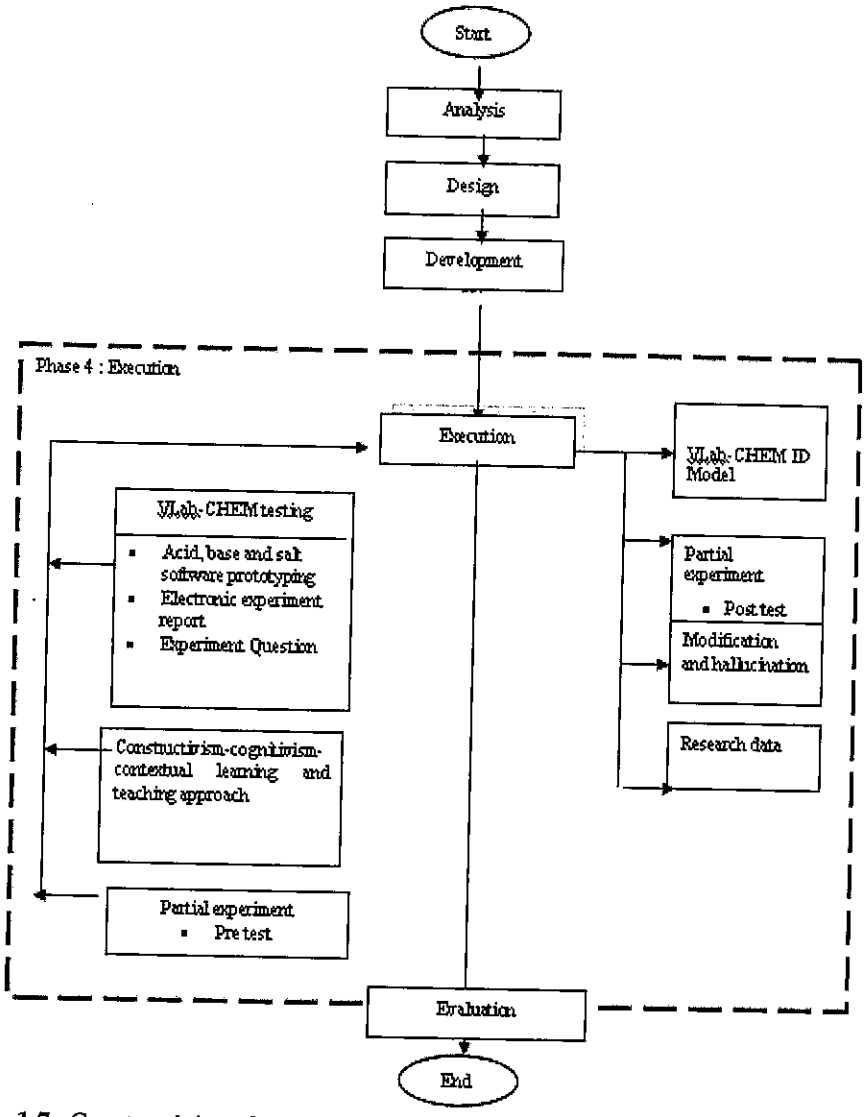

Fig. 1.7. Constructivism-Cognitivism-Contextual Life Cycle (LCC^3) for VLab-CHEM: Execution phase

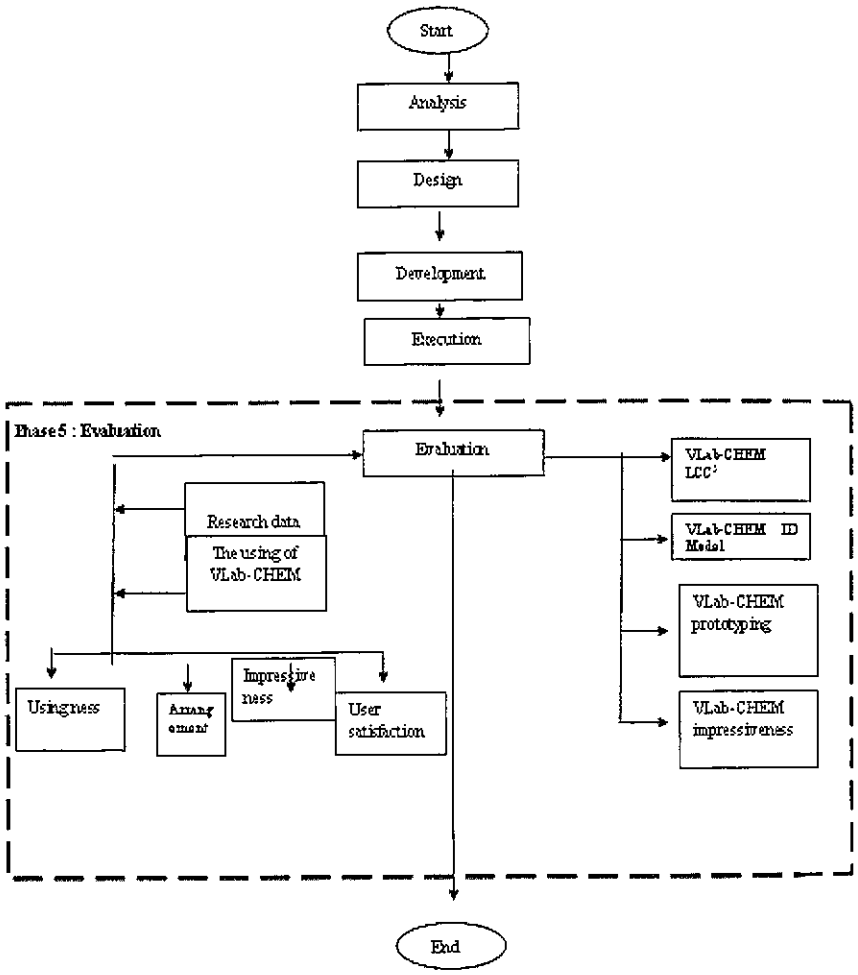

Fig. 1.8. Constructivism-Cognitivism-Contextual Life Cycle (Lcc^3) for Vlab-Chem: Evaluation Phase

7 VLAB-CHEM Model Instructional Design

ID model for the development of VLab-CHEM in educational for the chemistry subject Form 4 is based on technology integration. The core of teaching and learning process based on teaching theory and pedagogy.

The purposes of the model are to increase the knowledge of acid, base and salt, high level thinking skills and scientific skills within the student of the chemistry science.

The development of the model based on educational environment such as:

(a) Learning result.
(b) Pure value.
(c) Scientific skills and high level thinking skills.
(d) Teaching material based on achieving level.
(e) Holistic development.
(f) Science approach with the suitable module.

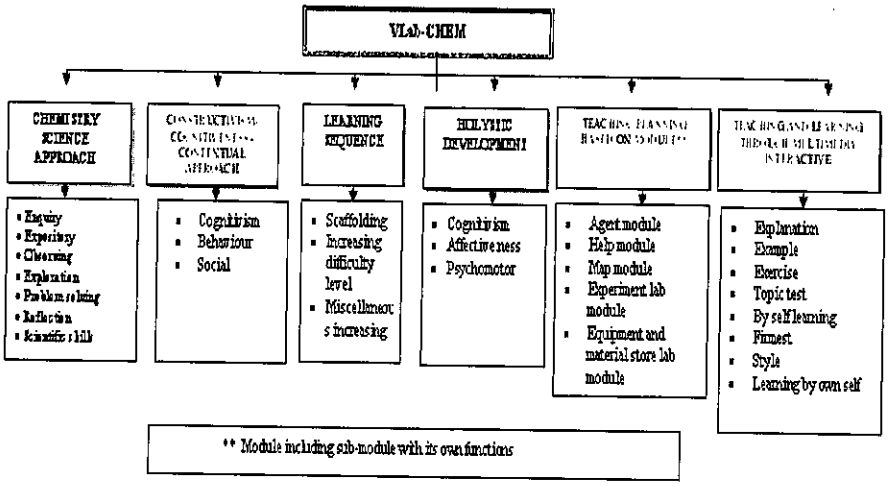

Fig. 1.9. VLab-CHEM ID Model Development

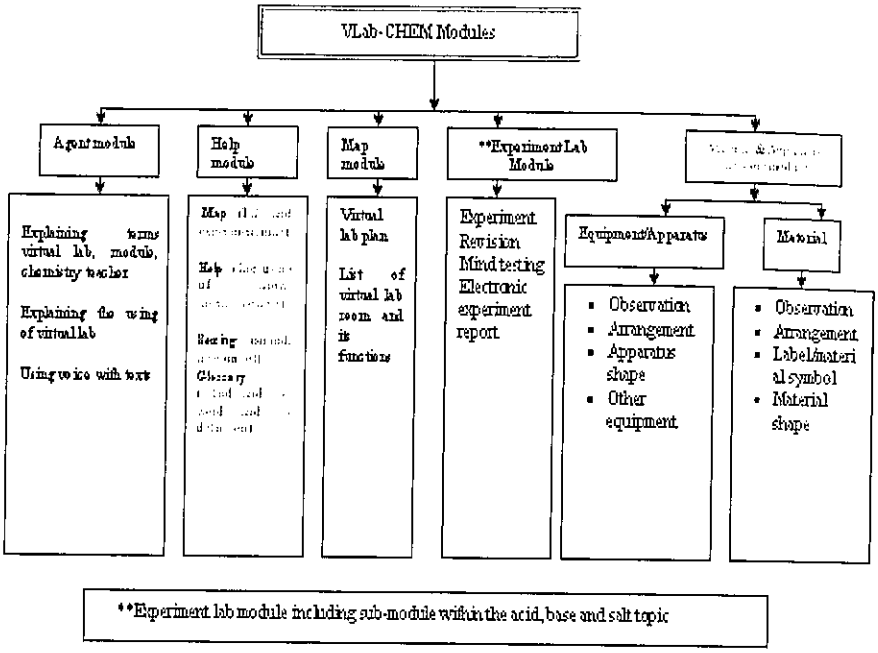

Fig. 1.10. VLab-CHEM modules

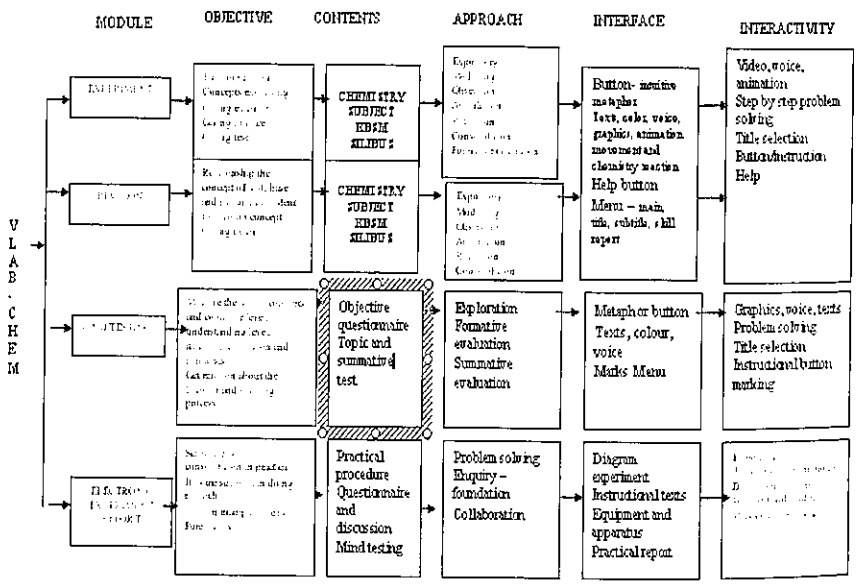

Fig. 1.11. Modules inside VLab-CHEM Experiment Lab

8 VLAB-CHEM Lab Architectures

The lab architectures were designed into 3 dimension and it has three sections as stated below:-

8.1 Main Hall

User will meet the main hall first after entering the VLab-CHEM lab via the main door. Therefore, the user can enter either Store room or Experiment room through this main hall section.

8.2 Store Room

The store room for VLab-CHEM are divided into two section which is : -

a. Chemical Equipments
   This section are mostly contains all the needed equipments that will be use during the practical experiment under the topic of Acid, Base and Salt. This section also equipped with relevant images, voices and information regarding on those equipments.
b. Chemical Substances.
   This section will be including all the substances that will be use during the experiment. as for related topic which comes with relevant images, voices and information.

8.3 Experiment Room

This room also divided into two sections:-

a. Acid and Base Experiment.
   All experiments and test for Acid and Base topic will be explained in type of lectures, videos, animations, graphic, text and audio.
b. Salt experiment.
   All experiment that will be conduct by the user are in interactive mode, where the user can choose any substances and equipments to conduct the experiment. As for the result, the experiment can be seen in real.

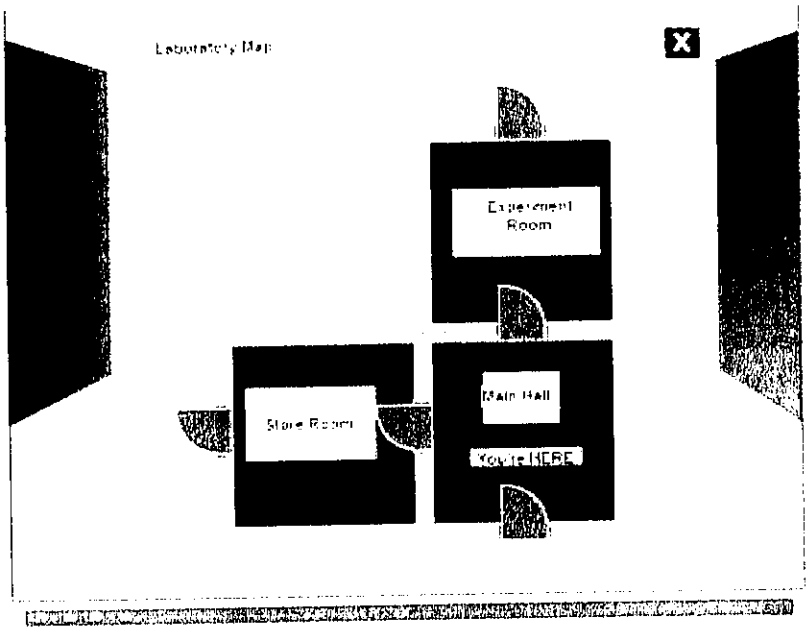

Fig. 1.12. VLab-CHEM Plan

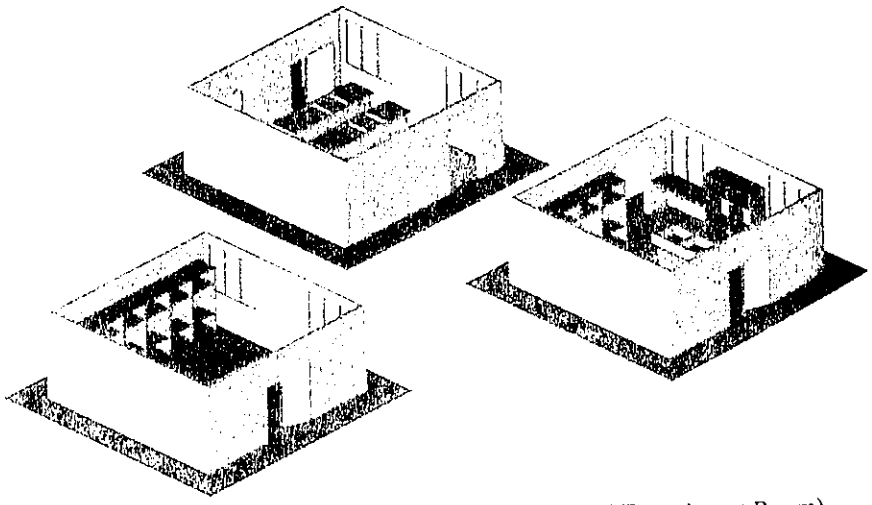

Fig. 1.13. VLab-CHEM Lab Architecture (Hall, Store and Experiment Room)

9 VLAB-CHEM Storyboard

According to Jamalluin Harun (2001), most of all the multimedia software development process are always referring to the process the been used to developed a film or movie, including the use of storyboard. Storyboard represent of what will be display on the screen and how the screen are connected into each other.

Therefore, the storyboard for this VLab-CHEM is still on the early stage where the development is only consisting of the three main room or hall as told above.

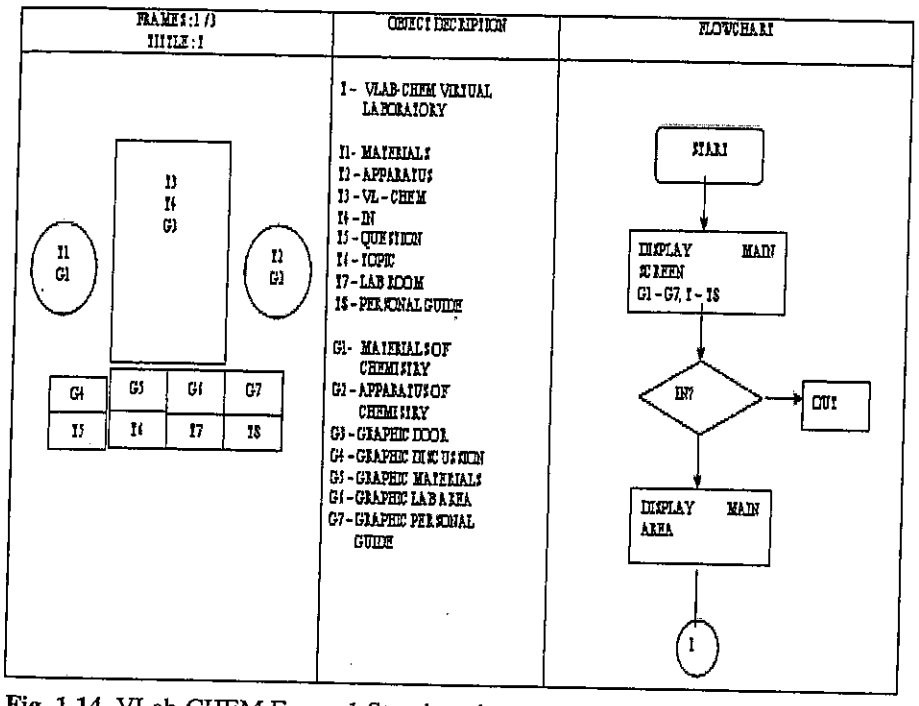

Fig. 1.14. VLab-CHEM Frame 1 Storyboard

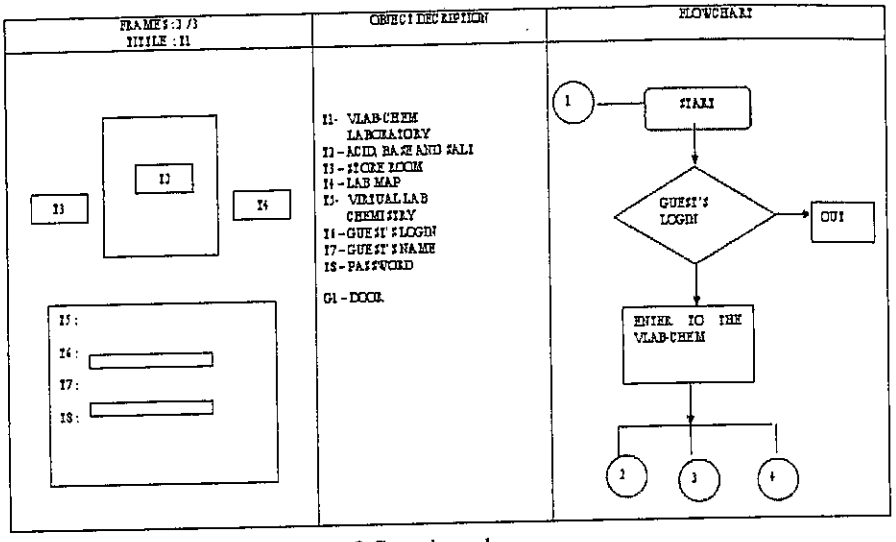

Fig. 1.15. VLab-CHEM Frame 2 Storyboard

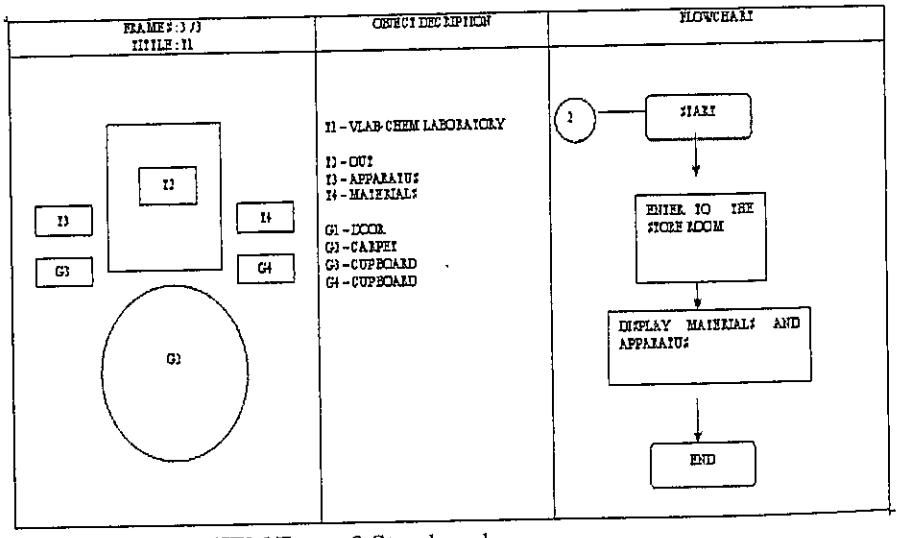

Fig. 1.16. VLab-CHEM Frame 3 Storyboard

10 Conclusion

This paperwork has been discussing the research methodology including VLab-CHEM development methodology. Detail description through phases involved in the development. Through virtual lab methodology, constructivism-cognitivism-contextual life cycle for chemistry subject has been produced. In the VLab-CHEM, one instructional model has been developed with the constructivism-cognitivism-contextual approach where model focused on science approach, learning sequence, holistic development, planning learning, and teaching and learning through interactive multimedia.

References

Ahmad Fauzi, Norhayati & Tengku Muhammad. (2005). *Pembangunan Perisian Kursus Tutorial Multimedia Matematik Kalkulus Menggunakan Pendekatan Pembelajaran Masteri.* Konvensyen Teknologi Pendidikan Ke-18. Inovasi Teknologi Instruksional Dalam Pengajaran Dan Pembelajaran : 179-184.

Alessi S.M. & Trollip, R. (2001). *Computer Based Instruction : Methods and Development.* Ed. Ke-3. New Jersey : Prentice Hall.

Hajah Norasiken Bakar & Halimah Badioze Zaman. (2005). *Analisis Awal Makmal Maya Bagi Pengajaran Kimia (Asid, Base dan Garam).* Konvensyen Teknologi Pendidikan Ke-18. Inovasi Teknologi Instruksional Dalam Pengajaran Dan Pembelajaran : 809-816

Hardy, T. C. (2003). Contextual Teaching In Science. Citing Internet sources URL http://www.kennesaw.edu/english/ContextualLearning/2003/Bartow/TeraHardy.pdf. (accessed 25 January 2006)

Jonassen, D.H. (1994). *Thingking Technology.* Educational Technology 34 (4):34-37.

Ketter, C. T., & Arnold, J. (2003). Implementing Contextual Teaching and Learning : Case Study Of Nancy, A High School Science Novice Teacher. Internet sources URL http://www.coe.uga.edu/ctl/casestudy/Arnold.pdf. (accessed 20 February 2006)

Mohd. Arif Ismail, Abdullah Mohd. Sarif, Rosnaini Mahmud. (2000). *Pembangunan Perisian Multimedia Interaktif Geografi.* Prosiding Konvensyen Teknologi Pendidikan Ke-13. Persatuan Teknologi Pendidikan Malaysia. Diedit Oleh Yusup Hashim & Razmah Man.

Oliver, K. M. (200). *Methods for Developing Construktivist Learning On The Web.* Educational Technology 40 (6) : 5-18.

Papert, S. 1980. *Mindstorms : Children, Computer and Powerful Ideas.* New York : Basic Books

Roziah Binti Abdullah. (2004). *Pembangunan Dan Keberkesanan Pakej Multimedia Kemahiran Berfikir Bagi Mata Pelajaran Kimia.* Ph.D.diss., Universiti Kebangsaan Malaysia.

Sears, S. J. (1999). What Is Contextual Teaching And Learning? Internet sources URL http://www.contextual.org/. (accessed 15 December 2005)

Shapiro, B. (1994). *What Children Bring To Light : A Constructivist Perspective On Children Learning In Science.* Teachers College Press : New York.

Simonson, M. R. Dan Thomson, A. (1990). *Educational Computing Foundations.* Ohio : Merill Publishing Company