

VIRTUAL LABORATORY: USING ELECTRONIC WORKBENCH AS ALTERNATIVE LEARNING PHYSICS IN COVID-19 MASS PANDEMIC

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ABSTRACT

The purpose of this research is to describe the use of assisted virtual laboratories of Electronic Workbench (EWB) in physics experiments learning. The method in this study used (1) calibration of the results of experiments with theory and (2) analysis of user responses to EWB in practicum activities. The study concluded that: 1) EWB is easy to use for practical learning, 2) capacitive reactance values obtained from calculations and observations following the theory (close to the same), 3) the time needed for one-time trial data retrieval until the analysis phase in this practicum activity is 10 minutes means that the experiment with EWB is very efficient. Based on the results obtained indicate that EWB is feasible to use as an alternative to physics learning in the mass pandemic COVID-19.

INTISARI

Tujuan penelitian ini adalah mendeskripsikan penggunaan laboratorium virtual berbantuan Electronic Workbench (EWB) dalam pembelajaran praktikum fisika. Metode yang digunakan (1) kalibrasi hasil eksperimen dengan teori dan (2) analisis respon pengguna terhadap penggunaan EWB dalam kegiatan praktikum. Diperoleh kesimpulan bahwa 1) EWB mudah digunakan untuk pembelajaran praktikum, 2) nilai reaktansi kapasitif yang diperoleh dari hasil perhitungan dan pengamatan sesuai dengan teori (mendekati sama), 3) waktu yang dibutuhkan untuk satu kali pengambilan data percobaan sampai tahap analisis dalam kegiatan praktikum ini adalah 10 menit artinya percobaan dengan EWB sangat efisien. Berdasarkan hasil yang diperoleh menunjukkan bahwa EWB layak digunakan sebagai alternatif pembelajaran fisika di masa pandemi COVID-19.

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I. Introduction

The government has adopted a physical distancing policy in suppressing the broad spread of the co-19 pandemic in Indonesia [1]. The consequence of this policy is that some gathering activities forced to be limited, one of which is an appeal to carry out the process of learning activities both from elementary to tertiary level from home online [2]. Choosing an online learning process requires educators to be more creative in selecting the type of learning and virtual media that will use during the learning process so that learning activities both theory and practice can run effectively and efficiently but still quality.

The selection of effective and efficient virtual practicum media is to consider several factors, including internet networks, computer specifications, digital literacy of students and learning time, because some of these are the main factors for the success of online learning to be carried out [3], [4]. Virtual practicum media is a device that helps students interact with experiments or activities that do not have direct physical reality but can work almost the same as the original [5], [6]. An example of a virtual laboratory that meets these criteria is the Electronic Workbench (EWB) software.

EWB chose with consideration of having all the components needed in online learning. This software can run without an internet network (offline), this software can be run on a computer with low specifications, easy to use because it only uses the click and drag concept, so it does not require a long time to apply. The results of previous research, this software recommended in learning activities. Its application is proven to be able to increase the productivity of students in learning, effective in engaging understanding concepts and helping students verify the theory by independently experimenting at home [7]–[9]. However, from some of the research conducted, this software is only utilized to introduce electronic circuit simulations that no one has used to test the characteristics of components and theories in physics learning; besides, the potential for online learning in sync with this software has not utilized.

II. Research Methodology

This research aims to describe the potential of virtual laboratories with the assistance of EWB in fundamental physics practicum. The research methods are 1) analysis of user responses to the use of EWB using the ease of perception questionnaire and time efficiency questionnaire. 2) calibration of the capacitive reactance theory. The response data collected through the Perceived Ease of Use questionnaire with five statements included 1) I find it easy to learn EWB, 2) I need a lot of consultation in operating EWB, 3) I can easily remember what what has been done with EWB, 4) I feel frustrated when using EWB, 5) I feel proficient after using EWB once [10]–[12]. Calibration applies by comparing the results of capacitive

reactance values applied to the series of experimental and calculation results. The capacitive reactance equation used is:

$$X_C = \frac{1}{2\pi fC} \quad (1)$$

The capacitive reactance experiment shown in Figure 1 performed virtually using the EWB application, making The capacitive reactance experiment shown in Fig performed using EWB.

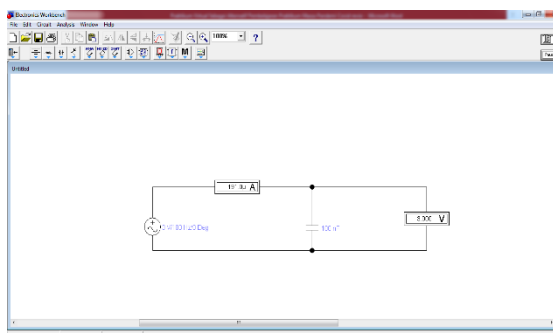


Figure 1. the series of capacitors on EWB

The process of making a circuit is quite simple, just simply clicking and dragging on the component screen used. The circuit is quite simple, just simply clicking and dragging on the component screen used. Setting the component specifications used are done by right-clicking on the component select the component properties set as needed, including the input voltage, frequency, capacitor capacity, and a voltmeter and amperemeter in AC mode. Click the power button on the right corner of the screen to run a circuit simulation. The magnitude of the capacitive reactance value results from the distribution of the experimental data output voltage and current from the simulation-based on Ohm's law concept. The trial process carried out by applying the frequency range from low to high, which shown so that it can plot a graph of the relationship between frequency and capacitive reactance.

III. Results and Discussion

EWB Use Facility in Learning

The EWB simulation application is effortless to use, only uses the concept of clicks and drags on components to be made in series. That can work according to the original device, four measuring tools with necessary analytical skills, four sweeping analyzes, two high-level analyzes, and two statistical analyzes[13], [14].

This software can operate on PCs with specifications that tend to be low, namely with 50MB hard drive specifications, 1GB RAM, Windows7 32 bit, screen resolution of 800 x 600 [15]. This small operating system makes software tend to run when

integrated with video conversion applications such as Google Meet so that virtual practicum activities can carry out with synchronous online approaches. The form of testing a virtual laboratory activity with this approach can see in Figure 2.

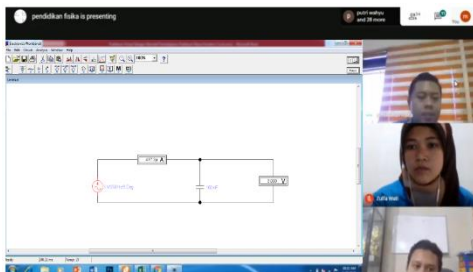


Figure 2. Testing integration of EWB with google meet

Response data collected through the Perceived Ease of Use questionnaire with five statements can see in Figure 3.

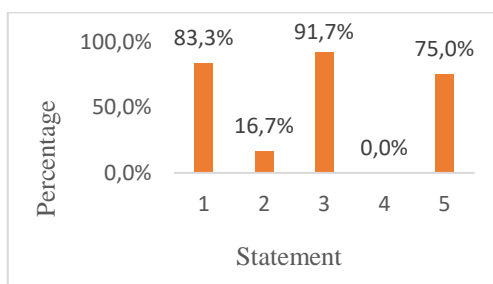


Figure 3. Percentage of perception of ease of response

Figure 3 shows that 83.3% of respondents said this application was easy to learn, and only 16.7% of respondents needed consultation in operation. Meanwhile, 91.7% stated it was easy to remember what had done with this software, 0% or all respondents did not experience frustration in testing this software, and 75% felt proficient after one use. This results means that from the trials conducted by respondents gave a natural perception of EWB. Based on the results, this software is suitable for the transition from real to virtual learning. It is easy to use, does not require students' high digital literacy abilities, and can be operated simultaneously with Google meet to create online learning.

Experimental data

The capacitive reactance practicum with EWB shown in this article takes one of the practicum samples with a capacitance value of 100 nanofarads, an input voltage of 3 volts a frequency range of 100 Hz, 200 Hz, 300 Hz applied. A comparison of practicum and calculation data shown in table 1.

Table 1. Experimental data for capacitive reactance

V_{in} (Volt)	Frequency (Hz)	Capacitor (Farad)	I (Ampere)	V_{out} (Volt)	X_c (Ohm) Experiment	X_c (Ohm) Calculation
3	100	0,0000001	0.0001911	3	15699	15924
	200		0.0003819	3	7855	7962
	300		0.0005729	3	5237	5308
	400		0.0007638	3	3928	3981

The experimental data in table 1 was obtained from the results of experiments with an EWB application of data processing using Microsoft Excel. V_{In} and frequency (F) data are taken from the alternator value applied to the circuit, Current strength (I) from the Ammeters measuring instrument values installed in series against the Alternator and capacitors, V_{Out} values from the Voltmeter measuring instrument mounted parallel to the capacitor, $Xc_{Experiment}$ obtained from the calculation of observational data V_{in} / I while $Xc_{Calculation}$ is obtained from calculation of equation 1.

The results of data analysis in table 1 show that at a frequency of 100 Hz the value of $Xc_{Experiment}$ 15699 Ω and $Xc_{Calculation}$ 15924 Ω with a difference of 1.4%, at a frequency of 200 Hz the value of $Xc_{Experiment}$ 7855 Ω and $Xc_{Calculation}$ 7962 Ω with a difference of 1.3%, at a frequency of 300 Hz the value of $Xc_{Experiment}$ 5237 Ω and $Xc_{Calculation}$ 5308 Ω with a difference of 1.3%, at a frequency of 400 Hz the value of $Xc_{Experiment}$ 3928 Ω and $Xc_{Calculation}$ 3981 Ω with a difference of 1.3% means that overall the experimental data generated from this application is very accurate and thorough. Experimental data in table 1 if observed $Xc_{Experiment}$ and $Xc_{Calculation}$ values both of them show smaller values along with the Frequency value that is fed, meaning that the results of this experiment are in accordance with the capacitive reactance theory.

Graphical analysis of the relationship of frequency with capacitive reactance in figures 4.(a) and 4.(b) represents the results that are in accordance with the theory that the capacitive reactance value of 100 nano farad capacitors is inversely proportional to frequency.

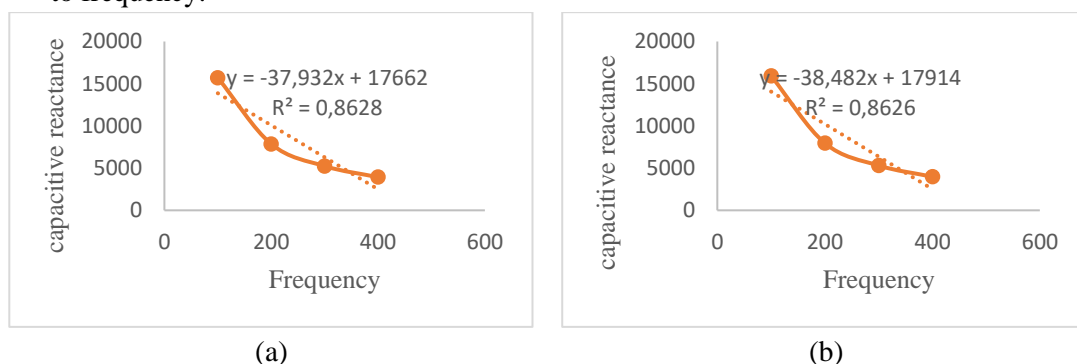


Figure 4. (a) Graph of the Relationship between F and Xc Experiments.
(b) Graph of Relationship of F and Xc Calculations

Time Experiment

Time efficiency was revealed by using a response questionnaire composed of 3 statements including 1) the activities that I did with EWB took less than 40 minutes, 2) the activities that I did with the EWB took more than 40 to 50 minutes, 3) the activities that I do with EWB take between 50 and 60 minutes. Data collected through the response questionnaire is shown in Figure 5.

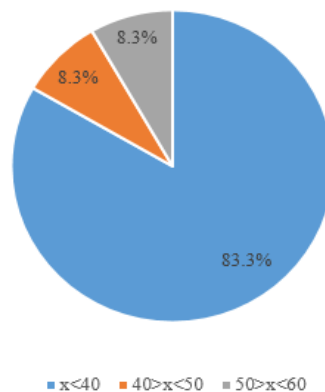


Figure 5. Diagrams of student responses to individual trials

Figure 5 shows that 83.3% of respondents completed the activity in less than 40 minutes, 8.3% stated that they completed the activity within 40 to 50 minutes, and another 8.3 percent said they completed the range of 50 to 60 minutes. In general, the data shows that the activities carried out starting from the process of making circuit simulation to the stage of graph data analysis in the sampling activities in this practicum only takes 40 minutes. If it is assumed in this capacitive rectification practicum activity every time the voltage variation takes only 10 minutes. Some research results also state that many other benefits of activities with this virtual laboratory include giving students many opportunities to learn while doing [16], low operational costs, easy to use and safe to use [17]–[19].

IV. Conclusion

The results show that respondents easily perceive this software. The low operating system makes this software smooth when integrated with Google Meet to create online learning with asynchronous approach.

Data analysis results by comparing the experimental data results and calculations show compliance with the capacitive reactance theory. The high frequency fed to the

capacitor makes the capacitive reactance values go down. The difference in the X_c value calculated by the X_c experiment is small.

This virtual practice's effectiveness and efficiency can also see from the time requirements, namely during the sampling process, until the analysis phase only takes 10 minutes. Based on these results, the virtual laboratory is feasible to apply in the COVID-19 Pandemic

Bibliography

- [1] Gugus Tugas Percepatan Penanganan Covid-19, "Pedoman Penanganan Cepat Medis dan Kesehatan Masyarakat Covid-19 di Indonesia," 2020.
- [2] Kemdikbud, "Pencegahan Penyebaran Corona Viruse Disiase di Perguruan Tinggi, Kementrian Pendidikan dan Kebudayaan," 2020.
- [3] J. Stern, "Introduction to Online Teaching and Learning," *International Journal of Science Education*, no. 3. pp. 1–10, 2018, doi: 10.1002/9781118784235.eeltv06b.
- [4] M. Ronen and M. Eliahu, "Simulation - a bridge between theory and reality: the case of electric circuits," *J. Comput. Assist. Learn.*, vol. 16, no. 1, pp. 14–26, 2001, doi: 10.1046/j.1365-2729.2000.00112.x.
- [5] P. A. Hatherly, "the Virtual Laboratory and Interactive Screen Experiments," *Connect. Res. Phys. Educ. with Teach. Educ.*, pp. 1–7, 2016.
- [6] M. Ronen and M. Eliahu, "Simulation as a home learning environment - Students' views," *J. Comput. Assist. Learn.*, vol. 15, no. 4, pp. 258–268, 1999, doi: 10.1046/j.1365-2729.1999.00101.x.
- [7] E. R. Doering, "Electronics lab bench in a laptop: Using Electronics Workbench to enhance learning in an introductory circuits course," *Proc. - Front. Educ. Conf.*, vol. 1, no. December 1997, pp. 18–21, 1997, doi: 10.1109/fie.1997.644802.
- [8] I. Islahudin and S. Soeharto, "Improving Students' Conceptual Mastery on Digital Circuit Topic Using Electronics Workbench Software," *JIPF (Jurnal Ilmu Pendidik. Fis.*, vol. 5, no. 1, p. 8, 2020, doi: 10.26737/jipf.v5i1.1127.
- [9] G. Banky and K. Wong, "Troubleshooting exercises using circuit simulator software: support for deep learning in the study of electronic circuits," *Int. Conf. Eng. Educ.*, 2007.
- [10] H. A. Ismail, "Intention to Use Smartphone Through Perceived Compatibility, Perceived Usefulness, and Perceived Ease of Use," *J. Din. Manaj.*, vol. 7, no. 1, p. 1, 2016, doi: 10.15294/jdm.v7i1.5748.
- [11] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Q. Manag. Inf. Syst.*, vol. 13, no. 3, pp. 319–339, 1989, doi: 10.2307/249008.
- [12] H. Holden and R. Rada, "Understanding the influence of perceived usability and technology self-efficacy on teachers' technology acceptance," *J. Res. Technol. Educ.*, vol. 43, no. 4, pp. 343–367, 2011, doi: 10.1080/15391523.2011.10782576.
- [13] Izadi, "Introduction to Electronics Workbench," 2015.

- [14] S. Waite and M. Bendame, "An introduction to electronics workbench for designing circuits and PCBs," *IEE Colloq.*, no. 64, pp. 39–42, 1999, doi: 10.1049/ic:19990380.
- [15] M. Ali, *Modul Simulasi Rangkaian Elektronika Analog dan Digital Dengan EWB*. Yogyakarta: universitas negeri yogyakarta, 2012.
- [16] L. Oidov, U. Tortogtokh, and E. Purevdagva, "Virtual laboratory for physics teaching," *2012 Int. Conf. Manag. Educ. Innov.*, vol. 37, pp. 319–323, 2012.
- [17] J. Ma and J. V. Nickerson, "Hands-on, simulated, and remote laboratories: A comparative literature review," *ACM Comput. Surv.*, vol. 38, no. 3, p. 1, 2006, doi: 10.1145/1132960.1132961.
- [18] marry celeste Reese, "Comparison of student achievement among two science laboratory types: Traditional and virtual," in *ProQuest Dissertations and Theses database.*, 2013.
- [19] R. K. Scheckler, "Virtual labs: A substitute for traditional labs?," *Int. J. Dev. Biol.*, vol. 47, no. 2–3, pp. 231–236, 2003, doi: 10.1387/ijdb.12705675.