KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

The Development of Chemical Representations-Oriented Virtual Laboratory for Teaching Electrolysis in Chemistry Classes

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Abstract.
This study aimed to describe the development of a chemical representation-oriented virtual laboratory. It produced a learning media application which could be used in electrolysis study materials. The study described the analysis phase and the design and development phase. It also analyzed the results of limited tests towards the product. The study showed that the virtual laboratory features a colorful, attractive design and interactivity. The virtual laboratory can be potentially used as a learning media in chemistry learning on electrolysis concepts.

Keywords: chemical, virtual laboratory, electrolysis

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Published: 3 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

The rapid development of technological knowledge on information and communication in the 21st century has allowed the globalization to influence the education world [1]. It has integrated computers in learning media [2] in order to make learning attractive [3]. A virtual laboratory could be used to make learning interesting [4]. Virtual laboratory is a digital form of laboratory practices which is presented in computer [5]. Virtual laboratory offers many benefits [6]. With virtual laboratory, students could perform experiment without producing chemical waste [7]. The virtual laboratory could be used indefinitely, significantly reducing school's expenses for facilitating high quality practices [8]. It could also allow students to modify parameters of practices which often cannot be done in the real world [9]. Besides that, it could also allow the establishment of independent or collaborative practices which are not only limited to school subjects, laboratory or available chemical materials and laboratory tools [10]. It can help that in real life not all

How to cite this article: Sari Sari*, Siti Nur Hamidah, Ida Farida , (2024), "The Development of Chemical Representations-Oriented Virtual Laboratory for Teaching Electrolysis in Chemistry Classes" in *International Conference On Mathematics And Science Education*, KnE Social Sciences, pages 335–345. DOI 10.18502/kss.v9i8.15565

schools have laboratories or not all school laboratories facilitate tools and materials is available [11]. As we know, laboratory has important role in Chemistry learning because it is the place where chemical concepts and theories are tested and put into practices [12].

Learning chemistry which integrates of connecting three level (microscopic, submicroscopic and symbolic) of chemical representations could deliver chemical concepts to students more completely [13]. One of chemical concepts which can be mastered with the method of connecting the three levels of chemical representations is electrolysis [14]. Electrolysis is important to be studied because that application can be found in daily life, such as gasses production, metal plating and refining [15]. Many beneficial gasses can be produced via electrolysis processes [16], for example hydrogen and chlorine [17]. Good corrosion can be plated with other metals which are more resistant to oxidation via electrolysis [18]. The automotive industry is one of the industries which employ metal plating in large scale [19]. Metal refining is also commonly used for fuel recycling process [20]. Electrolysis is easy to conduct [21]. The electrolysis concept in the three levels of chemical representations is displayed by observing an electrolysis process via an integrated practice at the microscopic level, studying the movement direction of atoms, ions, and electrons during the electrolysis process at the submicroscopic level and converting the observation results into chemical representations at the symbolic level [22].

Practices on laboratory is needed in learning chemistry. However, there are problems in practice [23]. Many schools even do not own chemistry laboratory and materials for practices and long duration of practice can make spending time in laboratory for doing experiment is seldom performed [24]. Therefore, a creative, innovative option is needed [25] which could minimalize practice expenses that can minimize these problems by using technology [26].

2. RESEARCH METHOD

The method used in this research was Design Based Research (DBR) with modification. The method, based on technology, consists of two phases, namely the analysis phase and the development of design phase [27].

2.1. The Analysis Phase

In this phase, the problem was identified from several sources as journal and textbooks. Next, electrolysis concept analysis, electrolysis concept mapping, chemical representations analysis, sources acquisition and selection of software for creating virtual laboratory media were conducted. To obtain the accuracy of functions, software media support virtual laboratory used is adobe Photoshop CS5, Corel Draw X7, Adobe Flash Professional CS6, and audacity.

2.2. The Development of Design Phase

In this phase, the virtual laboratory model is validated and revised based on evaluator from expert lecturers. Then, the media feasibility test was carried out virtual laboratory by ten Chemical Education Department students at UIN Sunan Gunung Djati Bandung through limited test questionnaire.

3. RESULT AND DISCUSSION

3.1. Create Image and Audio Support

The making a virtual laboratory begins with create images and sound support of a virtual laboratory. The images were created using two software, namely for vector-based images used Corel Draw X7 and for pixel-based images used Photoshop. Then, making sound effect for every practices. Because sound files in Adobe Flash Professional CS6 require the .wav sound extension, so some sounds need to be converted to .wav extensions using audacity. The process making images and audio support is depicted on Figure 1, Figure 2, and Figure 3.

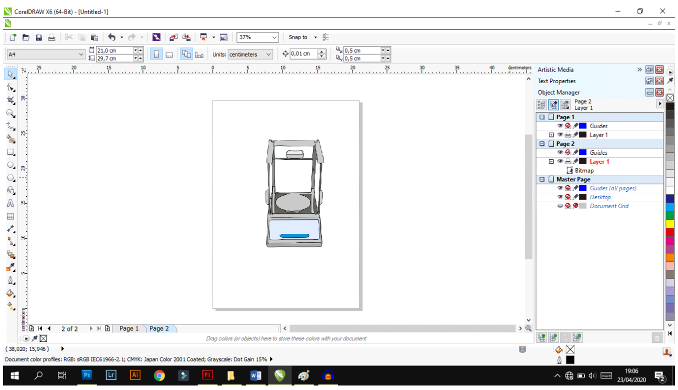

Figure 1: Vector images used corel draw x7.

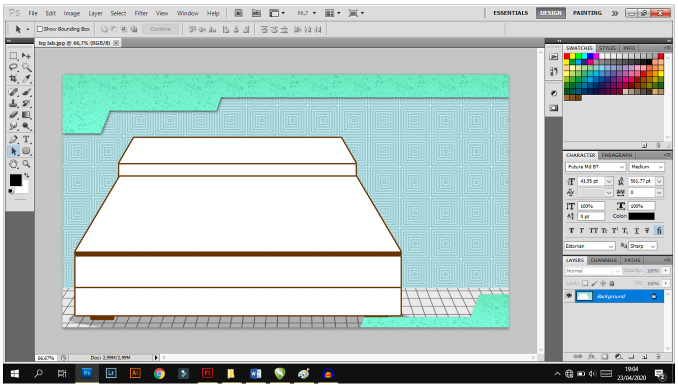

Figure 2: Pixel images used photoshop.

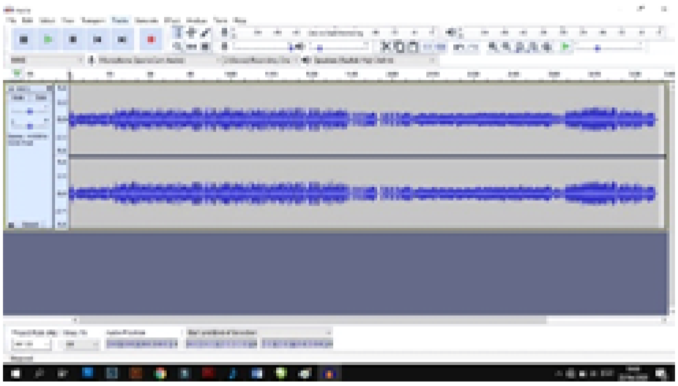

Figure 3: The process changing the sound extension.

3.2. Preparing of Images Support

In this phase, supporting images are arranged using Adobe Flash Professional CS6 based on the story board. After all the supporting images are arranged based on the story board, then each required image is entered in action script language 2.0 so that drag and drop techniques can be used. The process of preparing images support can be seen in Figure 4 and Figure 5.

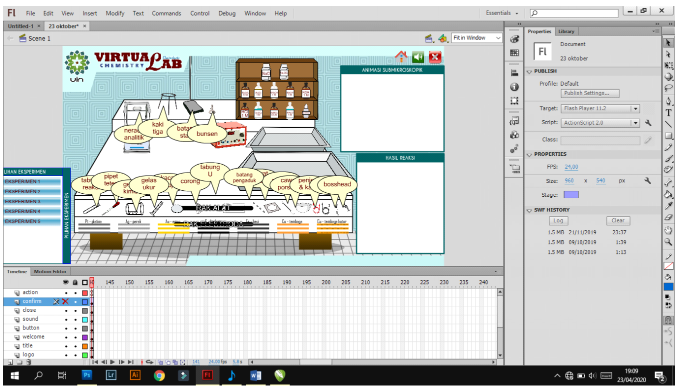

Figure 4: Preparing images support using adobe flash professional cs6.

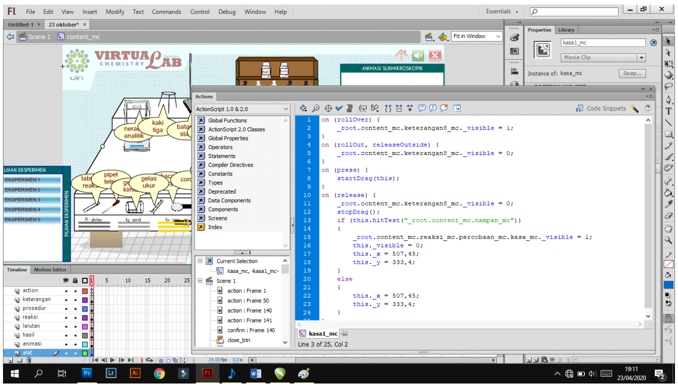

Figure 5: The Process of adding action script language 2.0 to the image.

3.3. Trial and Error and Finalization

In this step, a trial and error is performed at each event to find bugs and errors. This process takes a long time because usually to change a line of script, we must change the action script with the image. After all the steps are completed, then exporting the file to the .swf extension and .exe extension. .exe extension is used to make it easier to open the file because it usually not require the latest flash player version. The process of this step can be seen in Figure 6 and 7.

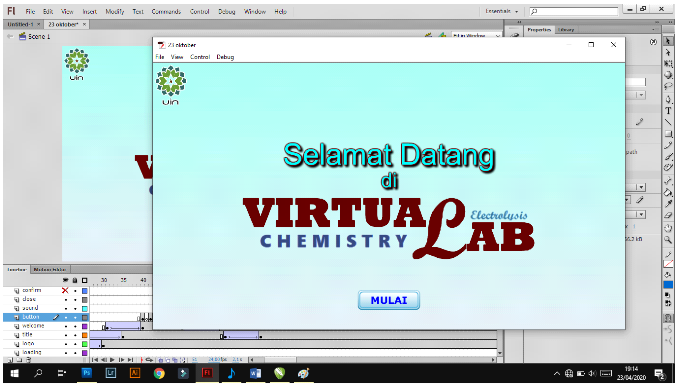

Figure 6: The process trial and error.

Finally display of the virtual laboratory has been created. First display of application is the introduction page which contains the overall identity of the virtual laboratory. The display showed in Figure 8 and 9.

On the introduction page (Figure 8), there is a mulai button which, when clicked, allows users to enter the main menu page (Figure 9). The main menu page provides several buttons such as Instructions, Basic Competence & Learning Objectives, Experiment, SRP Table, Post Lab, Credits and References. These buttons allow the users to enter related pages. The Instruction pages (Figure 10) contain the instruction for operating the virtual laboratory application. After reading it, hopefully the user will operate the

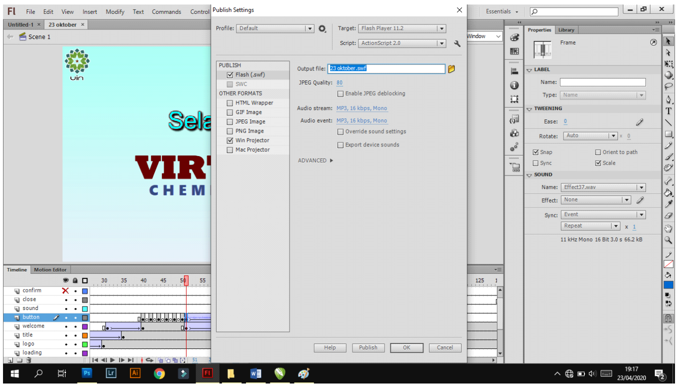

Figure 7: The process exporting to .swf and .exe extension .

Figure 8: The display of introduction page.

Figure 9: The display of main menu.

application more easily. The experiment page, PRS table and post lab page showed in Figure 11, 12, and 13.

On the Eksperimen page (Figure 12), there are buttons which direct the users to virtual practices they want to perform in the application, guide them through the process of learning electrolysis concepts with microscopic, submicroscopic and symbolic visualizations. Once the users finish their practices, they are asked to fill in the Hasil Reaksi (Reaction Results) column by dragging answers they choose into the column. The users may use the PRS (or Standard Reduction Potentials) table to assist them in answering

Figure 10: The display of instruction pages.

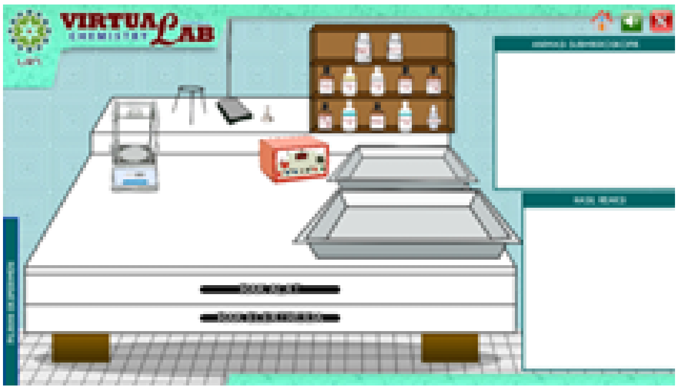

Figure 11: The display of experiment page.

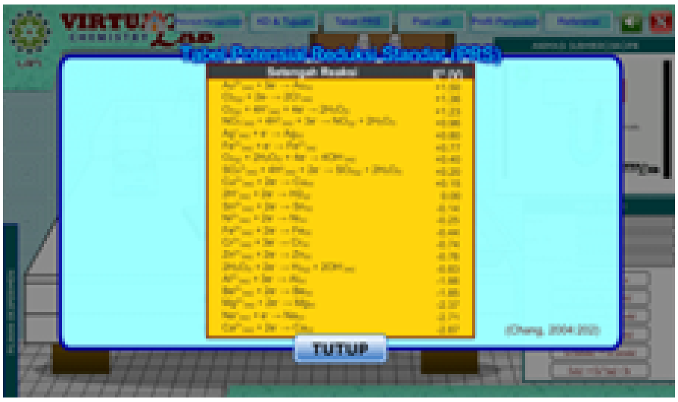

Figure 12: The display of prs table.

the Hasil Reaksi column. The PRS Table (Figure 13) contains information regarding the reduction potentials values from various metals to help the users in their practices and attempt to fill in the Hasil Reduksi column with their answers.

The Post Lab page (Figure 14) contains evaluative questions regarding the electrolysis practices the users have performed in the virtual laboratory. It is aimed to measure

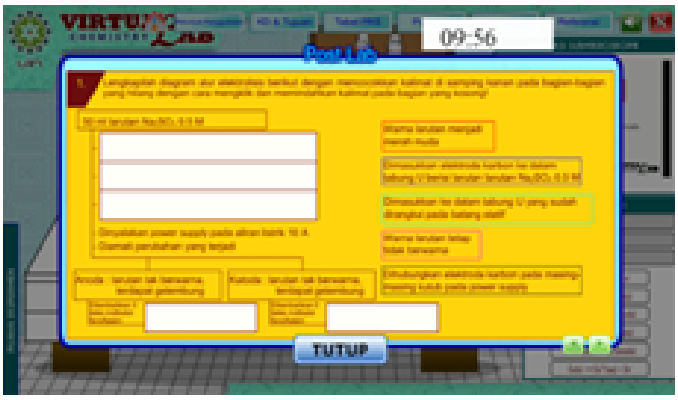

Figure 13: The display of post lab page.

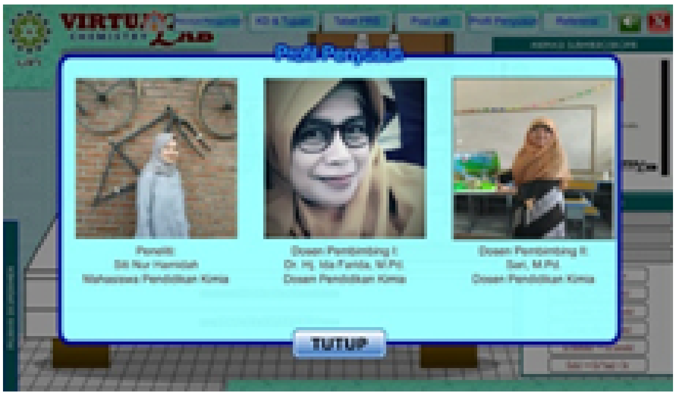

Figure 14: The display of credits page.

Figure 15: The display of references page.

the users' accomplishment of the learning objectives after using the virtual laboratory. The Credits menu (Figure 15) contains information regarding the developers of the virtual laboratory application. The References menu (Figure ??) contains information regarding the sources and references used during the development of the chemical representations oriented virtual laboratory in electrolysis practices.

Based on the results of the feasibility test through relevance indicators regarding the materials, product efficiency, media flexibility and visual communication, the average score of the application is 88.91%. This shows that virtual laboratories are able to visualize electrolysis with macroscopic, submicroscopic and symbolic representations.

4. CONCLUSION

The chemical representations oriented virtual laboratory is an interactive learning media which facilitates the electrolysis learning with the macroscopic, sub-microscopic and symbolic representations. It helps users in developing their understanding towards electrolysis processes more effectively. The results of feasibility test show that the virtual laboratory is feasible enough to be used as a learning media.

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