DEVELOPMENT OF VIRTUAL LAB PRACTICAL CHEMISTRY (A CASE STUDY OF THE NATIONAL HIGH SCHOOL OF SCIENCES XI CLASS)

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ABSTRACT

Subjects of chemistry is one of the subjects of the common existing exact on all secondary school (HIGH SCHOOL). In addition to the theory of chemical subjects also have practice too, that sometimes these practical activities could not be carried out in school because the tools and materials that are less complete or even schools do not have the space to carry out practical laboratory chemistry. As experienced in the NATIONAL HIGH SCHOOL schools cannot do the learning practical chemistry laboratory room because there are no major issues could not be doing practical chemistry in school activities, which led to a lack of knowledge of students about practical chemistry. In addition the materials should be purchased paketan (kilogram), whereas such materials only a few fields and the rest being expired and unused, this makes the school must issue more cost in the provision of practical tools and materials chemistry. The thing which is the background of the intention of the research was done. By utilizing the technology of computer-aided or commonly known as the CAI (Computer Assisted Instruction) and multimedia, the author makes an alternative media to conduct NATIONAL high school chemistry lab course. With the building of a virtual lab practical applications of chemistry, grade XI NATIONAL HIGH SCHOOL of SCIENCES is now able to do practical work virtually, without the need for laboratory space and without having to bother to provide tools and materials for teaching activities. This application will visualize a space laboratory as well as some practical pensimulasian that fit the textbook used in HIGH SCHOOLS nationwide.
Based on the beta test can be drawn the conclusion that the application of the virtual lab chemistry lab course managed to meet the research objectives, namely adding knowledge about teaching chemistry for Class XI NATIONAL HIGH SCHOOL of SCIENCES, and save the cost of procurement of chemical teaching tools and materials for the school NATIONAL HIGH SCHOOL.

Keywords: NATIONAL HIGH SCHOOL, virtual lab, a chemistry lab course.

1. INTRODUCTION

1.1. Background Problem

National HIGH SCHOOL is one of the leading private schools are there in Bandung. Accredited "A" makes this school dared to compete with other schools in Bandung. As in the other HIGH SCHOOL, in high school, there is in addition a national IPA and IPS. There are 3 classes i.e. first-class IPA IPA (X of SCIENCES), class two IPA (XI of SCIENCES), and class three IPA (XII of SCIENCES). According to Mother Anggia as teachers of chemical subjects in high school chemistry teaching, started in the class two IPA (XI of SCIENCES).

From the results of interviews with mother Anggia as a chemistry teacher in high school that used to be acquired NATIONAL implementation activities of the NATIONAL high school chemistry lab course about 30% that can be implemented. With the limitations of the tools and materials available at the NATIONAL HIGH SCHOOL also makes practical activities students can not be done. This impact to students which resulted in a lack of knowledge of students in the subjects of chemistry. For current chemical laboratory space is negated because the space is used for additional classes. With no lack of laboratory for conducting chemical causes a devastating practical knowledge of students in the subjects of chemistry especially in practical chemistry. To buy the ingredients need chemistry lab course tdak can get a little bit (as needed) must be directly paketan or kilogram which means the school must spend more to buy it, while according to mother Anggia ingredients (spirtus, NaOH, etc) to use when teaching just slightly about 10 gr.

On the basis of the problem, then needed a solution to help overcome problems that are in the NATIONAL HIGH SCHOOL environment. Then, the CONSTRUCTION of the VIRTUAL LAB PRACTICAL chemistry. With the building of a virtual lab this lab course, students can undertake practical chemistry virtually without needing a laboratory space as well as tools and materials, so bisamenjadi means an alternative for students who can't do NATIONAL high school chemistry teaching, as well as expected could add knowledge especially students about practical chemistry. The school can

also save costs for the procurement of tools and materials for teaching chemistry.

1.2. Goal and Purpose

The intent of doing research (writing) this is the virtual lab applications build practical chemistry at NATIONAL HIGH SCHOOL as an alternative means for students to do practical work.

As for the goal to be achieved from this research are :

a. Increase knowledge about chemical teaching for the students of Class XI NATIONAL HIGH SCHOOL of SCIENCES.
b. Save the cost of procurement of chemical teaching tools and materials for the school NATIONAL HIGH SCHOOL.

1.3. Research Methods

The research method is the stages that have been specified in the conduct of a study that is useful as a guide in the process of doing the research so that research can be done properly and systematically. Here are the stages that will be done in the research.

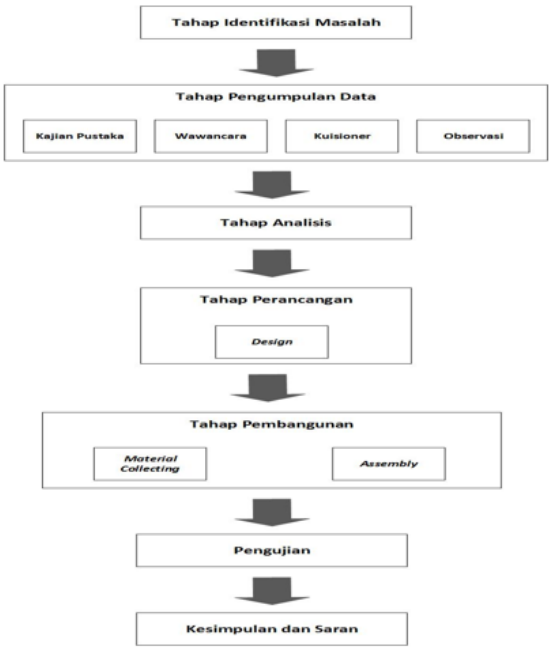


Figure 1. Stages of research

1.3.1. The Stages of Problem Identification

Problem identification is the action that is necessary to find out the crux of the issue, the cause of the problems that are encountered by the NATIONAL HIGH SCHOOL.

1.3.2. The Stages of Data Collection

In the data collection, there are multiple ways to use, here are some ways that are used in the collection of data in research.

a. Review of The Literature
   Learn the basic theory of various literature, journals, books and the internet about the theories that would later be used in the research.
b. Interview
   Data collection by direct questioning with mother Anggia as teachers of chemical subjects in National HIGH SCHOOL on matters related to issues that are examined.
c. Questionnaire
   Data collection by giving the now to the students of Class XI SCIENCE National HIGH SCHOOL.
d. Observations
   Collect data material learning practical chemistry in high school textbook in accordance with the National curriculum is used i.e. 2013, curriculum and plunge straight into the National HIGH SCHOOL environment.

1.3.3. Stages of Analysis

At this stage of the analysis of the system performed some analysis starting from the analysis of the problem, the analysis of a system that is running, the virtual lab analysis, and analysis of virtual lab to be built.

1.3.4. The Stage of Design

This stage is the stage of making spesifikasidari application architecture, style, look between the advance and other materials to support the creation of applications.

1.3.5. The Stages of Development

At this stage of the testing done against an application that is built by using a black box testing methods and User Acceptance Test to see if the applications that will be built have been appropriate as expected.

At this stage of development of the software used in building virtual lab practical applications of chemistry is a modification of the method of Luther-Sutopo with stages of collecting material and assembly. The following description of its stages :

a. Material Collecting
   Materials Collecting is a stage of collection materials in the form of images, texts, audio equipment, video, navigation buttons, the question of evaluation and assets related to application development.
b. Assembly
   The Assembly stage is a stage where all the multimedia material or object is created. Making virtual lab practical applications of chemistry is based on the stage of design.

1.3.6. Testing

At this stage of the testing done against an application that is built by using a black box testing methods and User Acceptance Test to see if the applications that will be built have been appropriate as expected.

1.3.7. Conclusions and Suggestions

At this stage it described the conclusions and suggestions of the results of the analysis of the description and discussion of the results of testing a hypothesis of the research that has been done.

1.4. Kajian Pustaka

1.4.1. Virtual Laboratory

Virtual lab or commonly referred to with the term Virtual Lab is a series of tools of the laboratory in the form of software (software) computer-based interactive multimedia, computer-operated and can simulate user activity in the lab as if it were in the laboratory. Virtual laboratory of potential to provide significantly improved and more effective learning experience. Development of the virtual laboratory is expected to solve the problems of learning experienced by learners and overcoming the problems of cost in the procurement of tools and materials used to perform the lab course for schools that are less able to [2]

Learning through multimedia in the form of a virtual laboratory, in general benefits that can be gained is a learning process to be more interesting, more interactive, the amount of time can be reduced, the quality of teaching and learning can be enhanced and the process of teaching and learning can be done anywhere and anytime. In addition, through virtual laboratories, the research cost savings could be made, as well as research that was not possible, due to the limitations of the current system of conditioning, could have been carried out [2].

1.4.2. Computer Assisted Instruction

Media learning computer-based or Computer-Assisted Instruction (CAI) is media of learning that utilizes a computer to aid in learning, or it is used include the presentation of the information content of the subject matter, exercise, or both. Learning media CAI allows in presenting a tutorial for understanding, as well as practice or simulation for implementation [3]. Learning devices or often called Computer Assisted Instruction (CAI) was defined as computer users to provide content instruction training with Drill format and Practice, simulated, and tutorials [4].

1.4.3. The Method of Luther Sutopo

Multimedia development is done on the basis of the 6-stage i.e., concept, design, collecting material, assembly, testing, and distribution. The sixth stage does not have to be sequential in practice. Each stage can mutually exchange position, though once the stage of concept indeed should be the first thing done. Here is a picture of luther sutopo method [7].

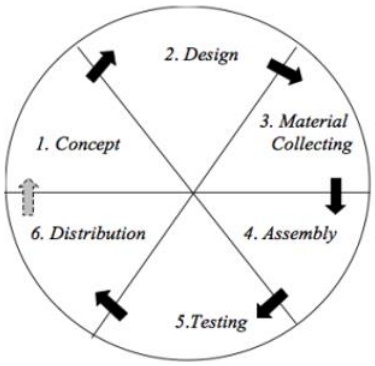


Figure 2. Development of multimedia Luther-Sutopo

An explanation of each of the stages are as follows :

a. Concept
The stage concept i.e. determining objectives, including identification of audiences, the kinds of applications (presentations, interactive, and others), the purpose of the application (information, entertainment, training, etc.) and general specifications. Basic rules for the design are also determined at this stage as the size of the application, the target, and others [7].

b. Design
Stage design is to create specifications in detail about the architecture project, style, and material needs for the project. The specifications made quite detailed so that at a later stage, i.e. collecting materials and assembly of the new decision is not required, but using what is already determined at the stage of design [7].

c. Material Collecting
Material Collection can be done in parallel with the stages of assembly. At this stage done gathering ingredients such as clipart images, animations, audio, here the making of images, photographs, graphics, audio and other things needed for the next phase [7].

d. Assembly
The assembly stage is a stage where the whole multimedia object is created. The manufacturer of the application based on the storyboards, the flowchart view, the navigation structure, or the diagram object that is derived from the design phase [7].

e. Testing
This stage of testing is done after finishing the stage of manufacture and all data have been entered. First of all carried out testing modular to ensure whether the results as desired [7].

f. Distribution
When a multimedia application will be used with different machines, use of the doubling of floppy disk, CD-ROM, or the distribution network is indispensable. This stage is also the stage where the evaluation of a multimedia product is done.

The evaluation is done with, will be able to dikebangkan a better system later [7].

2. The Content of Research

2.1 Description of The System

Virtual chemistry lab course lab system to be built is a desktop-based client-server system built using the method of Computer-Assisted Instruction (CAI) with the concept of a tutorial, drill and practice, and simulation. Now here is the overview of the architecture of the system that will be built. The system will have two interfaces i.e. a Front End and a Back End.

The frontend is part of the application that will be used by students for learning practical activities. The backend is a part of the application that is entirely done by chemistry teacher as teacher of the system to process data of students, material, and reserved. As for the system architecture to be built can be seen in the following figure.

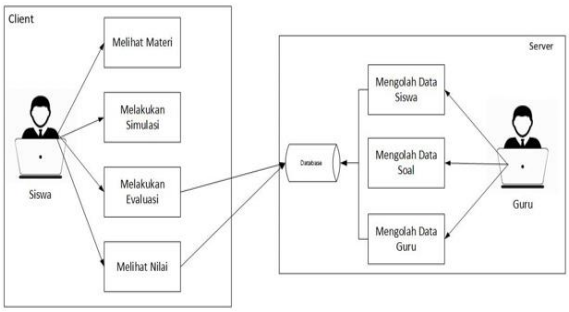


Figure 3. Description Of The System

2.2 Analysis of Learning Methods

Learning methods used can affect the success of the learning process, of course, need to be supported using the appropriate media so that the learning objectives can be achieved. Learning methods used in the development of this application is the method of Computer-Assisted Instruction (CAI) with the concept of a tutorial, drill and practice, and simulation.

a. *Tutorial*

The concept is used for the submission of tutorial material. The material will be presented in each chapter of his theory is the basis of his teaching activities only. So that in a short time, it is expected students can understand the gist of the material in the chapter. Groove concept tutorials on virtual lab practical applications of chemistry can be seen in the following figure.

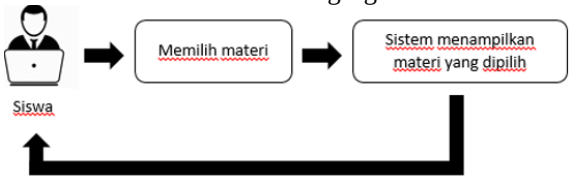


Figure 4. Flow Tutorial Concept

b. *Dril and Practice*

Dril and practice concept used to train or test the students by way of showing a series of exams, the students are already familiar to the overall material provided or not. The test is done in the form of test theory and practical exams. Test the theory in the form of a series of practical exam essay question whereas IE students do practical work, simulation activities without a referral will be assigned by the system. Groove concept dril and practice on teaching chemistry lab virtual applications can be seen in the following figure.

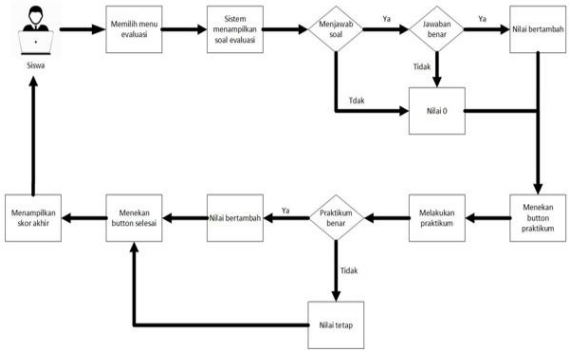


Figure 5. Flow *Dril and Practice* Concept

c. Simulation

The concept of simulation is used to give an overview to the students how the process of teaching activities undertaken. So the students are expected to understand and know how practical activities are carried out. Concept flow simulation on virtual lab practical applications of chemistry can be seen in the following figure.

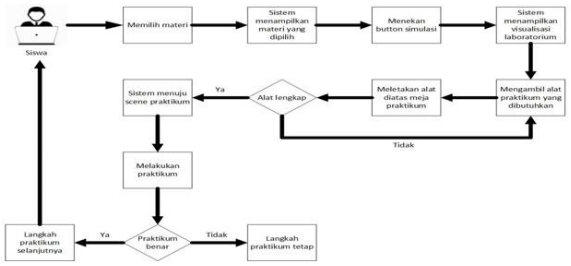


Figure 6. Flow Simulation Concepts

2.3 Use Case

Use case diagrams are used to describe a number of external actor with a use case that is contained in the system. Use case diagram this is only describing the State of the system environment which can be seen from the outside by the actor. Use case consists of three parts, namely the definition of actor, definition, and use case use case scenario. Use case development contained in the virtual lab chemistry lab course can be seen in the following figure :

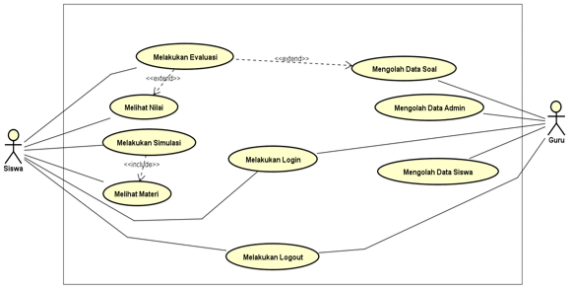


Figure 7. *Use Case*

2.4 Use Case Scenario

The following is a table of the use case scenario Login on the system that is being built, the following is a description of the actions Login use case.

Table 1. Use Case Scenario do Login

Use Case Name	Melakukan Login	**UniqueID :** SKPL-F01
Actor(s)	Siswa dan Guru	
Description	Melakukan login untuk bisa masuk ke dalam sistem (menu utama)	
Trigger Event	Menekan button login	
Actor		**Sistem**
Skenario Utama		
1. Memasukan username dan password		
2. Menekan button Login		
		3. Validasi inputan dari *actor* (Benar)
		4. Menampilkan menu utama
Actor		**Sistem**
Skenario Alternatif		
1. Memasukan username dan password		
2. Menekan button Login		
		3. Validasi inputan dari *actor* (Salah)
4. Memasukan username dan password yang valid		
Preconditions	Siswa dan guru berada pada halaman login	
Postconditions	Siswa dan guru berhasil masuk ke dalam menu utama	
Assunotion	Siswa dan guru menginputkan username dan password yang valid	

2.5 Activity Diagram

The following is an overview of the use case scenario Login described in an activity diagram Login.

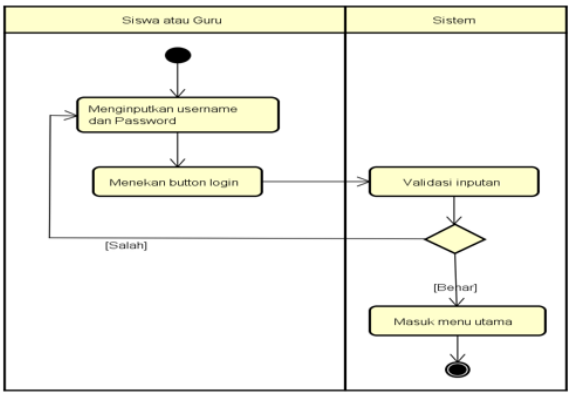


Figure 8. Activity Diagrams do Login

2.6 Class Diagram

The class diagram is a diagram that is used to display some of the classes that exist in the application to be built. Class diagram gives an overview of the application and the relationships that exist. As for the class diagram on the application virtual lab practical chemistry is as follows below.

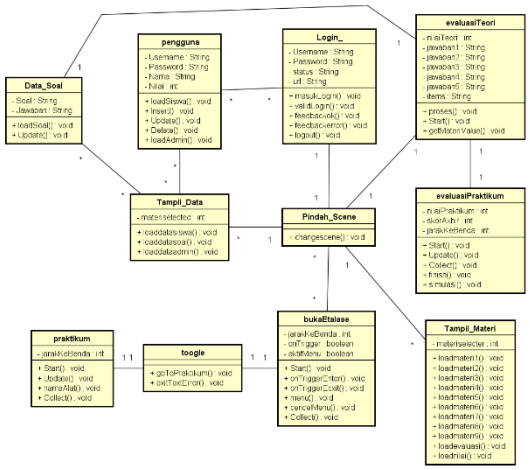


Figure 9. *Class Diagram*

2.7 Sequence Diagram

Sequence diagrams are used to describe the behavior of a scenario. This diagram shows a number of examples of objects in the message (message) which is placed between the objects in the use case.

The picture below is the explanation of sequence diagram Login on the application virtual lab chemistry lab course will be built.

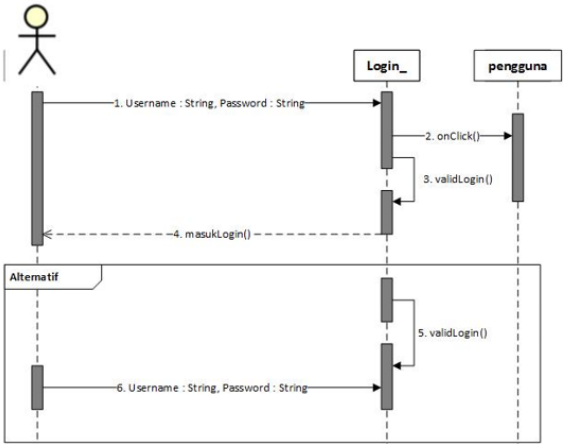


Figure 10. Sequence Diagram do Login

2.8 Design of Menu Structure

Menu structure on the application of virtual practical chemistry lab has 2 main menu i.e. main menu the main menu for students and teachers. Here is the design of the structure of the main menu for students and teachers.

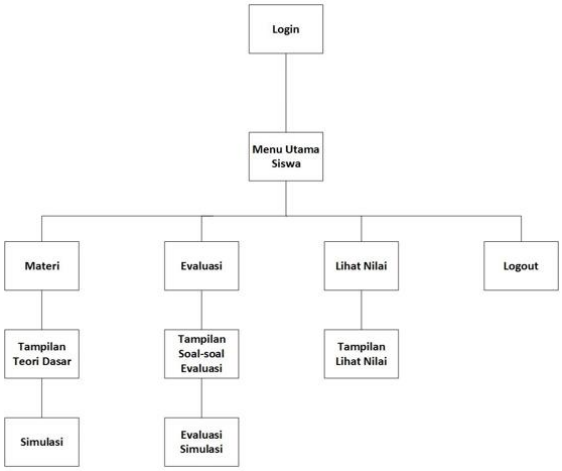


Figure 11. The Structure Of The Main Menu For Students

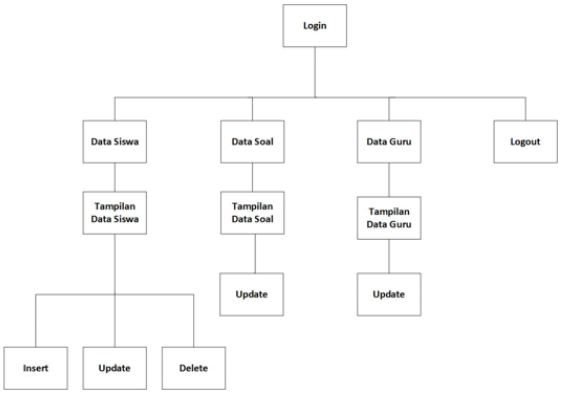


Figure 12. The Structure Of The Main Menu Teacher

2.9 Application Implementation

In the construction of the application there is a class contained in the virtual application lab practical-this chemical class implementation, a table can be seen as follows.

Table 2. Class Implementation

No	Nama *Class*	Nama File Fisik	Nama File *Executabel*	Keterangan
1	Login_	Login.unity	login.cs	*Class* yang digunakan untuk melakukan *login* dan *logout*
2	Pindah_Scene	menu siswa.unity praktikum 1.unity praktikum 2.unity praktikum 3.unity praktikum 4.unity praktikum 5.unity praktikum 6.unity praktikum 7.unity praktikum 8.unity praktikum 9.unity	changeScene.cs	*Class* yang digunakan untuk mengganti *scene*
		evaluasiTeori.unity evaluasiPraktek.unity		
3	Tampil_Materi	menu siswa.unity	menu_control.cs	*Class* yang digunakan untuk menampilkan materi teori dasarpraktikum
4	evaluasi Teori	evaluasiTeori.unity	loadSoal.cs	*Class* yang

				digunakan untuk menampilkan soal
5	evaluasi Praktikum	evaluasiPraktikum.unity	evaluasiPraktikum.cs	*Class* yang digunakan pada *scene* evaluasi praktikum
6	bukaEtalase	visualisasiP1.unity visualisasiP2.unity visualisasiP3.unity visualisasiP4.unity visualisasiP5.unity visualisasiP6.unity visualisasiP7.unity visualisasiP8.unity visualisasiP9.unity	bukaEtalaseKiri.cs bukaEtalaseKanan.cs	*Class* yang digunakan untuk *trigger* menampilkan menu alat dan bahan pada visualisasiP1-visualisasiP9. Unity
7	toogle	visualisasiP1.unity visualisasiP2.unity visualisasiP3.unity visualisasiP4.unity visualisasiP5.unity visualisasiP6.unity visualisasiP7.unity visualisasiP8.unity visualisasiP9.unity	toogle1.cs	*Class* yang digunakan untuk mengambil alat dan bahan praktikum pada visualisasiP1-visualisasiP9. Unity
8	praktikum	praktikum1.unity praktikum2.unity praktikum3.unity praktikum4.unity praktikum5.unity praktikum6.unity praktikum7.unity praktikum8.unity praktikum9.unity	praktikum1.cs praktikum2.cs praktikum3.cs praktikum4.cs praktikum5.cs praktikum6.cs praktikum7.cs praktikum8.cs praktikum9.cs	*Class* yang digunakan untuk melakukan simulasi praktikum
9	Tampil Data	Form1.cs	Form1.cs	*Class* yang digunakan untuk menampilan data
10	Penggguna	Form1.cs formEditSiswa.cs formTambahSiswa.cs	Form1.cs formEditSiswa.cs formTambahSiswa.cs	*Class* yang digunakan untuk mengakses data pengguna
11	Data Soal	formEditSoal.cs	formEditSoal.cs	*Class* yang digunakan untuk mengakses data soal

2.10Black Box Testing Scenario

Scenario testing exposed the sequence and it is tested in a test conducted on the application.

Table 3. Black Box Testing Scenarios

No	Komponen yang Diuji	Skenario Pengujian	Jenis Pengujian
1	Melakukan login	Memasukan username dan password	*Blacx Box*
		Memilih tombol "Login"	*Blacx Box*
2	Melihat materi	Memilih tombol "Teori Praktikum1" sampai tombol "Teori Praktikum9"	*Blacx Box*
3	Melakukan simulasi	Memilih tombol "Teori Praktikum1"	*Blacx Box*

		sampai tombol "Teori Praktikum9"	
		Memilih tombol "Next"	*Blacx Box*
		Memilih tombol "Yes"	*Blacx Box*
		Melakukan Praktikum	*Blacx Box*
4	Melakukan evaluasi	Memilih tombol "Evaluasi"	*Blacx Box*
		Mengisi soal	*Blacx Box*
		Memilih tombol "Praktikum"	*Blacx Box*
		Melakukan praktikum	*Blacx Box*
5	Melihat nilai	Memilih tombol "Lihat Nilai"	*Blacx Box*
6	Mengolah data siswa	Memilih tombol "Data Siswa"	*Blacx Box*
		Memilih tombol "tambah"	*Blacx Box*
		Mengisi form tambah data siswa	*Blacx Box*
		Memilih tombol "Simpan"	*Blacx Box*
		Memilih tombol "edit"	*Blacx Box*
		Melakukan pengeditan data siswa	*Blacx Box*
		Memilih tombol "Simpan"	*Blacx Box*
		Memilih data siswa	*Blacx Box*
		Memilih tombol "hapus"	*Blacx Box*
		Memilih tombol "Ya"	*Blacx Box*
7	Mengolah data soal	Memilih tombol "Data Soal"	*Blacx Box*
		Memilih tombol "Edit"	*Blacx Box*
		Memilih data soal	*Blacx Box*
		Melakukan pengeditan data soal	*Blacx Box*
		Memilih tombol "Simpan"	*Blacx Box*
		Memilih tombol "Ya"	*Blacx Box*
8	Megolah data guru	Memilih tombol "Data Guru"	*Blacx Box*
		Memilih tombol "Edit"	*Blacx Box*
		Melakukan pengeditan data guru	*Blacx Box*
		Memilih tombol "Simpan"	*Blacx Box*
		Memilih tombol "Ya"	*Blacx Box*
9	Melakukan logout	Memilih tombol "Logout"	*Blacx Box*

2.11 Black Box Testing Conclusions

Based on the results of testing a black box has done with cases that have been tested, then it can be inferred that in the virtual lab practical applications of this chemical can run well and there are no errors on the existing functional process i.e. login, display material, showing simulation, showing the evaluation, showing the value, manage student data, manage data, manage data of teachers and do logout runs as desired.

2.12 Beta Test Scenario

To find out the user's responses and assessment against a virtual lab practical applications of chemistry, dissemination of the questionnaire to the respondent based on target user in this case is the grade XI NATIONAL HIGH SCHOOL of SCIENCES of 33 people.

After it's done with likert scale calculation that is used to measure the attitudes, opinions, and perceptions of a person or a group of people about social phenomena. In this study where data were analyzed by calculating an average score based on the answers of each respondent who answers from then on the basis of the average of the answers of the respondents and then aggregated.

Table 4. Calculation of the 1st Question

Keterangan	Skor	Responden	Jumlah Skor
Sangat Setuju	5	17	5 x 17 = 85
Setuju	4	14	4 x 14 = 56
Biasa Saja	3	0	3 x 0 = 0
Tidak Setuju	2	2	2 x 2 = 4
Sangat Tidak Setuju	1	0	1 x 0 = 0
Jumlah		**33**	**145**

Table 5. Calculation of the 2nd Question

Keterangan	Skor	Responden	Jumlah Skor
Sangat Setuju	5	15	5 x 15 = 75
Setuju	4	12	4 x 12 = 48
Biasa Saja	3	3	3 x 3 = 9
Tidak Setuju	2	3	2 x 3 = 6

Sangat Tidak Setuju	1	0	1 x 0 = 0
Jumlah		**33**	**138**

Table 6. Calculation of the 3rd Question

Keterangan	Skor	Responden	Jumlah Skor
Sangat Setuju	5	16	5 x 16 = 80
Setuju	4	10	4 x 10 = 40
Biasa Saja	3	7	3 x 7 = 21
Tidak Setuju	2	0	2 x 0 = 0
Sangat Tidak Setuju	1	0	1 x 0 = 0
Jumlah		**33**	**141**

Table 7. Calculation of the 4th Question

Keterangan	Skor	Responden	Jumlah Skor
Sangat Setuju	5	12	5 x 12 = 60
Setuju	4	11	4 x 11 = 44
Biasa Saja	3	7	3 x 7 = 21
Tidak Setuju	2	3	2 x 3 = 6
Sangat Tidak Setuju	1	0	1 x 0 = 0
Jumlah		**33**	**131**

2.13Conclusion Beta Testing

Based on the results of the beta can be taken from the conclusion of the overall questions asked of respondents obtained the percentage above 70%. Questions 1 to 3, gained about more than 84% of the States could not agree to the questions asked and the question to 4 obtained 71% agree to the questions asked. So it could be said that application was built already in accordance with the expected goal.

3. CLOSING

3.1 Conclusion

Based on the results of the research, analysis, design and implementation of the system, as well as testing, can be drawn the conclusion that the development of virtual lab practical applications of chemistry are as follows.

a. Applications can add understanding or knowledge about chemical teaching for the students of Class XI NATIONAL HIGH SCHOOL of SCIENCES
b. the application can save the cost of the school in the provision of practical tools and materials chemistry

3.2 Advice

Based on the results of the research, then the advice that can be expressed in the future in order to be an improvement and considerations are as follows :

a. Submission of material could be upgraded again to make it more interactive.
b. Adding a feature to edit the 3 dimensional objects.
c. work closely with the chemical laboratory in order to get the more accurate chemistry lab course.

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