Effectiveness of Virtual Laboratory Guidelines Based on Academic and Kampus Merdeka

Suryandari[1]*, Khairunnisa[2] ,Meyninda Destiara[2] ,Yusinta Dwi Ariyani[1], Ismanto Ismanto[1], Ruwet Rusiyono[1], Budiman[1]

[1] Universitas Alma Ata, Indonesia
[2] Universitas Islam Negeri Antasari, Indonesia
suryandari@almaata.ac.id

Abstract. In the new normal era along with the closure of the Covid-19 pandemic, face-to-face lectures and real laboratories have been suspended throughout the world. In this condition, digital teaching and resources such as virtual laboratories are alternative learning media that are feasible to apply. Considering that virtual laboratories are relatively web-based digital learning, virtual laboratories are available all the time and are able to provide realistic science skills to students. Due to the emergency adaptation conditions for Covid-19, the implementation of virtual laboratories tends to be carried out in urgent conditions, so they are not managed comprehensively. This research into the development of virtual laboratory guidelines focuses on the need for implementing virtual laboratory learning so that it is right on target in accordance with the needs of academic policies and Merdeka Belajar. The development of this guideline is oriented towards research on the development of the 4D method using questionnaires, interviews, observations and tests. Validation results show that the virtual laboratory guidelines are declared valid with a percentage of 97%. Meanwhile, in small-scale user testing or development stages, virtual laboratory guidelines tested as Highly Capable [90%] are used as a reference for preparing academic documents in preparation for implementing virtual laboratory learning.

Keywords: Development, LKPD, HOTs, Critical Thinking, Fourt Grade of Elementary School.

1 Introduction

Since the Covid-19 pandemic disaster in 2020, the education sector has been faced with an emergency adaptation situation where face-to-face learning has been eliminated. One of the areas of science that is experiencing difficulties is science education where practicums cannot be carried out. This emergency adaptation apparently provides an opportunity for virtual laboratory-based learning to be held in the virtual classroom [1] [2]. This condition has made virtual laboratories become a popular learning medium among practicum learning practitioners [3]. The virtual laboratory itself actually existed long before the pandemic hit the world. However, its use is still relatively rare because the practicum process is facilitated in face-to-face meetings or real laboratories. This

K. S. Rouzi et al. (eds.), *Proceedings of the 1st Alma Ata International Conference on Education (AAICE 2023)*,
Advances in Social Science, Education and Humanities Research 920,
https://doi.org/10.2991/978-2-38476-414-3_11

emergency adaptation certainly provides learning challenges, namely preparation for implementing a virtual laboratory which is carried out in a short time [4] and in urgent conditions [5]. So it cannot be denied that the implementation of virtual laboratories creates obstacles, especially in learning outcomes for students who find it difficult to adapt [6] [7]. Virtual laboratories also provide no less benefits, including being able to be used as a distance learning medium [4] [8], as a medium to hone students' digital literacy [9] [10], as well as as a learning medium that attracts students' interest [11] [12]. In order for these benefits to be realized, good virtual laboratory management is needed. This management is regulated in academic documents such as university academic guidelines, so that the learning process can remain targeted and achieve common goals.

Badan Akreditasi Nasional Perguruan Tinggi [BAN-PT] issued BAN-PT letter Number 2 of 2017 concerning National Accreditation Standards [SAN] which explains that the assessment of Standar Penjaminan Mutu Internal [SPMI] by higher education institutions is the basis for assessing and determining accreditation ranking status [13]. Based on the BAN-PT regulations, it is mandatory for universities to implement SPMI which is one of the higher education academic documents. One of the learning process standards in the National Higher Education Standards explains that learning must be holistic, integrative, scientific, contextual, thematic, effective and collaborative, student-centered [14].

Apart from paying attention to national higher education standards, universities are also adapting to the latest curriculum during the Merdeka Belajar Kurikulum Merdeka [MBKM]. MBKM is a curriculum that provides opportunities for network expansion in study programs in carrying out learning across study programs and even across universities [15]. Apart from paying attention to national higher education standards, universities are also adapting to the latest curriculum during the Merdeka Curriculum or Independent Learning Curriculum [MBKM]. MBKM is a curriculum that provides opportunities for network expansion in study programs in carrying out learning across study programs and even across universities [16]. With regard to digital literacy, virtual laboratories can be a medium in the process of honing related literacy because it involves the use of digital platforms [17].

In the process of preparation and implementation of the laboratory which takes into account academic policies and the Kurikulum Merdeka, a guideline document for implementing virtual laboratories is needed to revitalize technology-based virtual laboratory management [18]. In the process of preparation and implementation of the laboratory which takes into account academic policies and the Merdeka curriculum, a guideline document for implementing virtual laboratories is needed to revitalize technology-based virtual laboratory management

2 Methods

In developing virtual laboratory guidelines based on academic policy and the Independent Curriculum, this research is oriented towards 4D model development research by Thiagarajan.

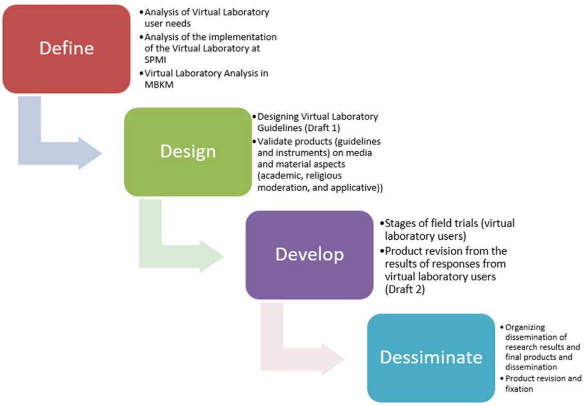

Fig. 1. Research Steps for Development of Virtual Laboratory Guidelines

In carrying out the development stages, this research is based on scientific sources and methods. The initial process of product development involves collecting survey data on virtual laboratory needs which is distributed to respondents in the scope of academic stakeholders, educational practitioners, laboratory assistants and practitioners. This process is a form of identification process step which is used as the basis for compiling components of laboratory guidelines so that they are appropriate and on target.

Next, the virtual laboratory guidelines design stage is carried out. In this stage, the research carried out Focus Group Discussion activities which invited respondents with a similar scope. This Focus Group Discussion is also a research commitment in exploring information and insight in preparing related guidelines. For this reason, the FGD presents experts who are competent in the field of higher education academic documents and virtual laboratories both from within and across universities. After the information and data were extracted, virtual laboratory guidelines were prepared with an attractive design and contained content according to the guidelines' requirements and were made into draft I. Draft I was distributed to 4 validators with similar competency scopes both in media and material. The validation results were analyzed using the validation equation on media and material expert instruments as follows [19].

Table 1. Percentage analysis eligibility criteria

Percentage	Information
80-100	Good/Valid/Decent
60-79	Fairly good/fairly valid/decent enough
50-59	Not good / not valid / not worth it
0-49	Not good [change]

The validation results that have gone through the revision stage are then used as draft II to be distributed to respondents who use the guidelines, namely academic officials at dean level and laboratory assistants. This validation process is an effort to determine the readability value of the guidelines both in terms of material and media [20]. this research. Data from the development stage is measured by the average user score.

By adapting to motivational instruments, the use of guidelines by responses can be converted as an indicator of ability in calculations

$$P = \frac{m}{M} x\ 100\%$$

The variable P is the percentage score for the ability to develop guidelines according to the questions listed on the instrument. Variable m is the score obtained by the respondent after working on the questions, and M is the maximum score, namely 100. The results obtained can be converted into the following criteria

Table 2. Table of Respondent Ability Indicators.

Percentage	Information
$86\% \le P \le 100\%$	Very capable
$72\% \le P < 86\%$	Capable Enough
$58\% \le P < 72\%$	Capable
$44\% \le P < 58\%$	Less Fortunate

Apart from measuring indicators of respondents' ability to use virtual laboratory guidelines, respondents were also given a questionnaire that explored the condition of virtual laboratory guidelines within the scope of practicality consisting of effective, interactive, efficient and creative aspects. Similar to the validation instrument, this practicality instrument is presented in a Linkert scale questionnaire with a score range of 1-5. The final stage in developing this guideline is the step of disseminating the guideline to parties who need it, including academic officials and laboratory managers. The analysis used in this research is quantitative descriptive which analyzes scientific data from 4 stages of development research. In this deployment stage, virtual laboratory guidelines based on academic policies and the Independent Curriculum have been revised according to input from user respondents.

.

3 Result and Discussion

The principle of choosing and acting under certain conditions to determine decisions is a basic ability in carrying out policies [21]. In teaching and learning activities, academic policy is a step to overcome problems regarding educational development. Therefore, academic policies must be based on comprehensive thinking and consider all related parties from graduate users, academic community members and alumni. Academic stakeholder officials must also always consider the identity values of higher education before formalizing academic policies because academic policies are useful as determining references and guidelines in planning and implementing education, research and community service. All of these efforts lead to continuous improvement of academic quality.

From the survey results regarding the need for virtual laboratories, it was recorded that 41% of respondents stated that they strongly agreed with the urgency of virtual laboratories in learning in higher education. The virtual laboratory as a virtual learning process simulation forum is able to create interactions that mutually regulate users [4]. The development of the times that have entered the era of society 5.0 has led to a learning character that adapts to the needs of students. In line with this, various efforts to develop learning documents need to be carried out, one of which is a variant of learning method innovation which is the result of an analysis of learning creativity needs [22]. The creativity of learning that can be done is virtual laboratory learning which is able to create a process of observing, investigating and interpreting findings so it needs to be prepared as well as possible.

Preparation for virtual laboratory learning must be carried out comprehensively so that a virtual laboratory digital platform can be provided in the form of animation media, videos, e-books and so on. Virtual laboratory animations have been developed on various sites or pages, including Go-Lab [9], PhET [23], BASF [11], Practical Circuit Design [24], TinkerCad [25], etc. The laboratory platform was developed unilaterally by the website developer, but there has been no research into the preparation of related virtual laboratory guidelines that suit the academic atmosphere of higher education. Regarding the analysis of the Independent Curriculum, the virtual laboratory has a strategic role if it can be implemented well. To gain insight, Focus Group Discussion activities were carried out and produced the first draft of virtual laboratory guidelines based on SPMI and MBKM.

Fig. 2. Focus Group Discussion

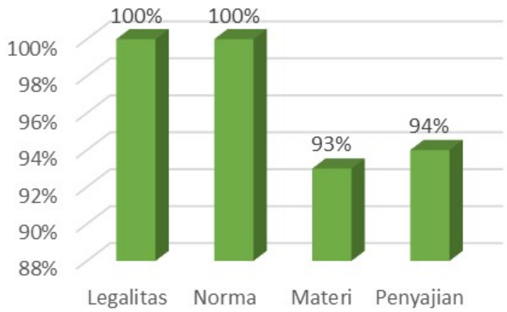

Fig. 3. Validation Graphic

The overall percentage of aspects is at 97% which is equivalent to valid in terms of material and media aspects. Some validator input is oriented towards deeper exploration regarding examples of virtual laboratory platforms that can be used as references. The results of the revision and validation have been made into draft II which is then distributed to users of the guidelines, including dean level academic officials and laboratory managers in science and teacher training programs. This step is a development stage where the results of draft II testing have been carried out quantitative descriptive analysis.

Apart from the benefits of virtual laboratories that have been stated previously, virtual laboratories can have a positive impact on the integrity of students where the process of implementing virtual laboratories will lead students to take responsibility for their virtual laboratory projects [24] [26]. These findings are the motivation for preparing guidelines so that virtual laboratory learning can be carried out optimally. After carrying out the validation process, the guidelines were tested on a small scale on respondents who had capabilities as academic officials and laboratory managers. The trial process instrument consists of 2 instruments, namely practicality and effectiveness instruments. Practical instruments are oriented towards monitoring user satisfaction in effective, interactive, efficient and creative aspects. The results of the survey distribution show that 92% of users agree that practical virtual laboratory guidelines are used as a reference in preparing virtual laboratory learning.

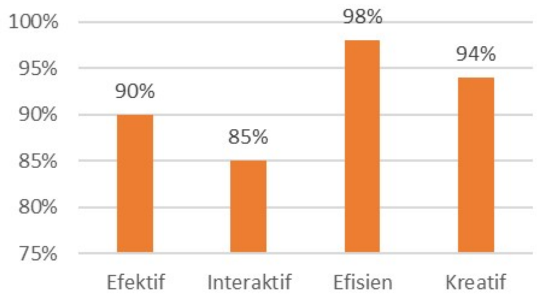

Fig. 4. Percentage Graph of Practical Aspect Trial Results

For effectiveness testing, respondents were asked to answer questions on an instrument consisting of 14 questions regarding needs, facility standards, organizational structure, management, learning planning documents, and practicum implementation documents. Each answer has an answer grid with a maximum score of 100. The results of the analysis show that the lowest score is in the aspects of management and practicum implementation documents. In the management aspect, respondents were asked to develop work rules and safety regulations needed to carry out virtual laboratory practicums. Meanwhile, in the practical implementation document aspect, respondents were asked to create a virtual laboratory module format according to the planned practicum. The scores obtained showed that only 50% of respondents were able to answer correctly in the categories "Able to determine 1-5 points of rules and 1-5 work safety" and "Able enough to develop the required virtual laboratory practicum module format [incomplete learning phase".

The module format in the SPMI and MBKM Based Virtual Laboratory Guidelines refers to the Go-Lab virtual laboratory platform. The factor that makes the practical implementation document aspect the aspect with the lowest score is that the respondent worked independently without integrated discussion with other laboratory managers. In addition, the time for collecting trial data was relatively short, so respondents did not have much time to develop. However, overall, the trial results were effectively used in developing virtual laboratory learning documents by 82%. Therefore, virtual laboratory learning has 2 opposing sides, namely one side has a positive effect because it is able to incorporate technology into learning, but on the other side it provides gaps in misconceptions, because students have to spend time and think about operating the technology rather than understanding the essence of the theory given [27] [28]. Thus, to minimize the negative effects of virtual laboratories, a virtual laboratory learning mechanism is needed that has been prepared comprehensively so that its implementation can be carried out optimally [29] [30].

Table 3. Percentage analysis eligibility criteria.

Aspect	indicator	Max. Score
Virlab Demands	Determine practicums that can use virtual laboratories	5
Facility Standars	Determine the need for facilities that will be provided in the realization of the implementation of the virtual laboratory	5
Organizational structure	Determine the virtual laboratory organization	5
Implementing regulations	Develop virtual laboratory work rules and safety	10
Learning planning document	Develop a learning plan for implementing a virtual laboratory	55
Practical implementation documents	Develop a virtual laboratory practical module format	20

4 Conclusion

The development of this guideline is oriented towards research on the development of the 4D method using questionnaires, interviews, observations and tests. Validation results show that the virtual laboratory guidelines are declared valid with a percentage of 97%. Meanwhile, in small-scale user testing or development stages, virtual laboratory guidelines tested as Highly Capable [90%] are used as a reference for preparing academic documents in preparation for implementing virtual laboratory learning. Virtual laboratory learning mechanism is needed that has been prepared comprehensively so that its implementation can be carried out optimally.

References

1. Handayani NA, Jumadi J. Analisis Pembelajaran IPA Secara Daring pada Masa Pandemi Covid-19. Jurnal Pendidikan Sains Indonesia. 2021 Mar 18;9(2):217–33.
2. Nurliani F, Rahmawati I, Suryandari S. Validity and Students' Responses to Interactive E-Modules Based on Inquiry Learning Assisted by the Virtual Laboratory on Static Electricity. Berkala Ilmiah Pendidikan Fisika. 2023 Sep 30;11(2):230–
3. Suryandari, Singgih S. Video-based learning for "learning from home" solution in pandemic. J Phys: Conf Ser. 2021 Jan;1760(1):012011.
4. Muhajarah K, Sulthon M. Pengembangan Laboratorium Virtual sebagai Media Pembelajaran: Peluang dan Tantangan. Justek : Jurnal Sains dan Teknologi. 2020 Nov 30;3(2):77–83.
5. Glassey J, Magalhães FD. Virtual labs – love them or hate them, they are likely to be used more in the future. Education for Chemical Engineers. 2020 Oct 1;33:76–7.
6. Asih RA, Alief L. Students' experiences and learning objectives: Implications for future online learning. Journal of Education and Learning (EduLearn). 2022 May 1;16(2):226–34.
7. Suryandari, Khairunnisa, Destiara M. Analisis kebutuhan virlabs dalam implementasi kebijakan akademik dan mbkm. Tulip (Tulisan Ilmiah Pendidikan): Jurnal Fakultas Keguruan dan Ilmu Pendidikan. 2023 Sep 21;12(2):120–7.

8. Ersoy M, Kumral CD, Çolak R, Armağan H, Yiğit T. Development of a server-based integrated virtual laboratory for digital electronics. Computer Applications in Engineering Education. 2022;30(5):1307–20.
9. Al-Sarray E. Engagement and authoring platform for teacher and learner of science, Go-Lab portal for learning at school. Journal Port Science Research. 2019 Aug 27;2(1):43–53.
10. Efektivitas Authoring Ils Go-Lab Dalam Menunjang Literasi Digital Pada Merdeka Belajar | Suryandari | Quantum: Jurnal Inovasi Pendidikan Sains [Internet]. [cited 2024 Dec 26]. Available from: https://ppjp.ulm.ac.id/journal/index.php/quantum/article/view/14841/pdf
11. Kismiati DA, Hutasoit LR, Rahayu U. Pengenalan BASF Virtual Lab Sebagai Media Pembelajaran Berbasis Technological Pedagogical Content Knowledge: Sebuah Survei Kepuasaan Guru Sekolah Dasar. Edukatif : Jurnal Ilmu Pendidikan. 2022 Jan 7;4(1):984–92.
12. Kurniawan RA, Rifa'i MR, Fajar DM. Analisis Kemenarikan Media Pembelajaran Phet Berbasis Virtual Lab pada Materi Listrik Statis Selama Perkuliahan Daring Ditinjau dari Perspektif Mahasiswa. VEKTOR: Jurnal Pendidikan IPA. 2020 Jun 14;1(1):19–28.
13. BAN-PT. Peraturan BAN-PT No. 2 Tahun 2017 Tentang Standar Akreditasi Nasional Pendidikan Tinggi [Internet]. BAN-PT; 2017. Available from: https://www.banpt.or.id/wp-content/uploads/2019/05/Exhibit-11-Peraturan-BAN-PT-No-2-tahun-2017-tentang-SAN-Dikti.pdf
14. PERMENDIKBUD-No.-3-Tahun-2020.pdf [Internet]. [cited 2023 Sep 8]. Available from: http://lldikti6.id/wp-content/uploads/2020/06/PERMENDIKBUD-No.-3-Tahun-2020.pdf
15. Home | Merdeka Belajar - Kampus Merdeka [Internet]. [cited 2022 Sep 14]. Available from: https://kampusmerdeka.kemdikbud.go.id/
16. Indarta Y, Jalinus N, Waskito W, Samala AD, Riyanda AR, Adi NH. Relevansi Kurikulum Merdeka Belajar dengan Model Pembelajaran Abad 21 dalam Perkembangan Era Society 5.0. Edukatif : Jurnal Ilmu Pendidikan. 2022 Mar 28;4(2):3011–24.
17. Rahayu R, Rosita R, Rahayuningsih YS, Hernawan AH, Prihantini P. Implementasi Kurikulum Merdeka Belajar di Sekolah Penggerak. Jurnal Basicedu. 2022 May 22;6(4):6313–9.
18. Nulngafan N, Khoiri A. Analisis Kesiapan Dan Evaluasi Pengelolaan Laboratorium Ipa Berbasis Teknologi Di Era Revolusi Industri 4.0. Jurnal Penelitian dan Pengabdian Kepada Masyarakat UNSIQ. 2021 Jan 30;8(1):10–7.
19. Riduwan, Akdon. Rumus dan Data dalam Analisis Statistika. Bandung: CV. Alfabeta; 2010.
20. Irmania N, Rahardjo R, Suyono S. Pengembangan Bahan Ajar Biologi Terintegrasi Imtaq Pada Materi Vertebrata Sesuai Kurikulum 2013 KELAS X SMA. JPPS (Jurnal Penelitian Pendidikan Sains). 2016;5(2):983–90.
21. Wibowo EDE. Kebijakan Mutu Akademik Pendidikan TinggI. Dinamika Sains [Internet]. 2011 [cited 2022 Sep 16];9(20). Available from: http://jurnal.unpand.ac.id/index.php/dinsain/article/view/8
22. Agustina RD, Putra RP, Listiawati M. Development of Sophisticated Thinking Blending Laboratory (STB-LAB) to Improve 4C Skills for Students as Physics Teacher Candidate. Jurnal Penelitian & Pengembangan Pendidikan Fisika. 2022 Jun 30;8(1):65–82.
23. Mashurin AH, Mubarok H, Prahani BK. Profile of Guided Discovery Learning Implementation Assisted by Virtual Lab and Students' Problem-Solving Skills on Gas Kinetic Theory. Jurnal Penelitian & Pengembangan Pendidikan Fisika. 2021 Dec 30;7(2):131–44.
24. Borodai V, Berdnyk L, Kuznetsov V, Tsyplenkov D, Havrylova A. Virtual Laboratory Works in Teaching Practical Circuit Design and Development of Responsibility Component of Students' Academic Integrity. In: Hu Z, Petoukhov S, Yanovsky F, He M, editors. Advances in Computer Science for Engineering and Manufacturing. Cham: Springer International Publishing; 2022. p. 160–9. (Lecture Notes in Networks and Systems).

25. Abburi R, Praveena M, Priyakanth R. TinkerCad - A Web Based Application for Virtual Labs to help Learners Think, Create and Make. Journal of Engineering Education Transformations. 2021 Jan 31;34(0):535.
26. Coenders F, Gomes N, Sayegh R, Kinyanjui I, Noutahi A, Madu N. Class Experiences with Inquiry Learning Spaces in Go-Lab in African Secondary Schools. African Journal of Teacher Education. 2020 Oct 28;9(2):1–22.
27. Makransky G, Terkildsen TS, Mayer RE. Adding immersive virtual reality to a science lab simulation causes more presence but less learning. Learning and Instruction. 2019 Apr 1;60:225–36.
28. de Jong T, Linn MC, Zacharia ZC. Physical and Virtual Laboratories in Science and Engineering Education. Science. 2013 Apr 19;340(6130):305–8.
29. Jong T de, Gillet D, Sotiriou S, Agogi E, Zacharia Z. Designing inquiry learning spaces for online labs in the Go-Lab platform. In 2015 [cited 2022 Jun 30]. Available from: https://research.utwente.nl/en/publications/designing-inquiry-learning-spaces-for-online-labs-in-the-go-lab-p
30. Hoehn JR, Lewandowski HJ. Framework of goals for writing in physics lab classes. Phys Rev Phys Educ Res. 2020 May 11;16(1):010125