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To cite this article: M.A. Hamid *et al* 2021 *J. Phys.: Conf. Ser.* **2111** 012054

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Performance efficiency of virtual laboratory based on Unity 3D and Blender during the Covid-19 pandemic

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Abstract. Testing the performance efficiency aspect was carried out to test the performance efficiency of the Unity 3D and Blender-based virtual laboratory media during the COVID-19 pandemic at the Electrical Engineering Vocational Laboratory. This test is carried out to test the performance of the media that has been created. The aspects tested are access speed, process speed, and simulation speed when run. Tests were conducted to measure processor and memory consumption through real time monitoring using MSI Afterburner. Divided into 2 stages of testing, namely time behavior and resource utilization. Time-behavior is focused on how long it takes the media or software to provide a response time to perform an action from a certain function. Resource-utilization is the degree to which software uses some resources when doing something under certain conditions.

1. Introduction

Online learning is learning with accessibility, connectivity, flexibility, and visibility in various forms of interactive learning using the internet [1]. The Government of Indonesia is transforming the learning process in the pandemic period through online learning and establishing regulations that regulate the online learning process to run optimally. This policy is intended to control the rate of transmission of the Covid-19 virus in the educational environment. It requires educators to create new models in online learning that are innovative, effective, and efficient. These are all challenges that must be faced in the implementation of education in the current era. [2]. This online learning must be carefully planned through lesson plan [3], [4]. Various innovations or distance learning platforms were successfully created by educational researchers and practitioners. Among them, using MOOCs platform [5], various learning media [6], modules [7] and innovative e-module learning [8], [9], trainer kits capable of supporting learning [10], and ICT-based learning assessment instruments [11].

Therefore, virtual media has been created to overcome the problems that exist during this covid-19 pandemic. In virtual laboratories, students work with computer representations of equipment to observe phenomena and make measurements [12]. In another study, virtual experiments allowed users to focus on conceptual explanations because virtual programs were able to track details and allow users to focus on the 'big picture' [13] [14]. The virtual learning environment, of course, must stimulate the learning



development of both students and teachers if we want to succeed in realizing the goals of the educational process with virtual methods [15]. Therefore, the features presented must also be able to stimulate learning, namely by presenting it in 3D (3 Dimensional) form. Practical practicum allows students to do it virtually with the support of the completeness of tools and materials presented in 3D so that it will not reduce the essence of the lecture material provided. 3D Virtual is a platform that users can develop by applying their imagination [16]. The ability of the 3D virtual world has a big hand in the development of technology. Virtual 3D was originally only for entertainment and gaming purposes, now it is also used for educational purposes [17]. Virtual 3D allows users to design interactive environments with specified or desired content [18]. Virtual 3D also makes it possible to view a given problem from a different perspective and can include virtual activities that are difficult to safely practice in real life.

To make it happen is to use software to create a virtual laboratory. In this case, the researcher uses Blender 3D and Unity 3D software. The combination of the two software is considered to make the laboratory more optimal in the process. Blender is used to design 3D animation and visual effects of an object or laboratory room. And to integrate it, Game Developing Software is used, namely Unity 3D. related to this, a performance test is carried out on the media that has been made. Performance testing is carried out to determine the quality of the software performance engine. This test assesses memory usage, battery consumption, CPU and load on the server under various conditions. In the ISO 25010 standard [19], a software meets the performance efficiency aspect if the device in the testing process is carried out at least 5 times by calculating the average response time of the application to run each existing feature and is said to meet the criteria if the results of the calculation of the average response time are less of 9 seconds. In ISO 25010 [19] there are 3 indicators to assess performance efficiency, namely time-behavior, resource-utilization, and capacity. Time behavior is the degree to which the software responds to the time it takes to perform an action of a particular function. Resource utilization is the level of software using some resources when doing something under certain conditions. Capacity is the degree to which the software has the maximum limitation of a product meeting certain requirements.

Aspects of performance efficiency measured using MSI Afterburner is a tool provided by MSI to monitor hardware and software. MSI Afterburner is also a graphics card overclocking utility that gives the user complete control over the graphics card or VGA being used. This tool provides a very detailed description of the graphics card hardware used and comes with several additional features such as customizable fan profiles, benchmarking, and video recording. There are two applications in the installation package, MSI Afterburner and Riva Statistics Server. The optimization options available are core voltage, power limit, temperature limit, core clock, memory clock and fan speed.

Based on the description above, the performance efficiency aspect to test the virtual media laboratory based on Unity 3D and Blender is based on ISO 25010, namely time-behavior, resource-utilization. The resource-utilization aspect focuses on memory and CPU requirements which are tested using MSI Afterburner.

2. Methodology

The purpose of this research is to develop a virtual laboratory media using Unity 3D and Blender in the basic electronics practicum course. Based on the objectives, this research uses the R&D (Research and Development) method to develop media that can meet the software quality standards in accordance with the objectives. According to [20] R&D is a research on the manufacture of certain products and testing the effectiveness of these products. And based on a review of the background and objectives, this media is made using a software development model, namely by using the development of the Linear sequential model or commonly called the Waterfall Model.

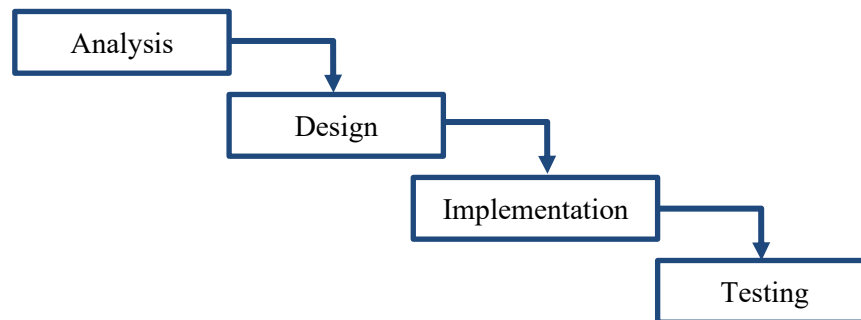


Figure 1. Waterfall Development Model

According to [21] this model provides a conceptual approach to software development systematically and sequentially starting at the level and progress of the system in analysis, design, code, testing and maintenance [21]. Therefore, this media development research aims to create learning media products that are ready to be used for lecture activities, especially practicum activities. This research is also focused on product design and product quality testing based on Unity 3D and Blender in the basic electronics practicum course.

3. Results and Discussion

The performance efficiency aspect is tested using MSI Afterburner which is tested in real time. In this test, time-behavior is tested, resource-utilization in the form of CPU and memory usage. The following are the results of testing aspects of performance efficiency:

3.1. Time behaviour

Time-behavior is focused on how long it takes the media or software to provide a response time to perform an action from a certain function. This test includes the use of time in the application launching process and execution tests. The use of the time required on the virtual lab media to carry out these processes is described in the specifications of different computer/laptop devices that are tested 5 times because a software meets the performance efficiency aspect if the device is in the testing process carried out at least 5 times by calculating the average response time of the application to run each existing feature and is said to meet the criteria if the results of the calculation of the average response time are less than 9 seconds. The devices were tested from Windows 7 to Windows 10 OS with a RAM capacity of 2 GB to 4 GB.

3.1.1. Acer Travelmate P243

This laptop provides performance performance through an Intel Core i3 2370M 2.4 GHz. It is supported by 2 GB of RAM and the OS used is Windows 7. In addition, it is equipped with a large enough HDD storage space of 500 GB. The results of the time behavior performance test that were tested 5 times were as follows.

Table 1. Media time usage on Acer Travelmate P243

No.	Process/ activity	Media	The time required for the session					Avg
			Session 1	Session 2	Session 3	Session 4	Session 5	
1	Launcing application		7,20 s	7,47 s	7,81 s	7,27 s	7,54 s	7,45 s
2	Test execution		1 min 23 s	1 min 29 s	1 min 25 s	1 min 34 s	1 min 22 s	1 min 26.6 s

Based on the table above, it shows that in launching the application, the results of the calculation of the average response time are quite fast, which is 7.45 seconds. In addition, test execution is also carried out. Test execution is the time required to test each function contained in the virtual lab media. In the

form of starting the simulation, zooming in and out, opening the options page, adding all the tools and materials to the simulation workbench.

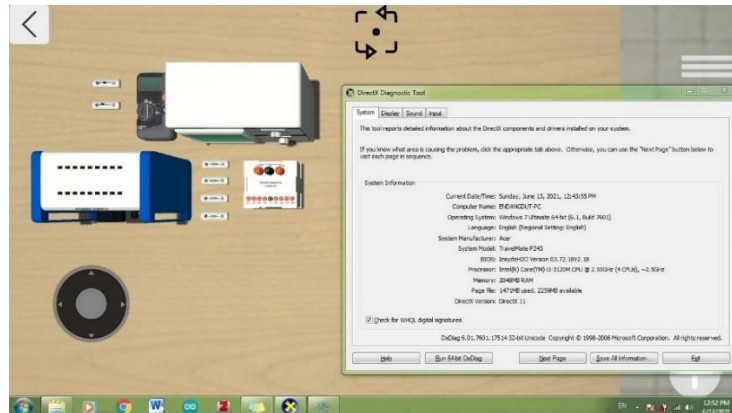


Figure 2. Test Execution on the Acer Travelmate P243

Based on the table, it shows that the response time is quite fast, which is an average of 1 minute 26.6 seconds. And also in the execution process there is also no system lag or slowness. So it can be concluded that the virtual lab media that is run on the ACER Travelmate P243 Laptop with an Intel Core i3 processor, 2 GB RAM and Windows 7 OS can run well without any problems in every process shown during testing.

3.1.2. *Lenovo Ideapad G40/45*

The performance of this laptop comes from an AMD A8-6410 Quad Core 2.0-2.4GH processor with 4GB RAM specifications and offers 500 GB of storage capacity. The OS used in this laptop is Windows 7, the results of the time behavior performance test were tested 5 times, namely as follows.

Table 2. Media time usage on Lenovo Ideapad G40/45

No.	Process/ activity	The time required for the session					Avg
		Session 1	Session 2	Session 3	Session 4	Session 5	
1	Launcing	6,20 s	6,40 s	6,15 s	6,49 s	6,35 s	6,31 s
2	Test execution	1 min 27 s	1 min 23 s	1 min 24 s	1 min 23 s	1 min 26 s	1 min 24 s

Based on the table above, it shows that in launching the application, the results of the calculation of the average response time are quite fast, namely 6.31 seconds. In addition, test execution is also carried out. Test execution is the time required to test each function contained in the virtual lab media. In the form of starting the simulation, zooming in and out, opening the options page, adding all the tools and materials to the simulation workbench.

Based on the table, it shows that the response time is quite fast, which is an average of 1 minute 24 seconds. And also in the execution process there is also no system lag or slowness. So it can be concluded that the virtual lab media running on the Lenovo Ideapad g40/45 Laptop with special specifications for the AMD A8 processor, 4GB RAM and Windows 7 OS can run well without any problems in each process shown during testing.

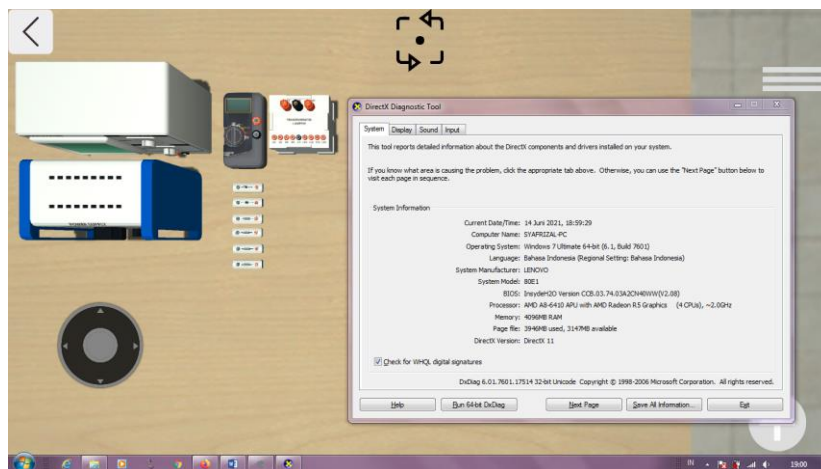


Figure 3. Test Execution on Lenovo Ideapad G40/45.

3.1.3. Acer Aspire 35 411

This laptop from Acer is equipped with an Intel Core Celeron N2830 Quad Core 2.16 GHz with 2 GB RAM and 500 GB HDD storage. The OS used in this laptop is Windows 8, the results of the time behavior performance test were tested 5 times, namely as follows.

Table 3. Media time usage on Acer Aspire e5 411

No.	Process/ Media activity	The time required for the session					Avg
		Session 1	Session 2	Session 3	Session 4	Session 5	
1	Launcing application	6,63 s	7,83 s	7,74 s	7,79 s	7,56 s	7,51 s
2	Test execution	1 min 27 s	1 min 29 s	1 min 20 s	1 min 25 s	1 min 26 s	1 min 25,4 s

Based on the table above, it shows that in launching the application, the results of the calculation of the average response time are quite fast, which is 7.51 seconds. In addition, test execution is also carried out. Test execution is the time required to test each function contained in the virtual lab media. In the form of starting the simulation, zooming in and out, opening the options page, adding all the tools and materials to the simulation workbench.

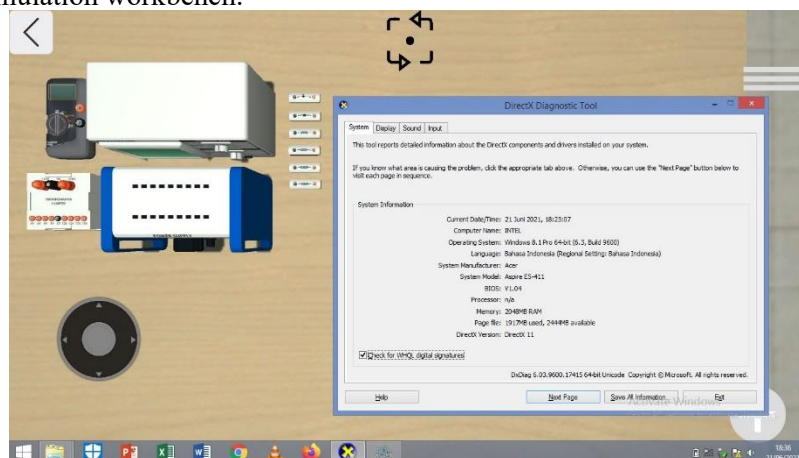


Figure 4. Test Execution on Acer Aspire e5 411

Based on the table, it shows that the response time is quite fast, which is an average of 1 minute 25.4 seconds. And in the execution process there is also a system lag or slowness when exploring the virtual

lab room. So it can be concluded that the virtual lab media running on the ACER Travelmate P243 Laptop with an Intel Core i3 processor, 2 GB RAM and Windows 7 OS can run well even though there is system lag when exploring the virtual lab room.

3.1.4. Asus a46Cb

This laptop from ASUS is equipped with an Intel Core i5 processor with Quad Core 1.70 GHz with 4 GB RAM and 500 GB HDD storage. The OS used in this laptop is Windows 8, the results of the time behavior performance test were tested 5 times, namely as follows.

Table 4. Media time usage on Asus a46Cb

No.	Process/ Media activity	The time required for the session					Avg
		Session 1	Session 2	Session 3	Session 4	Session 5	
1	Launcing application	5,11 s	5,43 s	5,40 s	5,31 s	5,27 s	5,3 s
2	Test execution	1 min 16 s	1 min 15 s	1 min 22 s	1 min 26 s	1 min 11 s	1 min 18 s

Based on the table above, it shows that in launching the application, the results of the calculation of the average response time are quite fast when compared to the others, namely 5.3 seconds. In addition, test execution is also carried out. Test execution is the time required to test each function contained in the virtual lab media. In the form of starting the simulation, zooming in and out, opening the options page, adding all the tools and materials to the simulation workbench.

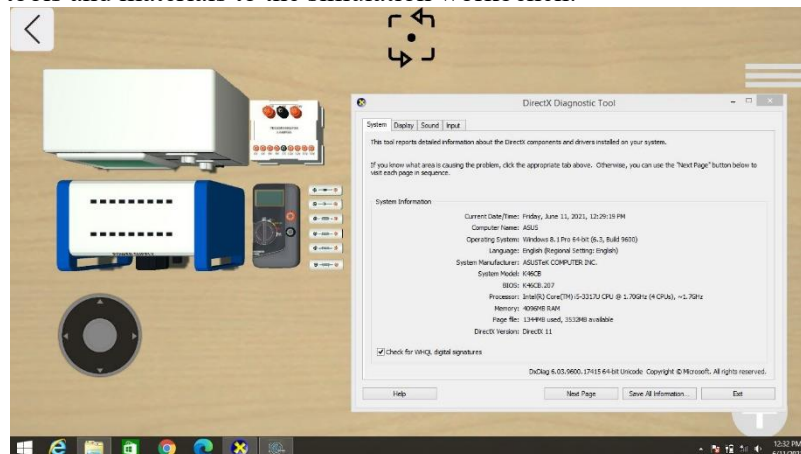


Figure 5. Test Execution on Asus a46Cb

Based on the table, it shows that the response time is quite fast, which is an average of 1 minute 18 seconds. And also in the execution process there is also no system lag or slowness. So it can be concluded that the virtual lab media that is run by the Asus a46Cb Laptop with special specifications for the Intel Core i5 processor, 4 GB RAM and Windows 8 OS can run well without any problems in every process shown during testing.

3.1.5. Asus E202SA

This laptop from ASUS is equipped with an Intel Celeron N3060 processor with Quad Core 1.60 GHz with 2 GB RAM and 500 GB HDD storage. The OS used in this laptop is Windows 10, the results of the time behavior performance test were tested 5 times, namely as follows.

Table 5. Media time usage on ASUS E202SA notebook

No.	Process/ Media activity	The time required for the session					Avg
		Session 1	Session 2	Session 3	Session 4	Session 5	
1	Launcing application	7,41 s	7,78 s	7,51 s	7,83 s	7,59 s	7,62 s
2	Test execution	1 min 16 s	1 min 31 s	1 min 20 s	1 min 22 s	1 min 17 s	1 min 21.2 s

Based on the table above, it shows that in launching the application, the results of the calculation of the average response time are 7.62 seconds. In addition, test execution is also carried out. Test execution is the time required to test each function contained in the virtual lab media. In the form of starting the simulation, zooming in and out, opening the options page, adding all the tools and materials to the simulation workbench.

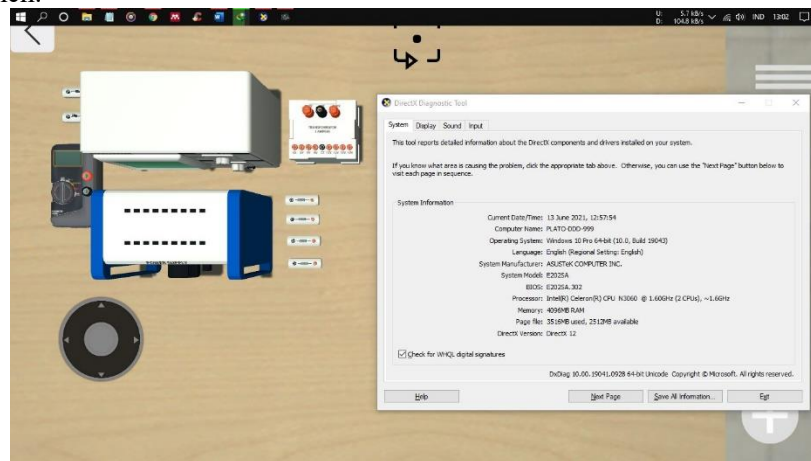


Figure 6. Test Execution on notebook ASUS E202SA

Based on the table, it shows that the response time is quite fast, which is an average of 1 minute 21.2 seconds. And also in the execution process there is also no system lag or slowness. So it can be concluded that the virtual lab media running on the ASUS E202SA Notebook with special specifications for the Intel Celeron N3060 processor, 2 GB RAM and Windows 10 OS can run well without any problems in each process shown during testing.

3.1.6. Asus E202SA

This all-in-one computer or desktop is powered by an Intel Celeron J3355 series processor equipped with 4GB RAM and 500 GB HDD storage. The OS used on this computer is Windows 10, the results of the time behavior performance test were tested 5 times, namely as follows.

Table 6. Media time usage on computer/desktop All In One Lenovo 310-20IAP (F0CL000KID)

No.	Process/ Media activity	The time required for the session					Avg
		Session 1	Session 2	Session 3	Session 4	Session 5	
1	Launcing application	8,23 s	8,43 s	8,28 s	8,30 s	8,47 s	8,34 s
2	Test execution	1 min 48 s	1 min 53 s	1 min 42 s	1 min 53 s	1 min 50 s	1 min 49.2 s

Based on the table above, it shows that in launching the application, the results of the calculation of the average response time are 7.45 seconds. In addition, test execution is also carried out. Test execution is the time required to test each function contained in the virtual lab media. In the form of starting the

simulation, zooming in and out, opening the options page, adding all the tools and materials to the simulation workbench.

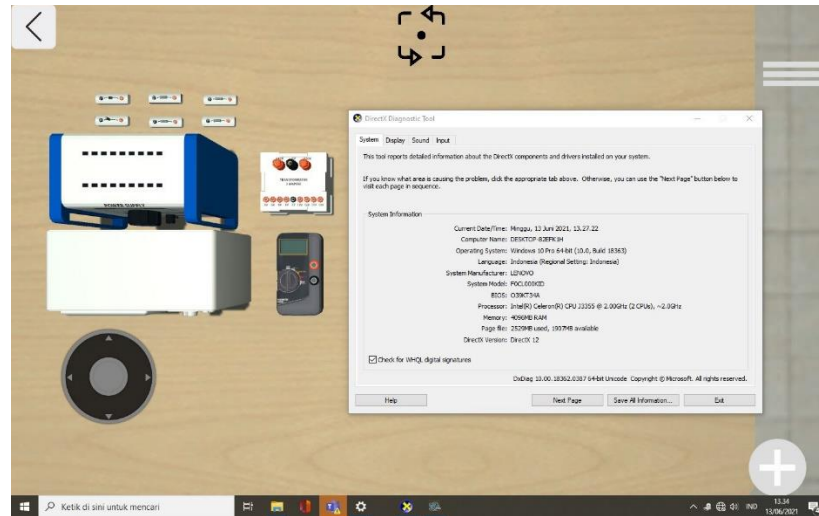


Figure 7. Test Execution pada komputer/ dekstop All In One Lenovo 310-20IAP (F0CL000KID)

Based on the table, it shows that the response time is slightly slower compared to previous tests with other laptops, which is an average of 1 minute 49.2 seconds because there is a lag when opening media or launching. In addition, in the execution process there is also no system lag or slowness. So it can be concluded that the virtual lab media that runs on the Lenovo All In One Desktop 310-20IAP (F0CL000KID) with special specifications for the Intel Celeron J3355 series processor, 4 GB RAM and Windows 10 OS can run well, there is only lag when opening the media. In addition, there are no more obstacles in each process shown during testing.

3.2. Resource utilization

Resource-utilization is the degree to which software uses some resources when doing something under certain conditions. This test shows how much memory usage is used by the system to run this virtual lab media application, as well as CPU usage shows how much CPU performance is in running media. The results of the calculation of memory and CPU usage in calculations on MSI Afterburner are shown in the following figure.

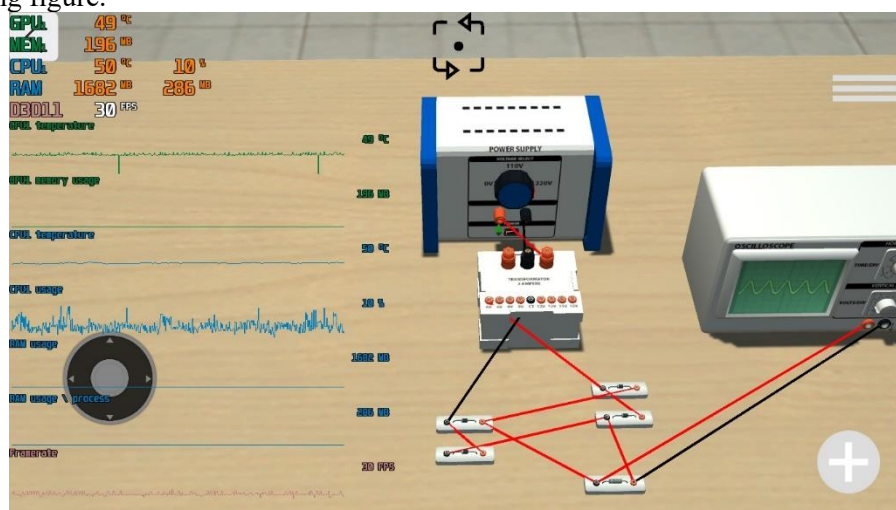


Figure 8. Grafik penggunaan memory dan CPU

Based on the observation data above, it shows that this virtual lab media runs without experiencing a memory shortage which causes the media to stop due to a memory leak which can cause a force close

or launch fail. Meanwhile, the average CPU usage is below 20%. This figure is still below the safe limit set by Little Eye (mobile app analysis tools) which is 25%. In addition, the use of GPU Temperature (Graphics Processing Unit), GPU memory, and FPS (Frames per second) framerate is also displayed.

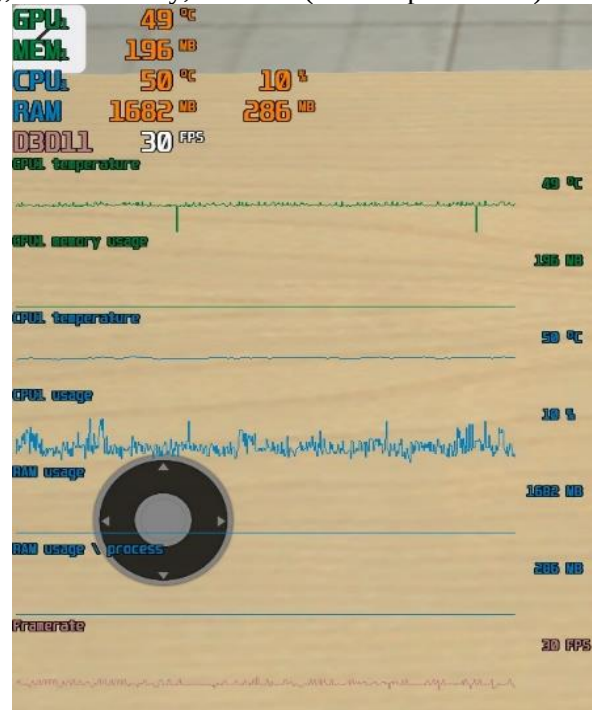


Figure 9. Grafik penggunaan memory dan CPU Zoom in

Based on these data, GPU usage is still in normal condition, namely 49°C, GPU memory usage is 196 mb, and with FPS 30, you can say it's good for use in media because it is able to provide a graphical display that is comfortable for the eyes. The following is the conclusion of the performance efficiency aspect test which is explained from the above description.

Table 7. The results of testing aspects of performance efficiency

No.	Desired results Test Results	Test result
1.	The media is able to run the application launching process, and test execution within a certain time without experiencing problems	corresponding
2.	This media can run without running out of memory	corresponding
3.	Maximum CPU usage in application does not exceed 25% percentage	corresponding

Based on the results of testing the performance efficiency aspect in the table above, the results are in accordance with the standards, so that it can be said that the virtual lab media based on Unity 3D and Blender is at a good level of performance efficiency.

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