

MEDIA DEVELOPMENT: VIRTUAL LABORATORY BASE ON STRUCTURED INQUIRY IN ACID BASE TITRATION

Nurmal Wanida
Graduate School, Universitas Negeri Yogyakarta
Yogyakarta - Indonesia

Prof. Dr. Sri Atun
Faculty of Mathematics and Natural Science, Universitas Negeri Yogyakarta
Yogyakarta- Indonesia

Abstract

This study aimed to develop and determine the feasibility of virtual-based laboratory media containing acid-base titration materials. The development model used in this study is the research and development carried out by Borg and Gall. Consists of 7 stages of the R & D development model, including; research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, final product revision. The instrument used in this study is a questionnaire used to obtain data input for products, and quantitative scores as the value of media feasibility. The results of the media expert's assessment were 100%, material experts 93.33%, and student responses were 84.87%. Therefore, laboratory media included in the category of feasibility, can be used as a medium of learning for middle school students.

Keywords: Development, Virtual Laboratory, Structured Inquiry, Acid-base titration.

INTRODUCTION

Chemistry was considered a challenging lesson because of the difficulty in building abstract concepts (Ayas and Demirbas, 1997). The results of research from Akani (2017) show that out of 18 chemical topics, there are 8 chemical topics that are considered difficult, among others; acid base titration, analysis of qualitative chemical reactions, reaction rates and effects of energy, nonmetallic and metal compositions, chemical applications, nuclear chemistry and astronomical chemistry. In line with this, Sheppard (2006) explained that the biggest difficulty in acid-base titration material is that students are less able to connect the acid-base concept accurately, lack of understanding of students about the underlying chemistry and not understanding about the microscopic form of the material.

One of alternative that can be used to support facilities and infrastructure in practicum is by using virtual laboratory learning media. Virtual laboratories can also help in visualizing various abstract concepts so that to deepen students' understanding (Faour and Ayoubi, 2018). Dangerous experiment can be carried out safely through a virtual laboratory. Virtual laboratories allowed students to repeat wrong experiment or incomprehensible practices so that they can deepen the experience and understanding of students (Scheckler, 2003).

Virtual laboratory was software that can simulate practical activities and provide various kinds of alternative practices (Sampaio et al., 2014). Chen (2010) defined virtual laboratories as a simulation environment where students interact with virtual equipment and materials and conduct experiments on computers. Virtual laboratories provided meaningful virtual experiences for students and present important concepts, principles and processes. By using a virtual laboratory, students have the opportunity to repeat the wrong experiment or to deepen the desired experience (Dalgarno et al., 2009). An example of a virtual lab is a collection of digital simulations supported by discussion forums, video demonstrations, glossary terms, and lists of emails organized in the World Wide Web format (Scheckler, 2003)

Virtual laboratories simulate real environments and laboratory processes, and are defined as the learning environment of learners, thus transforming their theoretical knowledge into practical knowledge by conducting experiments (Woodfield, 2005). Virtual laboratories help students to practice and explore phenomena that cannot be done in conventional lab, due to the lack of available laboratory tools and materials. The main advantages of virtual laboratories are not only related to time, space and resources. Virtual laboratory is software that provides various kinds of alternatives to carry out an activity. In addition, this application is not limited by the lack of any facilities or resources (Sampaio et al., 2014). Tatli and Ayas (2013) in their study showed that virtual laboratories were at least as effective as real laboratories, both in improving student learning outcomes and in the ability of students to recognize laboratory equipment.

Not only the appropriate media selection but also a learning model that can involve students in the learning process is needed so as to maximize learning outcomes and activeness of students (Coffman, 2009: 2). Structured inquiry is one of the learning models that creates a pleasant atmosphere so students are motivated to learn and provide opportunities to build and develop their understanding (Kuhlthau et al., 2007: 6). Structured inquiry is a student-centered learning model, so students can actively participate in the learning process. Thus, it can be said that in a structured inquiry process students try to find concepts using their intellects so that learning is more meaningful (Salim and Tiawa, 2015).

It was proven by the results of Nurrokhmah and Sunarto's (2013) explained that the use of inquiry-based virtual laboratory media could make learning more interesting, increase interest in learning, and help understand the concepts taught. There is a positive interaction between the application of structured inquiry learning models using interactive learning technology for student understanding (Salim and Tiawa, 2015). The used of structured inquiry learning models also has a positive impact on improving understanding, science process skills and attitudes of students (Koksal and Berberoglu, 2014).

METHOD

This research used research and development (R & D) method. Borg & Gall (1983: 772) described research and development representing the processes used to develop and validate educational products. This study used the development model Borg & Gall which consists of a 7 stages R & D development model, including; research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, final product revision.

The instrument used is the media and material expert validation sheet. The validation instrument is in the form of a questionnaire that uses a scale of 1-3 with the following provisions: 1: not worthy to use, 2: worthy with revision, 3: worthy without revision (Lawshe, 1975). Media validation is carried out by media experts with aspects of presenting media and software. While the material expert validation consists of aspects of learning design, material and language. The assessment sheet provided aims to see the response of students to the learning media developed. Assessment of product readability consists of two aspects, namely aspects of learning and display/operational media.

Qualitative and quantitative data obtained from the results of expert judgment and student responses as the basis for revising products, the average score obtained from expert judgment and student responses is then compared with the media validation category according to ideal assessment criteria (Widoyoko, 2009). Described in Table 1.

Table 1: Ideal Assessment Criteria

No	Score Range (i)	Category
1	$\bar{X} > \bar{X}_i + 1,8 S_{bi}$	Excellent
2	$\bar{X} + 0,6 s_{bi} < \bar{X} \leq \bar{X}_i + 1,8 s_{bi}$	Good
3	$\bar{X}_i - 0,6 S_{Bi} < \bar{X} \leq \bar{X}_i + 0,6 s_{bi}$	Enough
4	$\bar{X}_i - 1,8 S_{Bi} < \bar{X} \leq \bar{X}_i - 0,6 s_{bi}$	Poor
5	$\bar{X} \leq \bar{X}_i - 1,8 s_{bi}$	Very poor

Note: \bar{X} = empiric score; \bar{X}_i = $\frac{1}{2}$ (ideal max score + ideal min score); s_{bi} = $\frac{1}{6}$ (ideal max score - ideal min score)

RESULT

Practicum in structured inquiry-based virtual laboratory media consisting of 3 experiments and 6 sub-acid-base titration trials and 6 explanations in each lab. The first practice about strong acid titration and strong bases, second practicum about strong base titration with weak acids, and the third practicum about titrating strong acids with weak bases. Whereas the explanation menu contains an explanation of the submicroscopic titration process. With this explanation, students are not only able to understand the acid-base titration material on a macro basis but also submicroscopic. The syntax of the inquiry learning applied in the media models were adapted from Eggen and Kauchak (2012); Borich (2017); and Llewellyn (2011). The results of synthesis of inquiry steps are phase identification problems, formulating problems, making hypotheses, collecting data, proving hypotheses, concluding. In the problem identification phase, the teacher gives a problem or question to encourage students to build an investigation, then students formulate problems in the form of questions. The formulation of the problem is answered by students by making a hypothesis. Data is collected from various sources to answer the hypothesis. Next, experiment to prove the hypothesis so that answers to the problems given by the teacher will be found.

Developing Preliminary Form of Product

Structured inquiry-based virtual laboratory media developed to produce devices that can be used on computers / laptops. This stage is done by compiling content in the form of practicum on acid-base titration material and evaluation questions which will be incorporated into structured inquiry-based virtual laboratory media. The results of structured inquiry laboratory media that have been made can be seen in Figure 1, Figure 2, Figure 3 and Figure 4.



Figure 1: Main Menu Virtual Laboratory Media based on Structured Inquiry



Figure 2: Practical Menu for Acid-Base Titration

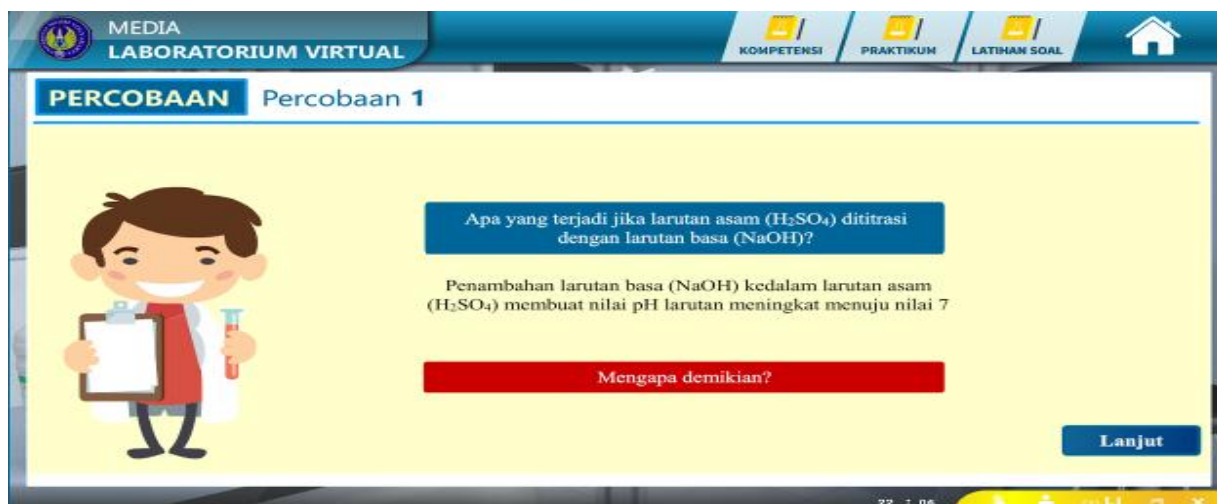


Figure 3: Menu for Practical Descriptions

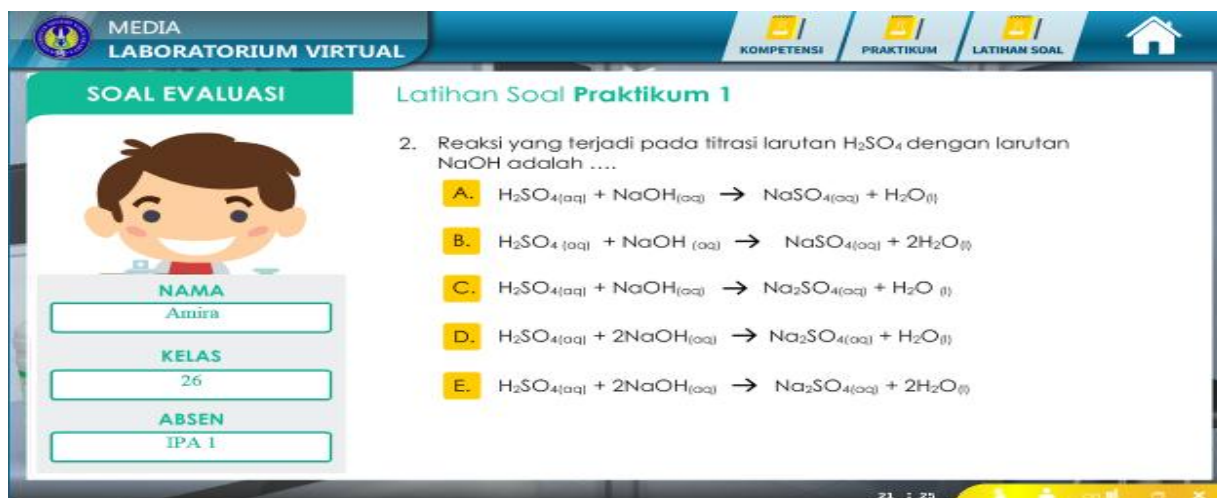


Figure 4: Evaluation Questions

An assessment of the media was carried out to find out the feasibility of the media. Aspects assessed were in the form of aspects of learning, material and language by material experts and assessment of audio visual aspects, software by media experts. The results of the assessment can be seen in Table 2 and Table 3.

Table 2: Media quality assessment by material experts

No	Aspects	Score	Quality
1	Learning	2.42	Good
2	Material	3	Excellent
3	Language	3	Excellent

Table 3: Media quality assessment by media experts

No	Aspects	Score	Quality
1	Visual and Audio	3	Excellent
2	Software	3	Excellent

This stage is carried out by a preliminary field testing consisting of 12 trial subjects (Borg & Gall, 1983: 775). As many as 12 students were chosen with different abilities to find out the responses of students to the media developed. The responses obtained are revised material in the next stage. The results of student responses can be seen in Table 5. The whole percentage of material experts, media experts and student responses can be seen in Figure 5.

Table 4: Readability assessment by students

No	Aspects	Score	Quality
1	Learning aspect	3,29	Good
2	Display aspect	3,5	Excellent

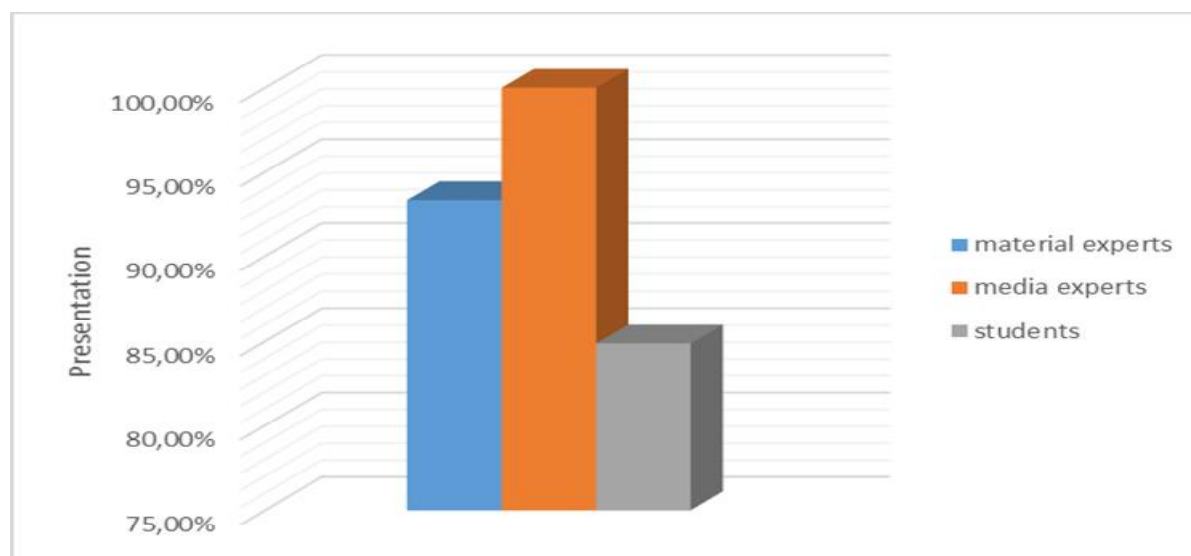


Figure 5: Presentation assessment media by material experts, media experts and students

DISCUSSION AND CONCLUSION

Development of laboratory media to help problems that occur in schools that have a lack of tools and lab materials. The results of the selection of material experts and media experts on the laboratory media developed excellent reached 93.33% and 100%. The response of students to virtual laboratory media is good 84.87%, making students very enthusiastic about learning media that can support the

learning process. The media developed consists of structured inquiry-based virtual laboratory media. Structured inquiry models that are used can help active students and increase students' interest in chemicals (Coffman, 2009: 2). There are three experiments in virtual laboratory media, consisting of six experiments and two practical explanations. Practicum given to students to complete step by step practicum in groups. Virtual laboratories help students work independently and collaboratively and do not have to help with time, chemicals and laboratory facilities (Herga et al., 2014).

Practicum in virtual laboratory media requires students to think and increase collaboration in completing practical steps, recording observations and making conclusions with the guidance of the teacher. Students think that the animation used in this program helps them to be better understand and remember information. So that there is a positive attitude of students towards learning with virtual laboratories (Herga et al., 2014).

Steps The inquiry model used is incorporated into virtual laboratory media so that it does not only display the media but is integrated with the inquiry structure model. Students have difficulty understanding sub-microscopic levels because they are beyond their vision. Virtual laboratories help to understanding the submicroscopic level by visualizing abstract material. So that student learning outcomes can be improved with the help of virtual laboratory media (Herga et al., 2015; Boujaoude and Jurdak, 2010). The 18 chemical topics there are 8 chemical topics that are considered difficult, one of which is acid base titration material. One of the biggest difficulties in acid-base titration material is that students do not understand the microscopic form (Sheppard, 2006; Akani, 2017).

Practicum with the help of virtual laboratory media has a significant impact on student learning processes and leads to more quality learning (Ostroukh and Nikolaev, 2013). Students will better understand the concept, interest learning increases and learning is more interesting (Nurrokhmah and Sunarto, 2013; Faour and Ayoubi, 2018) because virtual laboratory media developed visualize abstract concepts, similar to real labs and made as attractive as possible with the appearance of colors and practical activities. Another advantage of the development of virtual laboratory media based inquiry is that it has a positive effect on students' achievements and attitudes (Tüysüz, 2010). Development of laboratory virtual laboratory media refers to problems faced such as facilities and infrastructure, lack of practicum time and security issues (Faour and Ayoubi, 2018; Chu, 2000). Virtual laboratory media can be an alternative in solving the problem. The practicum time needed is more efficient with the use of virtual laboratory media (Winkelmann et al., 2014).

Virtual laboratories can provide a learning environment that motivates students, forms of learning that are more active, and offers more individualized and independent learning (Chu, 2000). According to Hawkins (2013) research, virtual laboratories are as good as real laboratories. but real laboratory practices teach techniques better than virtual laboratories, techniques can be taught incorrectly if students are not observed and corrected during the lab. While virtual laboratories help students learn concepts. Virtual laboratories and real laboratories can create constructivist learning environments related to their material and activities. both have their weaknesses and strengths, to maximize the learning process, virtual laboratory activities and real laboratory activities can be combined (Widodo et al., 2017).

BIODATA AND CONTACT ADDRESSES OF AUTHORS



Nurmal Wanida is a student of Chemistry Department, Graduate School, Yogyakarta State University, Indonesia. My interest researches are educational media development in learning chemistry, implementation media in chemistry learning, teaching and learning, various chemistry teaching method.

Nurmal Wanida, S.Pd.
Graduate School, Universitas Negeri Yogyakarta
Yogyakarta- Indonesia
E. Mail: nurmalwanida94@gmail.com



Sri Atun is a lecturer and researcher in Chemistry Department, Faculty of Mathematics and Natural Science, Yogyakarta State University, Indonesia. Her interest of researches are educational media development based technology in chemistry teaching learning, the effect of Technological Pedagogical and Content Knowledge (TPACK), Science Environment Technology Society (SETS), method development based inquiry and discovery in chemistry teaching learning.

Prof. Dr. Sri Atun
Faculty of Mathematics and Natural Science, Universitas Negeri Yogyakarta
Yogyakarta - Indonesia
E. Mail: sriatun@uny.ac.id

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