



Optimizing the Use of E-Worksheet and PHET Simulation in Science Learning during the Covid-19 Pandemic

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Abstract: This study examines the use of e-worksheets and PHET Simulation as virtual laboratories in science. This study aims to determine whether the use of PHET Simulation with e-worksheet guidance can optimize online learning to minimize learning loss due to the Covid 19 pandemic. E-worksheets are used as scaffolding media that are used to help guide students to do online practicums. The research was conducted in two stages. The first stage is conducting a direct trial of learning using PHET Simulation and e-worksheets through Google Classroom. For the second stage, the activities include collecting data using an accessibility questionnaire using a google form. The data were then analyzed by usability test covering aspects of usefulness, ease of use, ease of learning, and satisfaction. The usability test results show that the percentage of respondents to the questions given is dominated by the Agree (S) and Strongly Agree (SS) statements on all usability test indicators. This shows that the use of e-worksheets and PHET Simulation as a virtual laboratory fulfils the element of usability.

Keywords: e-Worksheet, PHET simulation, Virtual laboratory

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INTRODUCTION

COVID-19 has caused a very significant impact on every part of human life, be it economic, social, and education (Livana et al., 2020). To inhibit the spread of the outbreak and accelerate in the response to the outbreak, the government took policy by carrying out large-scale social restrictions through Government Regulation No. 2 of 2020. Following up on the implementation of the regulation, the Ministry of Education and Culture issued Circular Letter No. 4 of 2020 on the implementation of education in the pandemic period. One important part of the circular is the implementation of distance learning using online media (Hidayatulloh et al., 2020; Kahfi, 2020).

Based on Circular Letter No. 4 of 2020, most schools apply online learning both asynchronous and synchronous (Rosali, 2020). Online learning has its challenges for both teachers and students. Some obstacles in the implementation of online learning include inadequate internet networks in remote areas (Syahputra et al., 2020). In addition, teachers must adjust the method of learning online and there are some subjects that have not been able to be implemented online optimally (Asmuni, 2020). One of the subjects that have not been optimal in online learning is Science at junior level in which the subject demands practicum. One of the efforts that can be done to solve the problem is to use the virtual laboratory as a means of online practice (Sumardani et al., 2019).

However, not all schools already have their own virtual laboratory system integrated with the school's website. In order to overcome these obstacles, it is necessary to make efforts to use available virtual laboratories. A free virtual laboratory that can be used is Physics Education Technology (PHET) which is one of the virtual laboratories of the University of Colorado that presents physical materials comprehensively (Perkins et al., 2006). Simulations in this PHET are designed interactively so the practicum implementation can be done virtually by students (Hashim et al., 2020; Saregar, 2016).

This research aims to examine the use of PHET Simulation as a virtual laboratory in the implementation of science learning during pandemic. This study uses PHET Simulation guided by e-worksheet practicum to facilitate students in conducting experimental stages (Abdurrahman et al., 2020). The benefits of this study include: (1) pandemic learning can be carried out optimally, (2) students can carry out live practices virtually without risk, (3) PHET Simulation can be used as an online learning medium to minimize learning loss due to the Covid 19 pandemic.

METHOD

Research Design & Procedures

This study is an exploratory study consisting of two stages. The first stage is to conduct a trial of learning Science in grade VII using PHET Simulation and e-worksheet through Google Classroom. E-worksheet used in this learning is an e-worksheet adapted from worksheets that have been developed by Nurreda (2019). The second step is the retrieval of usability data using usability questionnaire instruments through a google form.

Population and Sample

The research was carried out at Ar Raihan Islamic Junior High School in Bandar Lampung city. The population in this study is students of 7 grade of Ar Raihan Islamic Junior High School in the 2021/2022 school year. The sample of this study was taken 100 students in VII grade.

Data Collection and Instrument

Data collection techniques use usability questionnaire instruments through a google form. The instrument used is an instrument resulting from the development of Asyana & Arini (2020). This Instrument have a reliable value 0.936 with very high criteria and the validity test result showed 9 of 12 questions have value greater than 0.707 with valid category. The usability test is used to measure the quality of use of PHET Simulation as a virtual laboratory.

Data Analysis

According to ISO 9241:11, a product or service can meet the level of usability if it meets the criteria of usefulness, ease of use, ease of learning, and satisfaction (ISO, 2017) as seen in Table 1. Before research instrument is used, it must be conducted validity test and reliability test. This instrument has been tested by Asyana & Arini (2020) in their research.

Table 1. Criteria of Usability Test

Faktor	No	Pertanyaan	Penilaian*			
			STS (1)	TS (2)	S (3)	SS (4)
Usefulness	1	Aplikasi <i>virtual lab</i> mudah digunakan	-	-	-	-
	2	Intruksi penggunaan aplikasi mudah dipahami	-	-	-	-
	3	Aplikasi ini membantu proses pembelajaran praktikum <i>online</i>	-	-	-	-
Ease of use	4	Aplikasi ini mudah digunakan	-	-	-	-
	5	Aplikasi ini sederhana digunakan	-	-	-	-
	6	Aplikasi ini <i>user friendly</i>	-	-	-	-
Ease of learning	7	Aplikasi ini memudahkan memahami materi praktikum <i>online</i>	-	-	-	-
	8	Penggunaan aplikasi ini dapat dipelajari dengan cepat	-	-	-	-
	9	Aturan penyajian materi dalam aplikasi ini tidak membuat saya kebingungan	-	-	-	-
Satisfaction	10	Penggunaan aplikasi ini sangat membantu memahami materi	-	-	-	-
	11	Aplikasi ini menyenangkan untuk digunakan	-	-	-	-
	12	Aplikasi ini nyaman digunakan	-	-	-	-

*Description: STS (strongly disagree), TS (disagree), S (agree), SS (strongly agree)

This table uses a likert scale with score of 1 to 4, in which number 1 is for the lowest score and number 4 is for the highest score.

The results of validity and reliability test conducted by Asyana & Arini (2020) using 10 respondents obtained 3 invalid questions, namely question number 6 with a value of $r_{xy} = 0.233$, question number 7 with a value of $r_{xy} = 0.571$, and question number 12 with a value of $r_{xy} = 0.644$. Other questions have valid criteria. Thus the 3 questions cannot be used as items in the instrument of the questionnaire for the usability test. The results of the reliability test showed all question items given have a reliable value of 0.936 with very high criteria. From the results of the validity and reliable tests, 9 questions obtained are valid and reliable criteria will be used for the usability test. The 9 questions used in the study were based on questionnaires tested by 1, 2, 3, 4, 5, 8, 9, 10, and 11.

RESULT AND DISCUSSION

Stage 1: Online Learning Trial with e-worksheet and PhET Simulation

Learning is occurred online with the help of LMS GoogleClassroom as a virtual classroom. The meeting begins with a video meeting using Google Meet platform that has been integrated with Google Classroom. All students of SMP IT Ar Raihan Bandar Lampung have joined a virtual Google Classroom through class code or link class that has been shared by teacher. Google Meet link and class code are seen in the following figure.

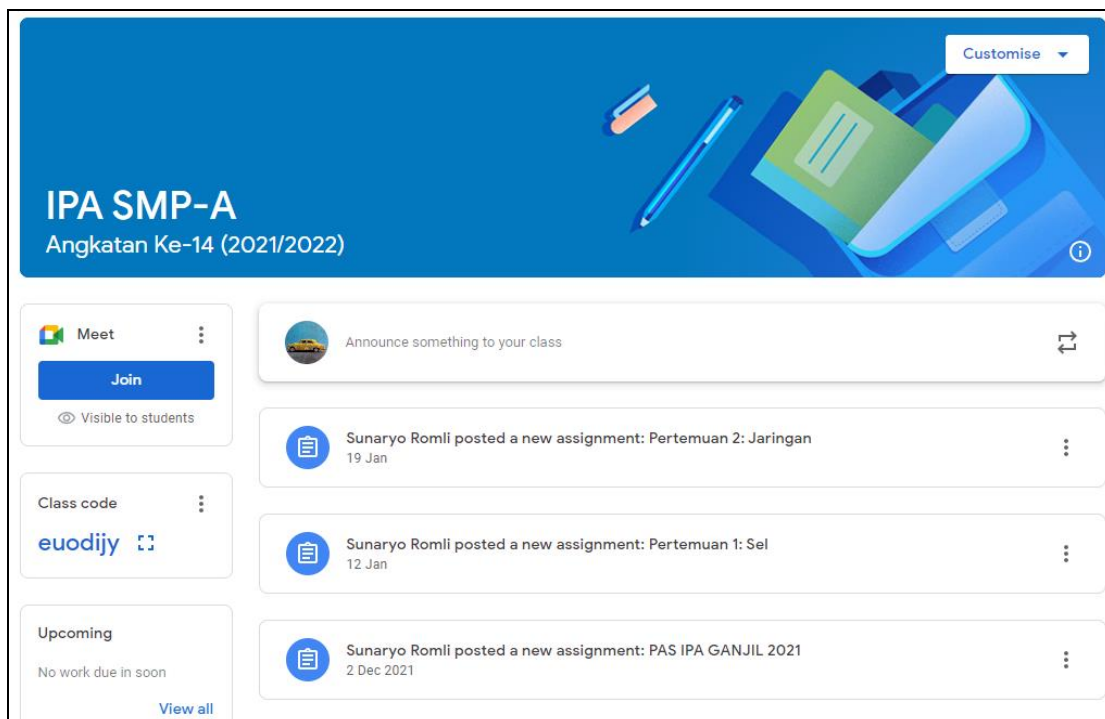


Figure 1. Google Classroom menu view that contains Google Meet links

Furthermore, in the video meeting occurred, students are directed to open Assignment at meeting 13: Energy and Its Change as in Figure 2. Students are briefed on practicum procedures using PhET with the help of e-worksheets.

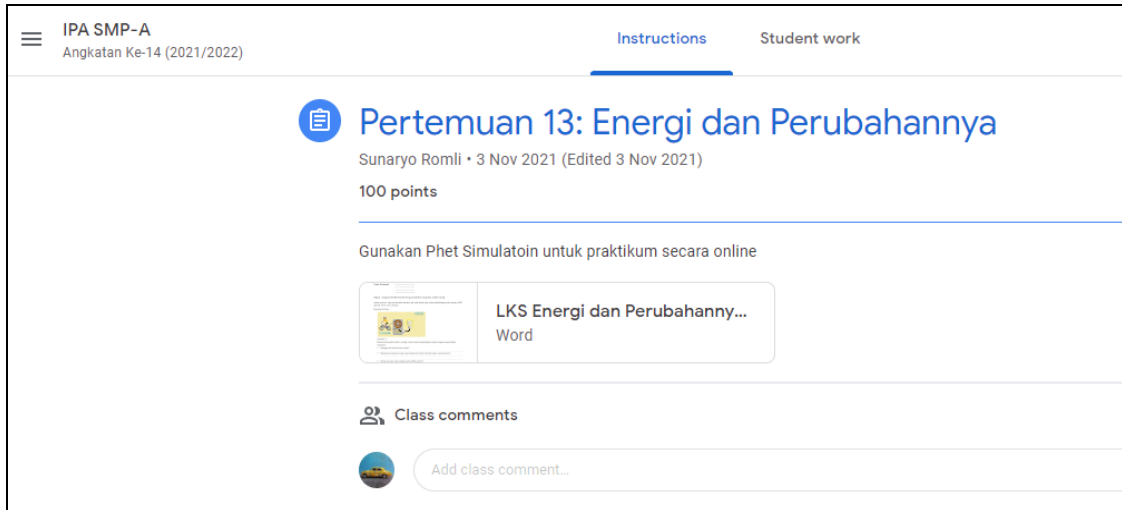
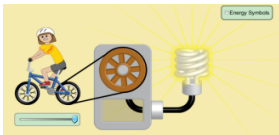
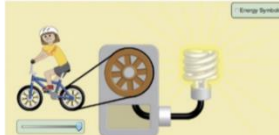


Figure 2. Assignment menu on Google Classroom

Students practice with e-worksheet guidance on PhET. Students can fill in answers in the columns provided using google doc application or Good notes 5 that have been supported with apple pencil so that they can use handwriting as in Figure 3a. Because the practicum is based on simulation applications, students can do practicum safely and repeatedly until students understand (Sylviani et al., 2020).

<p style="text-align: right;">LKS</p> <p style="text-align: center;">Konsep energi dan sumber energi</p> <p>Hari/tanggal : 3 November 2021 Kelas : 7A Nama Kelompok :</p> <p>Tujuan : mengenal bentuk-bentuk energi, perubahan energi dan sumber energi</p> <p>Amati peristiwa yang terjadi pada interaksi tiga buah benda yang saling berhubungan pada simulasi PhET (Energy Forms and Changes)</p> <p>Kegiatan Pertama</p>  <p>(Gambar 1) Berdasarkan gambar diatas seorang wanita dapat menhidupkan lampu dengan mengayuhkan sepedanya</p> <ol style="list-style-type: none"> Mengapa hal tersebut bisa terjadi? dikarenakan lampu tersebut dienergikan oleh dinamo yang akan mengubah energi gerak menjadi energi listrik Bagaimana pengaruh orang yang mengayuh sepeda terhadap lampu yang menyala? semakin cepat kayuhan maka lampu juga akan semakin terang dan saat kayuhan melambat cahaya yang dihasilkan akan meredup Energi apa saja yang terdapat pada aktifitas diatas? energi i. gerak, energi listrik, energi cahaya dan energi kinetik Jelaskan perubahan bentuk energi pada gambar diatas? Energi i. gerak menjadi energi i. listrik pada saat mengayuh sepeda terjadilah energi gerak lalu energi gerak berpengaruh pada dinamo sehingga menghasilkan listrik yang dapat menyalakan lampu. <p style="text-align: right;">3a</p>	<p style="text-align: right;">LKS</p> <p style="text-align: center;">Konsep energi dan sumber energi</p> <p>i/tanggal : Rabu, 3 November 2021 IS :</p> <p>an Kelompok : Tidak Berkelompok</p> <p>uan : mengenal bentuk-bentuk energi, perubahan energi dan sumber energi</p> <p>ti peristiwa yang terjadi pada interaksi tiga buah benda yang saling berhubungan pada simulasi PhET (Energy Forms and Changes)</p> <p>iatan Pertama</p>  <p>(Gambar 1) Berdasarkan gambar diatas seorang wanita dapat menhidupkan lampu dengan mengayuhkan sepedanya</p> <ol style="list-style-type: none"> Mengapa hal tersebut bisa terjadi? Karena adanya perubahan energi kimia menjadi energi mekanik, energi mekanik menjadi energi elektrik, dan seterusnya. Bagaimana pengaruh orang yang mengayuh sepeda terhadap lampu yang menyala? rang yang berpeda menyalurkan energi kimia yang kemudian di generator, energi kimia itu berubah menjadi energi mekanik, lalu saat menuju ke lampu energi itu sudah berubah menjadi energi cahaya yang membuat lampu dapat menyala, dan energi panas Energi apa saja yang terdapat pada aktifitas diatas? Energi panas, Energi Kimia, Energi Mekanik, Energi cahaya, Energi Elektrik <p style="text-align: right;">3b</p>
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Figures 3a and 3b. Student Answer Results after Practicum Using PhET

Stage 2: Usability Test

The collection of usability test data was obtained from respondents in amount of 100 students of class VII of SMP ITAr Raihan Bandar Lampung. Figure 4 shows the percentage of respondents to 3 usefulness questions given through questionnaires. The data showed agreed statements with an average percentage of 36.6% and strongly agreed with an average of 55.3%. From the results of this questionnaire, it can be seen that the majority of users agree and strongly agree with all three statements on the usefulness aspect. Thus, the use of PhET Simulation with e-worksheet has good uses and can be recommended as a virtual laboratory on learning science (Asnawi, 2018).

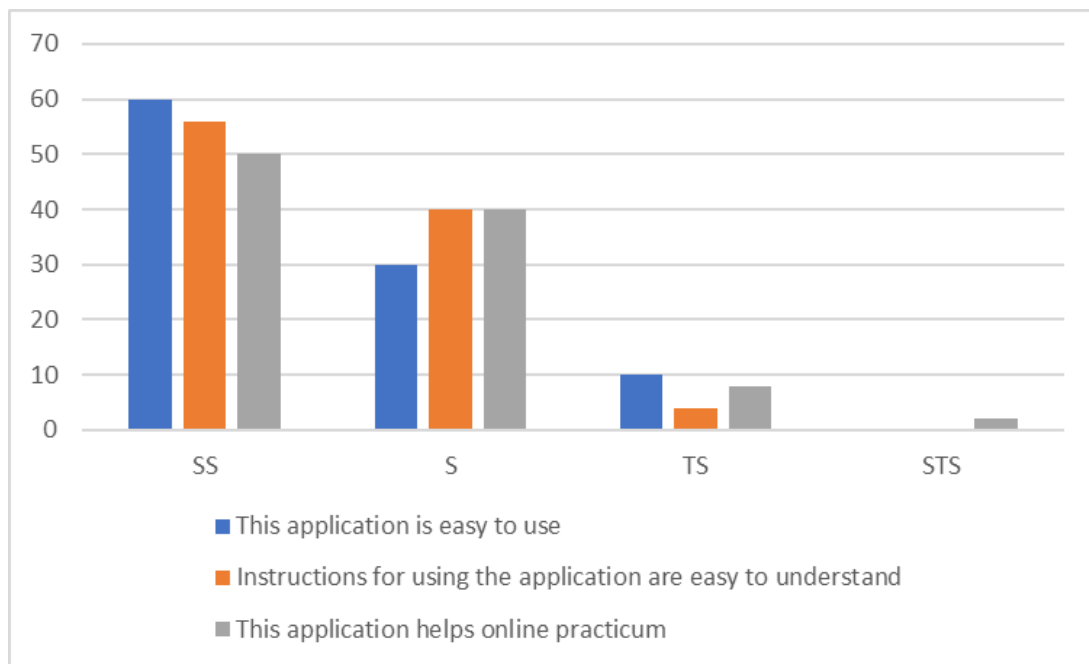


Figure 4. Indicators of usefulness aspects

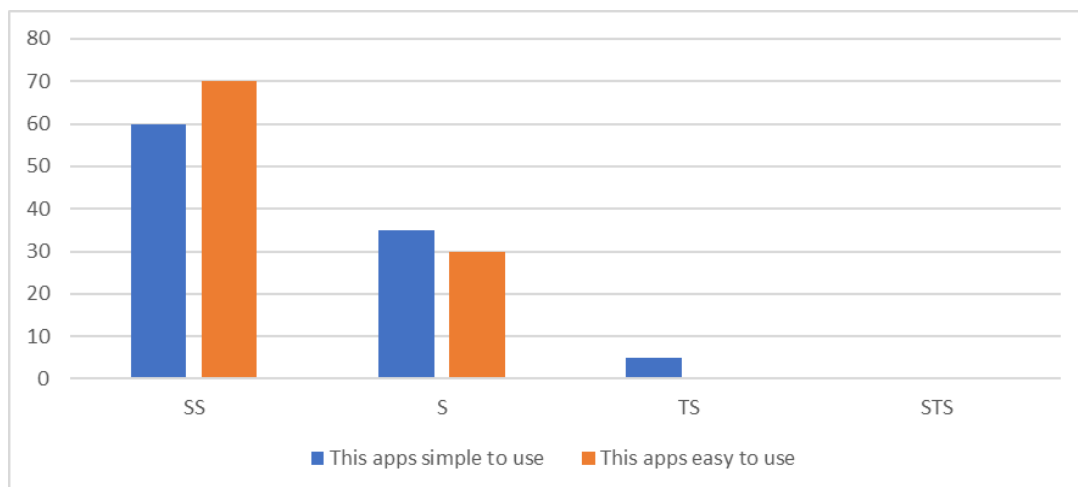


Figure 5. Indicator of ease of use aspect

Figure 5 shows the percentage of “ease of use” aspect statements that say they agree with an average of 32.5% and strongly agree with an average of 65%. From the results of this questionnaire, it can be seen that the majority of users agree and strongly agree that PhET Simulation is easy to use as a virtual laboratory. Thus, the use of PhET Simulation has good convenience so that users can complete the practicum stage when using it first (Rizaldi et al., 2020; Shafi'i, 2021).

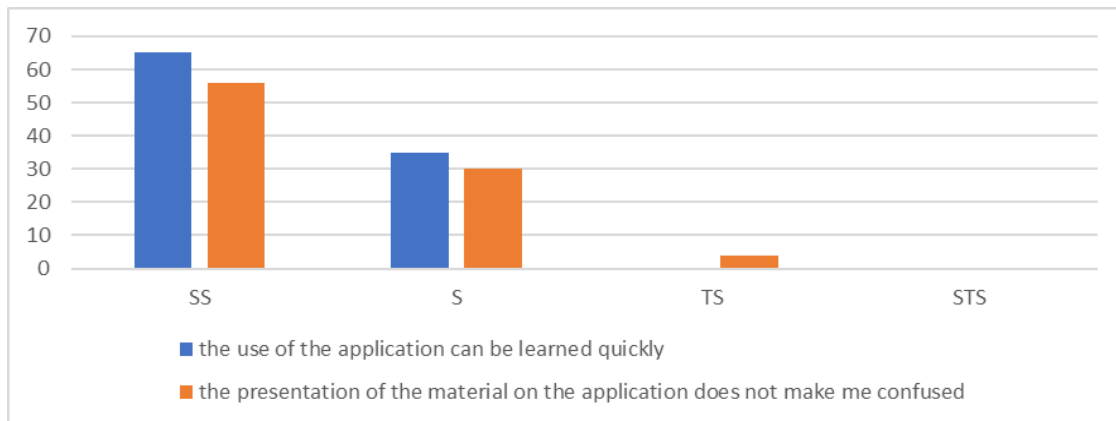


Figure 6. Ease of learning indicator

Figure 6 above describes the percentage of respondents to 2 statements in which ease of learning aspect shows agree with an average percentage of 32.5% and strongly agree with an average percentage of 60.5%. From the results of this questionnaire, it can be seen that the majority of users agree and strongly agree that this application is easy to learn and does not confuse users. Therefore, it can be concluded that students have no difficulty in using the PhET Simulation application as a virtual practicum learning medium (Prima et al., 2018).

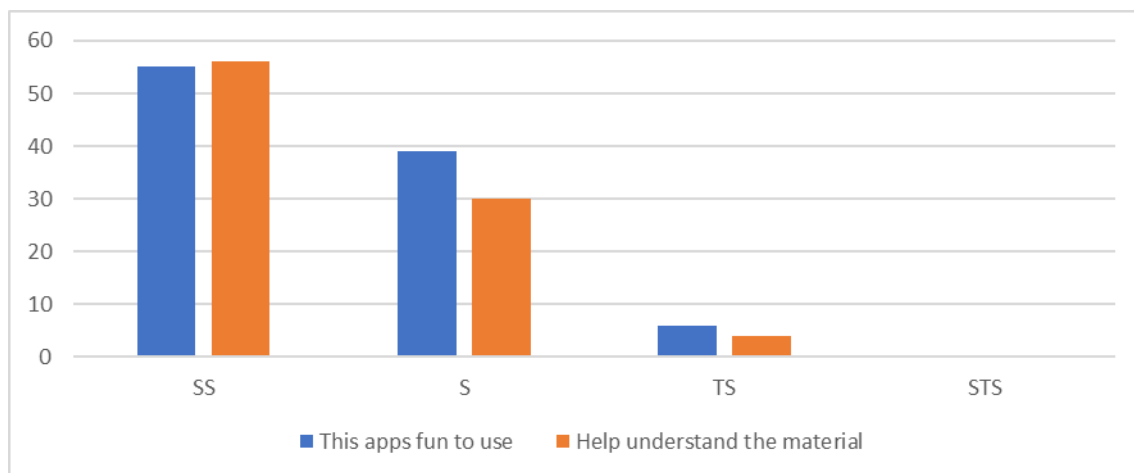


Figure 7. Indicator of satisfaction

Figure7 describes the percentage of respondents to 2 statements provided through the questionnaire showing that they agree with an average percentage of 34.5% and strongly agree with an average percentage of 55.5%. From the results of this questionnaire, it can be seen that the majority of users agree and strongly agree that the

use of this application is satisfactory. Thus, it can be concluded that this application gets good satisfaction from users. In other words, this application is very helpful and comfortable to use in the learning process with practicum (Alam et al., 2021).

Discussion

In this era of high technology, Science teacher can carry out practicum easily especially during the Covid 19 pandemic. Technological advances make it possible to conduct practicums through virtual laboratories, like Physics Education Technology (PhET). PhET Simulation is owned by the University of Colorado in the form of HTML-based applications that provide simulations of teaching and learning science based on virtual laboratory (Sylviani et al., 2020).

The simulations in PhET are interactive so they can stimulate students to learn by exploring directly. The simulation also contains abstract physics animations such as electrons, energy, atoms, and magnetic fields. The interactions that students do in the form of clicking a button drag (shift) objects or input a data. The results of the interactions carried out will be immediately visible right then and there (real-time). PHET also provides tools for quantitative data collection such as ruler, stop-watch, voltmeter, and thermometer (Riantoni et al., 2019).

PhET Simulation can be used online or offline by installing Java and Flash programs. The PhET-Java-Flash package is also available on the official PhET Simulation page (Kurniawan et al., 2020). PhET also has a feature of "Subject" to facilitate both teachers and students choosing activities according to the existing category, as seen in Figure 8 below.

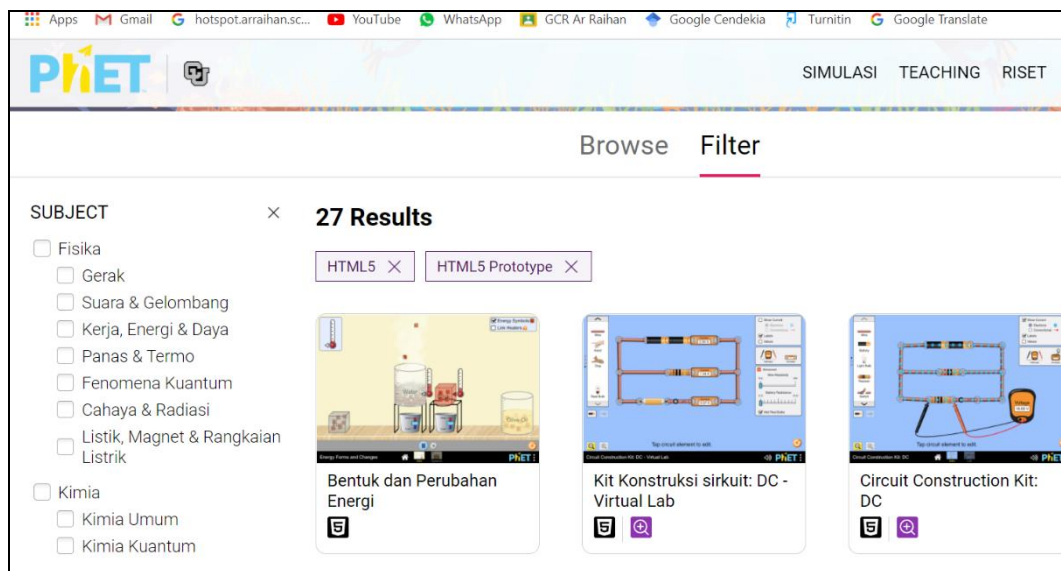


Figure 8. "Subject" display feature in PHET Simulation

Simulations contained in PhET are easy to use (user friendly) either for learning in the classroom or for self-study. Phet Simulation application also has the advantage of not being susceptible to viruses, not easily hang, and has a relatively small file size (Rizaldi et al., 2020). The simulation form in PhET can be interactive animation and designed like a video game. The features in PhET allow students to explore simulations.

The simulations also emphasize the interrelationships between everyday factual phenomena and computer simulations presented in easy-to-understand physical conceptual modeling, for example, the phenomenon of changing energy form as seen in Figure 9.

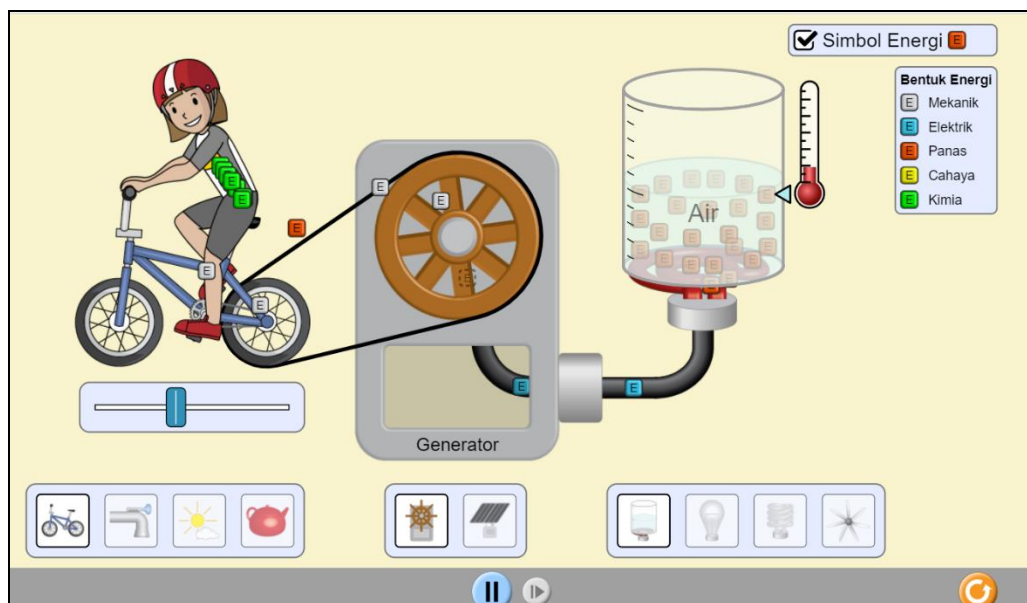


Figure 9. Simulation of energy form changes

Every application has its own advantages and disadvantages. As a virtual laboratory-based learning medium, disadvantages of PhET Simulations include: 1) the success of learning with the assisted virtual laboratory depends on the independence of students in learning. 2) saturation arises in students when students have lack understanding about computer use (Bhakti et al., 2019). The advantages of PhET Simulation simulation are as follows: 1) provide dynamic feedback. 2) train students to practice constructively by combining the initial knowledge possessed by students (pre-knowledge) with virtual findings from the simulation that is run. 3) make learning more interesting because students can learn while playing on the simulation. 4) visualize abstract physics concepts in the form of models such as electrons, photons, molecules (Astutic & Prahani, 2018).

The results of usability test on the use of PHET Simulation in the Science learning with the material of energy, at VII grade of odd semester at Ar Raihan Islamic Junior High School Bandar Lampung with e-worksheet showed that the majority of students agree and strongly agree with all aspects of usability usefulness, ease of use, ease of learning, and satisfaction.

CONCLUSION

The results of the usability test of the use of PhET simulation in the Science learning of energy material showed the percentage of respondents to statements given through questionnaires dominated by statements agreeing and strongly agreeing to all aspects of usability. This indicates the use of e-worksheet and PHET Simulation as a virtual laboratory meets the element of usability. Therefore, the use of e-worksheet and

PHET Simulation as a virtual laboratory are highly recommended as the online virtual practicum learning media even though the Covid 19 pandemic has ended.

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