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CONTENTS

DEVELOPMENT OF VLAB-CHEM FOR FORM FOUR STUDENTS BASED ON CONSTRUCTIVISM-COGNITIVISM-CONTEXTUAL APPROACH

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ABSTRACT

This paper is about the development of a virtual laboratory for the subject of chemistry in Malaysian secondary schools (VLab-Chem). In this research, the term virtual laboratory is used to demonstrate to the student that although they are not physically in a laboratory conducting an actual experiment, the VLab-Chem helps them to accomplish an experiment through computer interaction. Students have the capacity to utilize the materials and apparatus often used in experiments and see the complete reaction of the experiment through animation and simulation. The discussion involves the modeling of the theoretical framework where it divides into three parts which are analysis and design, development and evaluation. For the second objective, the researchers view on the constructivism- cognitivism-contextual lifecycle model. For the third objective, the researchers explain the laboratory architecture of development VLab-Chem. While designing the development of VLab-Chem, the researchers have used an approach in learning theory which is the constructivism-cognitivism-contextual theory which is concept through learning-by-doing, contextual education, simulation, animation to create virtual based on learning, added in the VLab-Chem.

Keywords:* *Virtual laboratory, virtual learning, chemistry, simulation

INTRODUCTION

Research in virtual laboratory is more than virtual learning approach. In this research, virtual learning environment utilized the animation and simulation virtual learning approach in the form of 2D. Students can explore the virtual chemistry laboratory, do their experiments and get the output from those experiments. Students can also record information acquired from experiments such as inference and observation in the electronic experiment report and worksheet while having the flexibility to edit and print the information later for reporting purposes.

Dillenbourg (2000) explained that questioning about virtual learning environment should not entirely refer to the educational web sites in Internet. In other words, it also encompasses static websites. He also explained that virtual learning does not exclusively reflect the system to include a 3D technology or virtual reality technology. Some environment has an interface based on texts. As the definition states above, there is a range of different environments based on the stated criteria. The main objective here is that one cannot define the perfect environment for virtual learning environment but rather one can provide an understanding about its specification. Virtual learning environment is not referring to a structured information space but rather its management content as the big issue. Research should find the approach to understand functional affairs on how information is been structured and presented, and how it can be used in learning environment and its interaction.

For this research, simulation is used to show the actions of experiment otherwise done in the chemistry laboratory, with focus on the aspects of color exchange, precipitation, shine, dissolve, burning heat and etc. Morozov (2004) shows that virtual laboratory development with simulation approach to the laboratory apparatus and experiment makes user feel that they are in a real laboratory. It also helps users who engage in long-distance education.

Nor Azan (2005) states that, simulation is a computer program that orders the interaction between user and computer as a physical world scientific model, real world or theoretical system. Simulation is being used as part of a learning plan whether in a tutorial as a learning strategy, learning equipment itself or as a based to achieve learning objectives.

PROBLEM STATEMENT

The result of an interview with a chemistry teacher shows that the topic of salt is found to have a significant level of difficulty due to the many sub-topics. Learning through conventional approach may expose students to unsafe material. Besides that, early preparation is required in preparation for an experiment such as material and apparatus, resulting in higher costs and excessive materials. Peplow and Marris (2006) states that the death of a French professor in a laboratory explosion at the National Institution of Higher Learning in Chemistry (ENSCMu) on 24 March, 2006 was a shocking reminder that research can be a "risky business".

Due to the higher costs of conventional experiments, experiments in schools have to be done in groups. Azwan and Rozita (2002) show that new technology can save time, energy utilization, easier transformation and in virtual space. It is now a reality for education in Malaysia. Mohd Arif et al (2006) said that integrating technology in using computer effectively and efficiently lets students acquire computer skills in a more meaningful way.

Norizan & Raja Maznah (2004) said that students who integrate technology in learning their learning process will search, analyze and evaluate information and in turn become an informative user, solving problem and making decisions using productive material in a creative and effective way, thus becoming an informative citizen, responsible and possibly contribute to the country's development.

Teachers often have to meet deadlines which force them to go through the syllabus and choosing only the important experiments. Mohd Arif (2006) said that as an example, there are two topics in Chemistry which requires more on reading that is "Chemical Material in Industry" and "Chemical for User". Other difficult topics include "Acid, Base and Salt" and "Electrochemistry". De Jong and Van Joolongen (1998) state that among the problems that students face include development of hypothesis, design of experiment, data integration and summary. Roziah (2004) explained that the effectiveness of teaching and learning based on information technology and communication relies on the teacher in their integration of the aspect of pedagogy, physiology and technology and also the ability of student to access and learn from the serving material.

Roziah (2004) shows that the readiness of teacher and student is the factor that ensures students are really good in using ICT. Mohd Arif (2006) said that it is important to integrate learning based on information technology and communication. Schram (1977) states that learning can be influenced by the planning contents and learning strategy through a certain media. Yusup (2003) adds that teachers should have the skills in instructional designing to deliver using ICT.

OBJECTIVE OF RESEARCH

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.

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 the Research on Theoretical Framework Model in Figure 1. It includes research questioning and research hypothesis. To achieve the purpose of research, some main questions and research hypothesis are designed as below:

(Sa) What is the methodology used in developing virtual lab for the chemistry subject (salt)?

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

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

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

- Hypothesis Mol 1 (Ho 1): No difference marks in pre test and post test for the control group in salt topic.
- Hypothesis Mol 2 (Ho 2): No difference marks in pre test and post test for the experiment group in salt topic.
- 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.

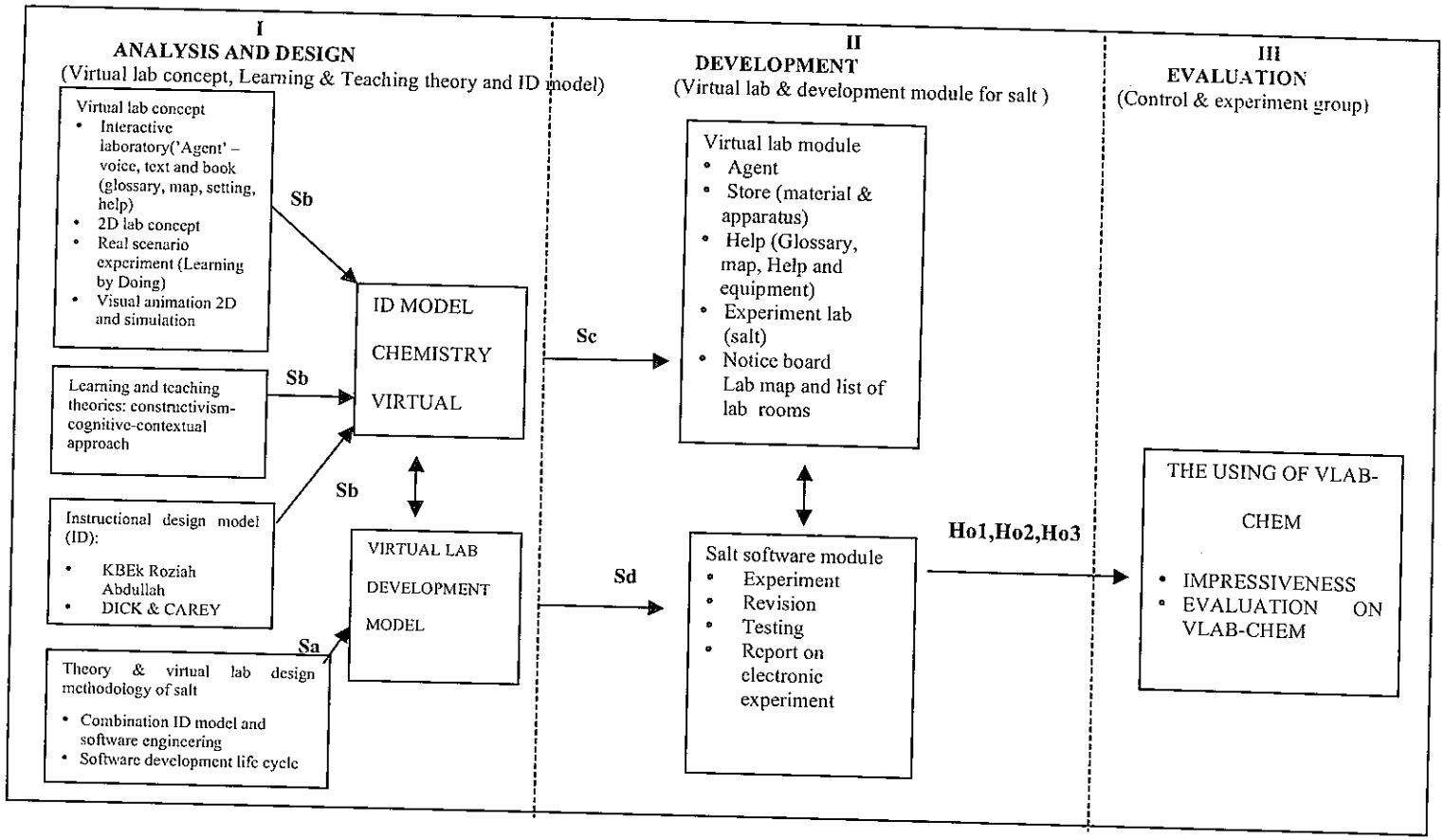

FIGURE 1

Research on Theoretical Framework Model

DEVELOPMENT MODEL FOR VLAB-CHEM

The development of VLab-Chem is designed in a form of a cycle to show the complete Constructivism-Cognitivism-Contextual Model Life Cycle as shown in Figure 2. Based on the waterfall model, this cycle will give the inner and outer entity of education which encompasses the three areas which cognitive, psychomotor and affective. There are 5 phases involved in the model namely analysis, design, development, implementation and evaluation. The model developed is hence called the constructivism-cognitivism-contextual model life cycle.

Analysis Phase

Several entities have been used in this phase to meet the requirements of software development. The entities are as follows:

- Target group
- Teaching and learning objectives
- Student background
- Student known knowledge
- Ability to grab content such as material of teaching and learning
- Laboratory and module designing of salt
- Constraints (access, hardware, operating system)

Research on Theoretical Framework Model

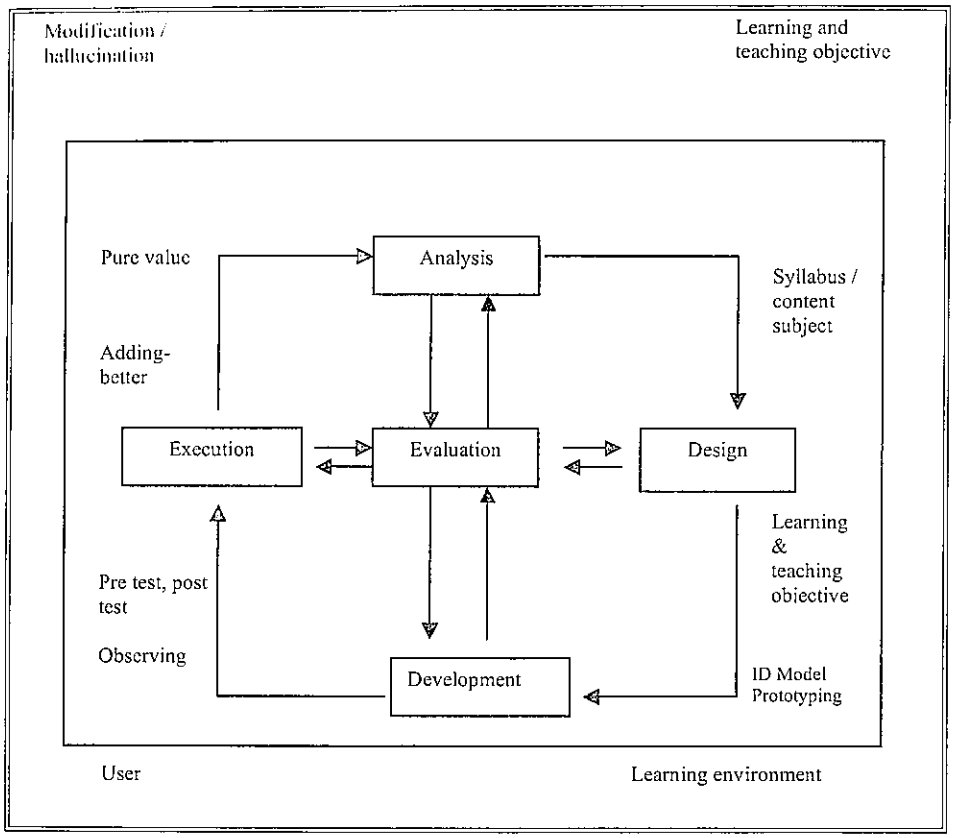

FIGURE 2

Constructivism-Cognitivism-Contextual Model Life Cycle for VLab-Chem

Designing Phase

Designing phase includes elements needed in the virtual laboratory based on conception model and theory build. This phase involves the design of processes such as:

- Designing of conception ID model for VLab-Chem virtual laboratory
- Designing of teaching and learning content VLab-Chem virtual laboratory

Development Phase

Elements in this virtual laboratory are based on conception and theoretical model. Modules in the VLab-Chem virtual laboratory include experiment module (user interactive with the material and apparatus, simulation), revision module, mind testing module and electronic experiment report module. Figure 3a, 3b, 3c, and 3d show the various Screen Designing for The VLab-Chem Virtual Laboratory modules in constructivism-cognitivism-contextual life cycle for the VLab-Chem virtual laboratory. Some of the factors that were considered in this phase are:

- The development of storyboard
- Flow chart development
- Authoring
- Graphics preparation
- Media such as voice recorder, sound and video clip editing
- System integration

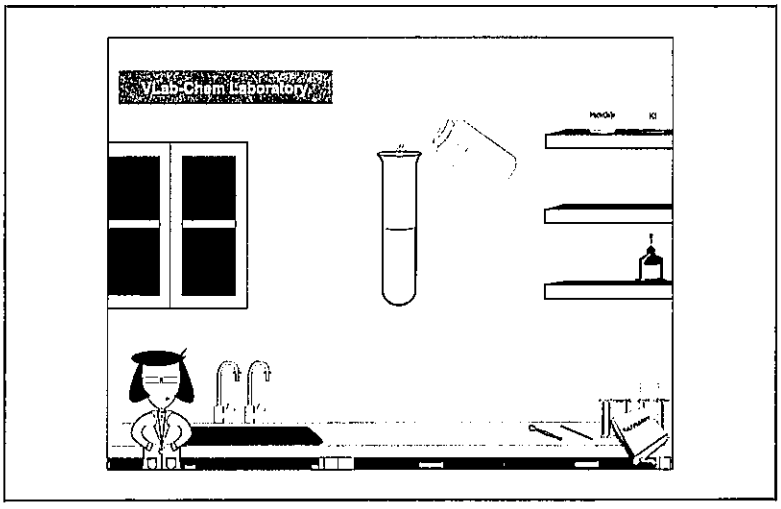

FIGURE 3a
PRINT SCREEN 01
(Constructivism-Cognitivism Approach)

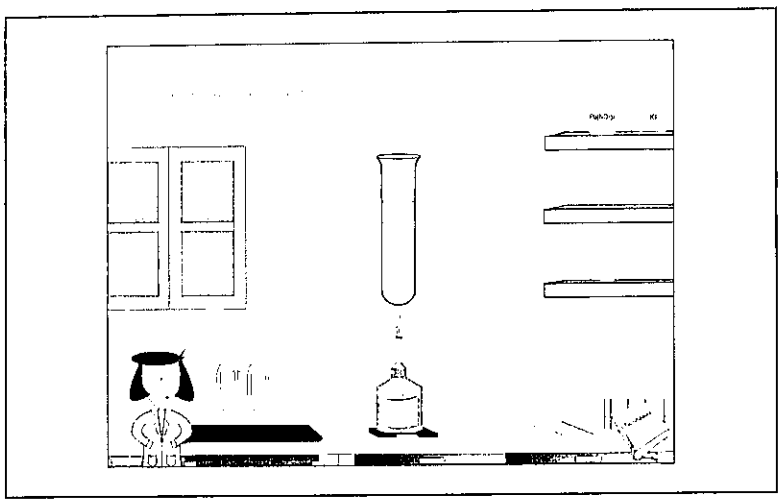

FIGURE 3b

PRINT SCREEN 02

(Constructivism-Cognitivism Approach)

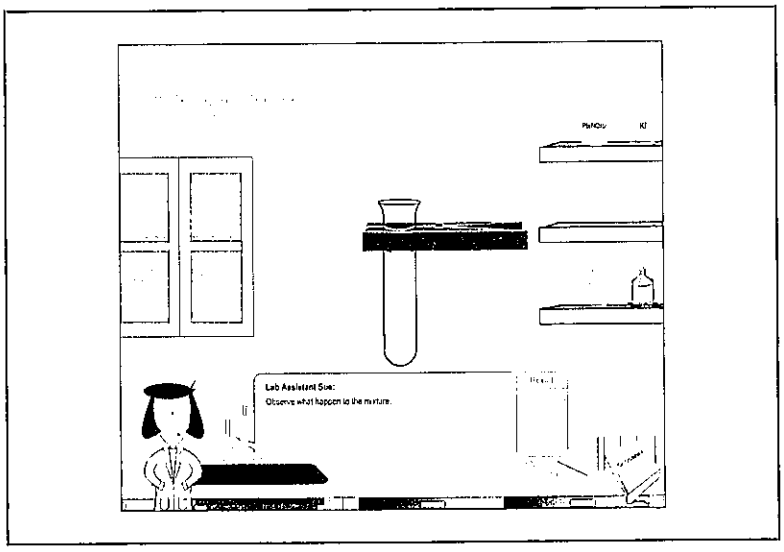

FIGURE 3c

PRINT SCREEN 03

(Constructivism-Cognitivism Approach)

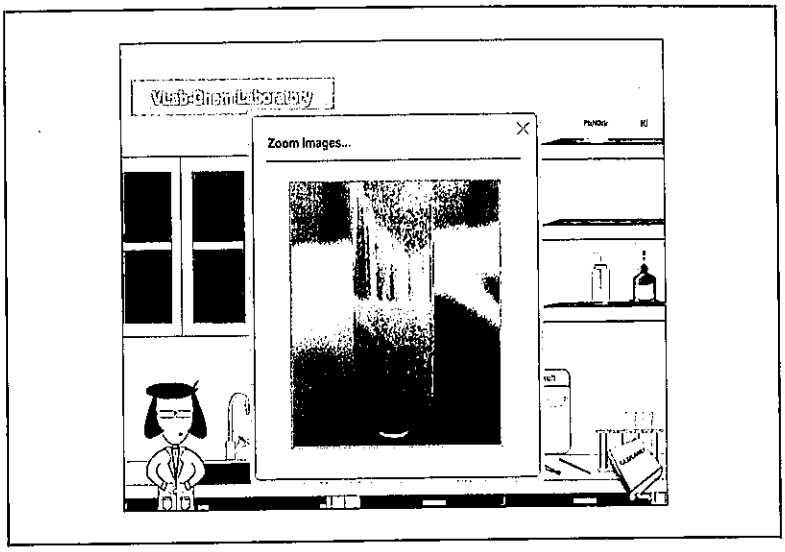

FIGURE 3d

PRINT SCREEN 04

Real Result

Execution Phase

Execution phase involved testing each unit and element developed in the teaching and learning process with the VLab-Chem, based on constructivism-cognitivism-contextual approach. It also includes prototyping that has been developed. This approach will give a chance to a teacher to integrate teaching and learning based on computer approach and conventional approach.

Evaluation Phase

This is the important phase whereby the testing of VLab-Chem virtual laboratory is conducted. It will show the effectiveness of the virtual laboratory based on constructivism-congnitivism-contextual approach to the Form 4 student of Sekolah Menengah Dato' Dol Said, Alor Gajah, Melaka, Malaysia. Besides that, this is the final stage to complete the constructivism-congnitivism-contextual life cycle for the VLab-Chem virtual laboratory.

DESIGN FOR VLAB-CHEM

This section will explain the results of the research in developing VLab-Chem virtual laboratory for the Form 4 chemistry subject in the topic of salt. There are six subtopics in this prototype such as below:

- Gas verification testing
- The effect of heat with the carbonate salt
- The effect of heat with nitrate salt
- Verification testing of anion in the aques melting
- To define kation with the melting natrium hydroxide and ammonia
- To define ferum (II) ion, ferum (III) ion, plumbum (II) ion and ammonia ion.

All experiments under the sub topic of the qualities of salt will be conducted by the user, where the user can choose any substances and equipment to conduct the experiment. As for the result, the experiment can be seen in real. Following are pictures depicting an experiment to define plumbum (II) ion.

EVALUATION OF THE EFFECTIVE USAGE BASED ON CONSTRUCTIVISM COGNITIVISM-CONTEXTUAL APPROACH

In this section, the effectiveness of VLab-Chem virtual laboratory and its overall performance is measured. The respondents of the evaluation are made up Form 4 students of Sekolah Menengah Kebangsaan Dato' Dol Said, Alor Gajah, Melaka, Malaysia and consist a two groups namely, those who use the VLab-Chem virtual laboratory and those who use conventional learning approach. VLab-Chem virtual laboratory will be tested using English. Result based on the research case of. Table 1 shows the tabulation of students who were involved in this research.

TABLE 1

Student Tabulation

Group	Female	Male	TOTAL
Control (C)	15	15	30
Experiment (E)	18	12	30
TOTAL	**33**	**27**	**60**

Pre-test and post-test questionnaire were used to evaluate students' performance. There are two sections in this questionnaire. Section A has 20 objective questions while section B consists of structured questions. Questions in section A will evaluate the cognitive level of students which encompasses knowledge, understanding, application and analysis. Questions in section B involve higher cognitive level such as analysis, application, synthesis and evaluation.

Is there any difference in students' achievement between students who use VLab-Chem virtual laboratory and students who use the traditional approach?

A partial research experiment was done on two groups of Form 4 students at Sekolah Menengah Kebangsaan Dato' Dol Said, Alor Gajah, Melaka, Malaysia. The experiment (E) group has gone through the salt topic through VLab-Chem virtual laboratory based on the constructivism-cognitivism-contextual approach. The control (C) group on the other hand, learned the topic through the traditional approach. Evaluation was done through the marks given in the pre-test and post-test for both groups.

Descriptive analysis of overall achievement for the topic of salt

Students in the control (C) group used the traditional approach and are labeled with the letter C followed by the number 1 through 30. Students in the experiment (E) group used VLab-Chem virtual laboratory and are labeled with the letter E followed by the number 1through 30.

The marks of the Pre-test and post-test for the control (C) group are shown in Table 2. Table 3 depicts the Pre-test and Post-test marks achievement for the experiment (E) group in the topic of salt. Results show that there is an increase in the students' performance for the both group.

Results from the Pre-test show that the average mark for the control (C) group is 14.10% while the experiment (E) group is 13.53%. It shows a small difference of about 0.57%. In the Post-test, average mark for the experiment (E) group is 47.00% while control (C) group is 29.23%. This means that the average difference to test the students' performance between the 2 groups is 17.77%. Therefore it shows that average increasing performance for the experiment group is higher than control (C) group.

Information from the Table 2 and 3 shows the lowest mark for the pre-test for both groups is 0%. The highest mark for the control group pre-test students (C14, C17, and C20) is 25% while for the student in the experiment group (E17) get 33%. If the passing mark is set to 40%, percentage passing for the experiment group in post test is 83.33% higher than control group get only 16.67%.

Table 2 showed the highest increasing shown by the C28 student that is 30% meanwhile C11 and C21 show –5%. Based on Table 3, student in experiment (E) group show the E27 student increase about 56% while the lower mark shown by the E13 student about 10%.

TABLE 2

Pre-test and post-test marks achievement for the Control group in the salt topic

Student	Pre-Test (%)	Post-Test (%)	Increasing (%)
C1	0	10	10
C2	0	15	15
C3	12	24	12
C4	10	20	10
C5	10	30	20
C6	17	33	16
C7	20	35	15
C8	0	11	11
C9	15	34	19
C10	20	25	5
C11	24	19	-5
C12	20	40	20
C13	15	27	12
C14	25	41	16
C15	15	30	15
C16	18	33	15
C17	25	35	10
C18	0	23	23
C19	15	20	5
C20	25	37	12
C21	20	15	-5
C22	15	25	10
C23	11	36	25
C24	10	30	20
C25	10	31	21
C26	15	38	23
C27	20	44	24
C28	0	30	30
C29	16	43	27
C30	20	43	23
Min	14.1000	29.23333	15.1333

TABLE 3

Pre-test and post-test marks for the Experiment group in the salt topic

Student	Pre-Test (%)	Post-Test (%)	Increasing (%)
E1	10	51	41
E2	5	32	27
E3	15	40	25
E4	13	26	13
E5	10	40	30
E6	18	60	42
E7	0	30	30
E8	17	32	15
E9	10	40	30
E10	25	70	45
E11	7	52	45
E12	20	40	20
E13	20	30	10
E14	11	45	34
E15	20	50	30
E16	5	45	40
E17	33	55	22
E18	15	65	50
E19	20	45	25
E20	18	56	38
E21	20	40	20
E22	11	52	41
E23	6	44	38
E24	15	42	27
E25	15	51	36
E26	10	55	45
E27	16	72	56
E28	0	45	45
E29	12	55	43
E30	9	50	41
Min	13.5333	47.0000	33.3333

(i) Statistical analysis for student achievement for the salt topic

To define the differentiate relation between marks in the pre-test and post-test, difference achievement for both groups, couple t-test has been used. Data has been analyzing using SPSS software version 12.0.

a. Hypothesis Mol 1 (Ho 1) : No difference marks in pre-test and post-test for the control group in salt topic.

Paired t-test has been used to show the student achievement to define effect in higher level thinking skill for the experiment group and the results are as shown in Table 4. They have been gone the learning through VLab-Chem virtual laboratory. Result shows that t value =9.948, with the significant value for the both end, p=0.000. As the p value is less than 0.05, statistically it shows that there is an achievement in pre-test and post-test in their higher level thinking skills. This means that mol hypothesis has been rejected.

TABLE 4

Coupled t-test in the pre-test and post-test for the control (C) group

Variables	Mean	Std.Dev.	N	error	t-value
Cpre	14.1000	7.81400			
			30	1.52129	-9.948
Cpost	29.23333	9.55450			

b. Hypothesis Mol 2 (Ho 2): No difference in marks in pre test and post test for the experiment group in salt topic.

Table 5 depicts that the t value is equal to 15.977, with the significant value for the both end, p=0.000. As the p value less than 0.05, statistically it show that there is increasing in mark achievement in pre-test and post-test in their higher level thinking skills. This means that the nul hypothesis has been rejected.

TABLE 5

Coupled t-test in the pre-test and post-test for the experiment (E) group

Variables	Mean	Std.Dev.	N	error	t-value
Epre	13.5333	7.915220			
			30	2.09473	-15.977
Epost	47.0000	11.42290			

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

Comparison in achievement in the pre-test based on the set of question in the post-test for both groups using t-test. Results as shown in Table 6 illustrates that average mark for the C group, mean=29.23333, while E group, mean=47.0000 with the t value, t=7.892, taking into consideration at the both end, p=0.00. It shows that a significant difference in higher level thinking skill for both groups. Meaning that nol hypothesis is been rejected. Experiment group gone the learning process through virtual lab VLab-Chem show the better achievement rather than control group, learning through conventional technique.

TABLE 6

Coupled t-test in the post-test for the control (C) and experiment (E) group

Variables	Mean	Std.Dev.	N	error	t-value
Cpost	29.2333	11.42290			
			30	2.25127	7.892
Epost	47.0000	9.55450			

CONCLUSIONS

The researchers in this study try to use computer-based learning to develop a virtual laboratory for the chemistry subject with specific focus on the study of salt. This study is found particularly useful for students in Form 4 and 5 as well as teachers. The results were analyzed and compared with the existing learning approach.

It is hoped that this research will provide an alternative for students to become more interested in the subject of Science and increase students' and teachers' understanding in this subject. In other words, the educational level in this country will increase parallel with the advancement in information technology. Therefore, computer-based learning can be seen to have the capacity to build and increase the efficiency of students' ability with the aid of multimedia.

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