

PRELIMINARY STUDY: CHEMISTRY LABORATORY VIRTUAL INNOVATION AS AN OPTIMIZATION OF SCIENCE LEARNING DURING THE COVID-19 PANDEMIC

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ABSTRACT

The purpose of this research is to conduct a preliminary study to create a virtual chemistry laboratory innovation to optimize learning during the Covid-19 pandemic in the Natural Science Education Study Program of the Teacher Training and Education Faculty Universitas Sebelas Maret (FKIP UNS). The Natural Science Education Study Program of FKIP UNS itself teaches chemical concepts that require laboratory activity. This study used the descriptive qualitative method. Data was collected using observation, interviews, and analysis of related documents and equipped with a Focus Group Discussion (FGD) with students and lecturers (Science Education and Chemistry Education FKIP UNS). The results showed that 11 chemistry practicums required virtual laboratory innovation in the Natural Science Education Study Program of FKIP UNS due to restrictions on the use of laboratories by the campus. It was concluded that a virtual chemistry laboratory was needed as an alternative to student practicum activities to maintain and optimize laboratory skills in online learning. In addition, the developed virtual laboratory needs to be embedded online and can be accessed through various gadgets so that it can be used anytime and anywhere.

Keywords: *a preliminary study, virtual chemical laboratory, science learning, Covid-19.*

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Introduction

The Corona Virus Disease or Covid-19 pandemic has occurred since 2019 has had an impact all over the world, including Indonesia. Based on data from the Ministry of Health of the Republic of Indonesia (Kemenkes RI, 2020), confirmed cases of Covid-19 on August 31, 2020, were 174,796 people with 7,417 deaths. With these data, Indonesia has the second-highest number of cases in ASEAN after the Philippines.

The high number of Covid-19 cases in Indonesia has prompted the government to issue policies to suppress the spread of the virus by implementing restrictions in the form of physical distancing and social distancing (Yamali & Putri, 2020). Changes in community activity patterns have resulted in the emergence of new problems that have severe impacts in the fields of Economics, Health, Social, and other fields, without exception in the field of Education (Quezada et al., 2020).

Based on Circular Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period for the Spread of Covid-19 (Kemendikbud, 2020), every education unit in Indonesia is encouraged to organize online learning. The implementation of online learning is based on the importance of physical and mental health for educators, students, and all citizens at the primary, secondary, and even university levels.

Sebelas Maret University (UNS) is one of the academic units that participate in applying restrictions on the implementation of campus activities that can cause crowds and replace them with other methods under the development of the situation. It is based on UNS Circular Number: 1480/UN27/HK/2020 concerning Early Alertness, Preparedness, and Anticipatory Measures to Prevent the Spread of Covid-19 Infection at UNS. (UNS, 2020) which contains several points, including 1) An appeal for UNS campus residents to implement a healthy lifestyle according to the direction of the Ministry of Health of the Republic of Indonesia; 2) Changing the form of face-to-face lectures into online learning (on-line learning systems) and limiting laboratory practice, clinical practice, field practice, industrial practice, and practice in various institutions; 3) Rescheduling of research and community service activities involving community activities; 4) Postponing the implementation of various activities that cause large crowds of people; 5) Postponing or rescheduling trips abroad, and 6) An appeal for all campus residents not to travel within the country

that is not essential. Each implementing component in the UNS environment must adapt in carrying out its duties and functions with these points.

Science Education is one of the Study Programs at the Faculty of Teacher Training and Education at Sebelas Maret University, which this policy affects. The thing that has the most impact is the change in online learning methods and restrictions on practicum activities in the laboratory. The Science Education Study Program FKIP UNS itself, in its lectures, often applies practical methods in the laboratory. With the online learning policy and restrictions on laboratory access, practicum lectures have been changed to other methods or even abolished.

The Science Education Study Program FKIP UNS teaches science or science disciplines that are closely related to the disciplines of physics, mathematics, biology, and even chemistry in an integrated manner. Chemistry is one of the concepts in science learning that often uses laboratory practicum. It is due to the effectiveness of students' understanding when chemistry concepts are explained through practical learning. Baeti et al. (2015) and Aeni et al. (2017) stated that chemistry concepts taught through various laboratory practicums would increase students' cognitive values and laboratory skills (laboratory skills) because it is essential to have laboratory activities in chemistry learning.

Activities in a virtual laboratory can trigger the learning environment and make it more constructive. Activities in virtual laboratories are different from real laboratories. The thing that distinguishes it is that the virtual laboratory emphasizes the interaction of variables that produce outcomes (Widodo et al., 2017). Virtual laboratories are the best solution for presenting laboratory activities to students to carry out practical activities using computer software. Furthermore, virtual laboratories help students repeat the experiment several times without significant danger (Aljuhani et al., 2018).

However, a policy limiting the use of laboratories in the UNS environment has forced the Science Education Study Program of FKIP UNS to find alternative solutions to keep these activities running. Based on the results of interviews with several lecturers of the Science Education Study Program, FKIP, that in delivering the concept of chemistry in science learning, it is necessary to have alternative practicums that can be applied through online learning and continue to optimize student laboratory skills, for example in

the form of virtual laboratories. Based on the observations, there are no virtual laboratories owned by lecturers or the study program itself. For this reason, a virtual chemical laboratory innovation was carried out to optimize learning during the Covid-19 pandemic at the Science Education Study Program FKIP UNS. This article will describe a preliminary study in the virtual innovation effort of the chemistry laboratory as the first step in research.

Research Methods

Chemical laboratory virtual innovation to optimize learning during the Covid-19 pandemic at the Science Education Study Program FKIP UNS is included in Research and Development. Currently, the research is still in the preliminary study stage.

The preliminary study in this RnD research used a qualitative descriptive method. The research instruments used were observation checklists, interview guidelines, and focus group discussion (FGD) minutes. Methods of data collection and data analysis were carried out in 4 ways. First, document analysis (content) in Curriculum and Semester Learning Design of the Science Education Study Program FKIP UNS. Second, virtual observation of chemical laboratories inside and outside the UNS environment based on three indicators (Science/Chemistry content suitability, ease of access, and interactivity).

Third, interviews with related parties, namely, four lecturers of the Science Education Study Program, one lecturer of the Chemistry Education Study Program, three students from the Science Education Study Program, two students from Chemistry Education FKIP UNS, and one person from the campus ICT unit. Finally, a Focus Group Discussion with 2 Chemistry Education students, 2 Science Education students, 9 Science Education lecturers, and one lecturer from Chemistry Education FKIP UNS.

The data obtained will be analyzed descriptively qualitatively, namely, the data collected from the data collection process in interviews, discussions, and observations of the RPS document for the Science Education Study Program FKIP UNS and virtual chemistry laboratories inside outside the UNS environment.

Result and Discussion

Data collection is done through document analysis, observation, interviews, and Focus Group

Discussions as a preliminary study of the need for virtual innovation of chemical laboratories in the Science Education Study Program, FKIP UNS. The document (content) analysis stage is carried out on the curriculum document and Semester Learning Design (RPS) Science Education Study Program FKIP UNS to determine the number of courses that apply practical learning in the laboratory. Based on the analysis, several courses carry out practical activities in learning chemical concepts. The details of these courses can be seen in Table 1.

Table 1. Courses of Chemical Concepts with Laboratory Activities.

No	Course	Chemistry Concept (Laboratory Activity)
1	Basic Chemistry	Thermochemistry Chemical equilibrium Carbon Chemistry
2	Redox and Electrochemistry	Reduction Potential Application of Electrolysis in Daily Life Applications of Electrochemistry/Electrolysis in Industry
3	Geoscience	Factors Affecting Reaction Rate
4	Science Instrumentation	pH Measurement Instrument
5	Units and Measurement of Objects	Measurement in Chemistry
6	Science Lab Management	Identification of Chemicals and Their Properties
7	Food Chemistry	Proximate Analysis

Based on the data in Table 1. It is known that there are seven courses, namely, 1) Basic Chemistry; 2) Redox and Electrochemistry; 3) Geoscience; 4) Science instrumentation; 5) Unit and Measurement of Objects; 6) Science Lab Management, and 7) Food Chemistry. Of the seven courses, there are 11 chemical concepts taught through a practicum in the Science Education Study Program FKIP UNS including, 1) Thermochemistry; 2) Chemical Equilibrium; 3) Carbon Chemistry; 4) Reduction Potential; 5) Application of Electrolysis in Daily Life; 6) Application of Electrochemistry/Electrolysis in Industry; 7) Factors Affecting Reaction Rate; 8) PH Measurement Instruments; 9) Measurement in Chemistry; 10) Identification of Chemicals and their Properties, and 11) Proximate Analysis.

With the online learning policy and restrictions on using laboratories, the 11 chemical concept practicums have been changed using other

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methods or even eliminated. For this reason, a virtual laboratory is needed as an alternative to these problems. Based on research by Aliyu & Talib (2019), virtual laboratories can improve students' understanding and achievement in learning chemistry. The virtual laboratory also functions as a complement to practical activities in a real laboratory. Supported by Maksun & Saragih (2020) research, virtual laboratories can solve problems using real laboratories. However, virtual laboratories are only complementary and cannot fully replace real activities in the laboratory. Hauriyah et al. (2019), in their research, said that there was a positive influence of virtual laboratories in practicum activities on students' laboratory skills. Based on these studies, it can be concluded that virtual laboratories can be applied as an alternative solution (not a substitute) for the limitations of using real laboratories. The existence of a virtual laboratory can have a positive influence on maintaining the laboratory skills of students.

Another data collection stage is by observing using an observation checklist instrument based on three indicators (Science/Chemistry content suitability, ease of access, and interactivity). It is done to find a virtual laboratory reference that can be used or utilized by the Science Education Study Program in online chemistry learning. The observations in various information systems owned by FKIP and UNS did not find any embedded virtual laboratories. Observations were then continued outside the UNS environment. The results obtained are several websites that provide virtual laboratories suitable to be implemented in the Science Education Study Program. The list of these websites can be seen in Table 2.

Table 2. Virtual Laboratory Provider Website

No.	Name of Website	Link
1	Phet Colorado	phet.colorado.edu
2	Olabs	olabs.edu.in
3	Laboratorium Maya	vlab.belajar.kemdikbud.go.id
4	Labster	labster.com
5	Virtual Labs	vlabs.co.id

Table 2. shows that five websites provide virtual laboratories, namely, 1) Phet Colorado; 2) Olabs; 3) Virtual Laboratory; 4) Labsters; and 5) Virtual Labs. These five websites provide virtual practicums on chemical concepts needed by the Science Education Study Program, FKIP UNS, according to the data in Table 1. These websites provide virtual laboratories equipped with theories,

procedures, and discussions of the observational data obtained. From the results of this observation, visuals are obtained from the virtual laboratory that has been created, which will then become a reference for the development of a virtual chemistry laboratory for the Science Education Study Program, FKIP UNS.

Data collection through interviews was carried out with lecturers and students from the Science Education and Chemistry Education Study Program, FKIP UNS. 4 lecturers from the Science Education Study Program, one lecturer from the Chemistry Education Study Program, three students from the Science Education Study Program, and two students from the Chemistry Education FKIP UNS, and one person from campus ICT unit) the result is that there is a need for a virtual laboratory to implement chemistry concept learning. Students and lecturers responded positively to the virtual laboratory innovation plan. Then continued interviews with the FKIP UNS ICT unit showed that it could embed a virtual laboratory on the FKIP UNS Science Education Study Program (<https://ipa.fkip.uns.ac.id/>) and the ICT party was willing to provide access to the website server. The advice given by the ICT FKIP UNS is to develop a virtual laboratory using software with HTML output to be embedded on the Study Program website.

The Focus Group Discussion was conducted with 14 participants consisting of 2 Chemistry Education students, 2 Science Education students, 1 Chemistry Education lecturer, and nine lecturers from Science Education FKIP UNS. This FGD was held virtually through the Zoom Meeting application on September 24, 2021, discussing technical matters needed to develop a virtual chemistry laboratory.



Figure 1. FGD with Lecturer

Chemistry Laboratory Virtual Innovation

the laboratory to optimize the student's laboratory skills.

The most suitable solution is the development of a virtual laboratory because it is considered the most effective alternative to online practicum. Research conducted by Ismail et al. (2016) states that virtual laboratories can be applied as an alternative to practical learning, and in practice, virtual laboratories can improve students' scientific literacy. In addition, research conducted by Akaike et al. (2012) states that interactive practicum simulations in the medical field can increase students' confidence because they are not afraid to make mistakes. In addition, the interactive practicum simulation can improve laboratory skills if done correctly.

Alneyadi (2019) adds that virtual laboratory student activities can improve scientific knowledge, science process skills, cognitive abilities, attitudes, and innovation. It shows the important role of using virtual laboratories as a support for teaching and learning activities. Aljuhani et al. (2018) added that laboratory activities play an essential role in supporting science learning through experimental activities and providing problems to encourage understanding the content being trained. The use of virtual laboratories indicates a positive impact on students. The application of technology can improve teaching and learning processes and support science education by providing an interactive learning environment for students.

Virtual laboratories provide advantages in the teaching and learning process. First, virtual laboratories improve students' conceptual understanding (Faour et al., 2018; Alneyadi, 2019). Second, it gives a significant effect compared to the demonstration method in real laboratory applications (Faour et al., 2018). Third, it has an impact on students' scientific attitudes (Alneyadi, 2019). Finally, virtual laboratories improve students' perceptions (Aljuhani et al., 2018; Faour et al., 2018; Alneyadi, 2019). Darrah et al. (2014), the results of their research, show that virtual laboratories are more effective than real laboratories. Virtual laboratories are innovative and effective in the learning process, especially in the pandemic era. However, students' motivation to use virtual laboratories needs to be improved (Putra et al., 2021).

Besides being an alternative, virtual laboratories can also optimize and improve student laboratory skills. In addition, the developed virtual laboratory needs to be equipped with interactive simulations, basic theory, procedures, and data



Figure 2. FGD with students

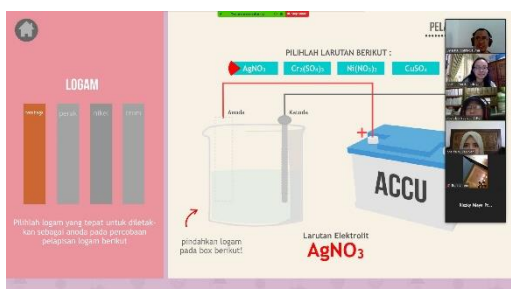


Figure 3. Presentation Virtual Lab 1



Figure 4. Presentation Virtual Lab 2

The discussions conducted at the FGD obtained several inputs: 1) A virtual chemistry laboratory was developed as an alternative to an online practicum. Not a Substitute for practicum in a real laboratory; 2) The developed virtual chemistry laboratory must be interactive so that users can still experience practical activities. It is also to empower students' laboratory skills; 3) The developed virtual chemistry laboratory must be accessible easily, anytime and anywhere; and 4) The developed virtual laboratory must contain simulations, procedures, theories, and discussion of data analysis adapted to the chemistry practicum that has been carried out in the Science Education Study Program, FKIP UNS—making it easier for users to apply in learning.

The policy of limiting activities in the UNS environment due to the Covid-19 pandemic makes the Science Education Study Program FKIP UNS need to provide solutions to deliver online chemistry concept practicum learning. Conclusion: there are seven courses with 11 practicums that need to be carried out even though they cannot use

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analysis. Then it needs to be embedded in a website and can be accessed through various types of gadgets so that it can be accessed easily by lecturers and students anytime and anywhere so that the student learning environment becomes more spacious and enjoyable, which is expected to motivate and encourage students to learn more meaningful content.

Conclusion

Based on the results of data collection and discussion, it can be concluded that there are 11 chemical concepts taught through a practicum in the Science Education Study Program laboratory, FKIP UNS, namely, 1) Thermochemistry; 2) Chemical Equilibrium; 3) Carbon Chemistry; 4) Reduction Potential; 5) Application of Electrolysis in Daily Life; 6) Application of Electrochemistry/Electrolysis in Industry; 7) Factors Affecting Reaction Rate; 8) PH Measurement Instruments; 9) Measurement in Chemistry; 10) Identification of Chemicals and their Properties; 11) Proximate Analysis. Therefore, it is necessary to develop an interactive virtual chemistry laboratory to become an alternative online practicum solution and optimize and maintain student laboratory skills. In addition, the developed virtual laboratory needs to be equipped with interactive simulations, fundamental theories, procedures, and data analysis to facilitate learning. In addition, virtual laboratories need to be embedded in a website and can be accessed through various types of gadgets to be accessed easily by lecturers and students. This research is expected to be the basis for the development of virtual chemistry laboratory innovations that can be used in learning during the Covid-19 pandemic. The results of this study can be used as a reference for other similar studies with different contexts.

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