



Practical Lab-Based Chemistry Learning Using PhET (Physics Educational Technology) Simulation

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Abstract : Practical Lab-Based Chemistry Learning Using PhET (Physics Educational Technology) Simulation. The Covid-19 pandemic has brought changes in many aspects of life, one of which is learning in schools. This study aims to analyze the use of PhET Simulation (Physics Educational Technology) as an online medium in facilitating chemistry practicum learning at SMA Borces Taruna Terpadu Bogor. Qualitative content analysis was carried out on the acid-base solution material. Data collection techniques in the form of interviews, class and school observation sheets, student response questionnaires, and written tests. The research was carried out in 3 meetings with a time span of 2 x 45 minutes for each meeting and was observed by 1 observer. During the research students are trained operating the PhET platform by researchers and teachers explaining Acid-Base material using PhET simulation in the classroom. Then at the end of the lesson, the students were given a post-test and the distribution of student response questionnaires after using the PhET media. The success of students is assessed from the Minimum Learning Completeness Criteria (KKBM) with a score of 75. The results of the study indicate that using PhET simulation can improve student learning outcomes and activities in carrying out chemistry lab work on acid-base solutions.

Keywords : Chemistry Practicum, PhET Simulation, Acid-Base Solution, Virtual Lab

Abstrak : Pembelajaran Praktikum Kimia Berbasis Lab-Virtual Menggunakan PhET (Physics Educational Technology) Simulasi. Pandemi Covid-19 telah membawa perubahan dalam banyak segi kehidupan, salah satunya dalam pembelajaran di sekolah. Penelitian ini bertujuan untuk menganalisis penggunaan PhET Simulation (Physics Educational Technology) sebagai media online dalam memfasilitasi pembelajaran praktikum kimia di SMA Borces Taruna Terpadu Bogor. Analisis konten secara kualitatif dilakukan terhadap materi larutan asam-basa. Teknik pengumpulan data berupa wawancara, lembar observasi kelas dan sekolah, angket respon peserta didik, dan tes tertulis. Penelitian dilaksanakan dalam 3 kali pertemuan dengan masing-masing rentang waktu 2 x 45 menit setiap pertemuan dan diamati oleh 1 orang observer. Selama penelitian peserta didik dilatih mengoperasikan platform PhET oleh peneliti dan guru menjelaskan materi Asam-Basa menggunakan PhET simulation di kelas. Kemudian pada akhir pembelajaran peserta didik diberikan post-test dan pembagian lembar angket respon peserta didik setelah menggunakan media PhET. Adapun keberhasilan peserta didik dinilai dari Kriteria Ketuntasan Belajar Minimal (KKBM) dengan skor 75. Hasil penelitian menunjukkan bahwa dengan menggunakan PhET simulation dapat meningkatkan hasil belajar dan aktivitas peserta didik dalam melaksanakan praktikum kimia materi larutan asam-basa.

Kata Kunci: Praktikum Kimia, PhET Simulation, Larutan Asam-Basa, Lab-Virtual

• INTRODUCTION

At the end of 2019, the whole world, including Indonesia, was shocked by a new outbreak called Covid-19. Corona Virus Disease 2019 has been declared by WHO as a global pandemic and in Indonesia it is declared as a type of disease that causes public health emergencies and non-natural disasters, which not only cause death but also cause substantial economic losses, so it is necessary to undertake mitigation efforts including prevention and control (Ministry of Health, 2020b).

The government issued regulations regarding distance and social restrictions as an effort to reduce the spread of the virus and minimize the spread of infectious diseases, especially in increasing the number of deaths. This includes providing a circular through the Ministry of Education and Culture with instructions so that each school can organize Distance Learning (PJJ) and students carry out learning from their respective homes (Firman, 2020: 81).

The education sector that has been affected during this pandemic is involving many routine activities. The impact experienced by education is felt, starting from distance learning/online learning methods, internet quota budgeting problems, supporting facilities and infrastructure, to the targets that must be addressed, requiring readiness for teaching and learning activities to run effectively. This of course involves educational institutions to swiftly accept the demands for change. School organizations must be ready with all possible supporting facilities and infrastructure, teachers are also required to be proficient and agile in utilizing the sophistication of digital technology in the application of learning and provide interesting learning experiences for students, while students must adapt to suddenly changing circumstances.

In conventional learning, of course, teachers can still overcome the problems of online learning, but new difficulties have been found related to the implementation of practical learning that cannot be carried out online. One of the practical lessons that have been impacted by the Covid-19 pandemic is chemistry practicum learning. As a branch of science whose development and application of knowledge requires the results of experimental work with certain standards, chemistry learning cannot be done only by providing theoretical material (Faika & Side, 2011). With the enactment of safety protocols during the pandemic, lab work in automated laboratories cannot be carried out properly.

On the other hand this practicum activity cannot be simply eliminated so that it is in line with the nature of the chemistry learning. This gap in the implementation of chemistry practicum learning requires the most possible alternative solution to be carried out. The alternative appears in the form of using online technology as a learning medium (Setiaji & Dinata, 2020). Online technology tends to be chosen because it is the spearhead of implementing education during a pandemic, is relatively easy, and can reach many people in many places. Utilizing online technology at the prepracticum stage, for example, students can create and upload practicum journals containing detailed experimental designs to their respective class groups. Mobile devices such as smartphones, tablets and laptops that can be used to access information anywhere and anytime (Gikas & Grant, 2013). The use of mobile technology has a major contribution in the world of education, including the achievement of distance learning goals (Korucu & Alkan, 2011). Various media can also be used to support the implementation of online learning.

The online-based media used by researchers in chemistry practicum learning is

PhET Simulation (Physics Education Technology). PhET function is to make it easier for students to learn the concepts that exist in the acid-base solution material virtually and can support at least the real implementation of chemistry practicum in the lab because it is interactive. PhET is a simulation developed at the University of Colorado United States which is useful to help the needs of students for both individual learning and classroom learning. In the PhET app there is various kinds of simulation learning one of which is a simulation in learning chemistry. PhET Media media focuses on the relationship between real life events and the underlying science, helps learning with constructivist and interactive interactive approaches , provides feedback , and provides creative and innovative work. All PhET simulations can be downloaded for free on the PhET site. Using PhET also requires a computer or android facility with java installed. PhET used online at the site <http://phet.colorado.edu>.

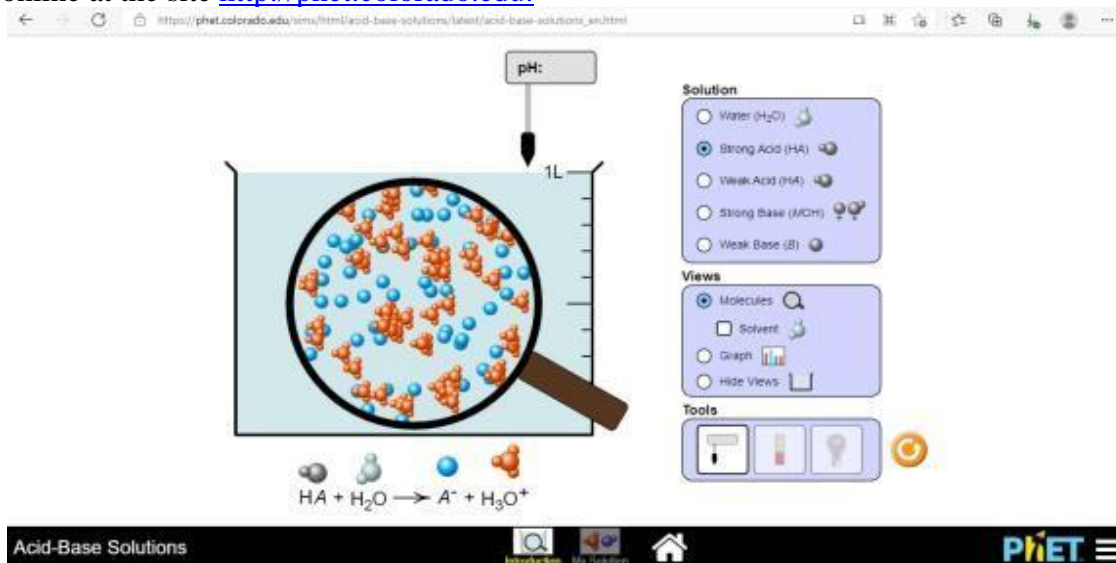


Figure 1. Display of PhET Chemical Acid Base Solution

Based on the above background, it is necessary to conduct a study entitled "PhET Simulation", as a Learning Media on Acid-base Solutions at SMA Taruna Terpadu Bogor (Borces)".

• METHOD

Population and Research Sample

The population in this study were all students of class XI MIPA at SMA Borces Taruna Terpadu Bogor in learning chemistry practicum with acid-base solutions. The sample was determined using a purposive random sampling technique by taking into account the consideration that the material used as the research sample was material taught during the Covid-19 pandemic.

Research Method

This research was conducted through a qualitative content analysis of the acid-base solution material to determine the relationship between the implementation of the chemistry practicum learning process and the use of technology in the form of PhET Simulation as a learning medium during the Covid- 19 pandemic. Content analysis is a research technique that collects and analyzes the content of a text. Content analysis is a research method that does not use humans as the object of research. Content analysis uses symbols or text in certain media, then the symbols or text are processed and analyzed. Qualitative content analysis uses a variety of tools and methods to study media content.

According to Kohlbacher in Helaluddin & Wijaya (2019), qualitative content analysis refers to material analysis in each implementation procedure. The steps to be followed are as follows: first, to formulate the research problem. Second, choosing seven practicum courses in the Chemistry Department whose learning process was carried out during the Covid-19 pandemic. Third, analyzing the duration of the practicum, types of media, learning methods, and comparison of the learning process before and during the Covid-19 pandemic. The results of the analysis are interpreted into descriptive analysis, percentages and frequencies to determine the results of the study. Fourth, the data are analyzed and reported systematically starting from the duration of lectures, types of media, learning methods, and comparisons of the practicum lecture process before and during the Covid-19 pandemic. Then the researchers made conclusions and suggestions for improvement.

Daltal Anallysis Techniques

The learning tools used in this study include : 1) Syllabus; 2) RPP ; 3) teaching materials; 4) Student worksheets. The data collection instruments used include: 1) Test sheet learning outcomes are useful for seeing completeness after using PhET media ; 2) class teacher interview sheet; 3) the observation sheet is useful for observing student activities during the learning process; 4) response questionnaire sheet, this questionnaire is useful for knowing the responses of students after using PhET media in an acid-base solution. Students are said to be complete in the learning material after doing the Posttest and getting a score of 75. Furthermore, the value is converted into the letters AD according to Table 1.

Table 1 . Category Interval Learning Outcomes

Value Interval	Predicate
85 < N 100	A
70 < N 85	B
55 < N 70	C
55	D

Analysis data Student activity is known based on the results of the student activity observation sheet. Observers observe the dominant activities carried out by students during teaching and learning activities in progress, Observations were made every 5 minutes. The percentage of criteria for active students is presented in Table 2

Table 2. Activity Criteria

Active Students %	Criteria
81-100	Very active
66-80	Active
56-65	Active Enough
0-55	Less Active

Responses can be obtained from the data from the results of filling out the response questionnaire sheet. The student response questionnaire contains responses from students during learning using the PhET media. The questionnaire compiled by the researcher is based on the Guttman Scale which is stated in the form of a statement. The completed questionnaire is calculated based on the criteria in Table 3

Table 3. Guttman Scale Statement

Statement	Score/Score Statement	Score/Score Statement
Yes	1	0
No	0	1

The results of the student response questionnaire on the use of PhET . media analyzed by presenting the results of student answers with formulas.

$$P = \frac{F}{N} \times 100\%$$

Information:

P : Percentage of answers respondents

F : The number of respondents' "Yes" answers to positive statements, the number of "No" answers to negative statements .

N : Number of respondents

If the percentage of students who gave a positive response 61%, then the PhET media can be said to be good for use in learning.

Test Scoring

Guidelines for scoring the three-tier multiple choice diagnostic test were used as a guideline to determine the results of the tests used. According to Alrikunto (2013), the formula used for student scoring can be seen in the equation:

$$S = R$$

Description:

S : Score obtained

R : Correct answer or reason

• RESULTS AND AN DISCUSSION

The study was conducted in one meeting and only used a sample of one class without a comparison class. During the learning process participants educate Students are given a Student Worksheet (LKPD) and a manual for operating the PhET media. The number of students in one class is 28. The students are then divided into 7 groups to have discussions and cooperate in completing the tasks given by the teacher by working on the questions in PhET . At the end of the learning activities students are given post - test questions to determine the learning outcomes obtained by students after learning acid - base solutions with the help of PhET media .

Descriptive analysis results data on the percentage, duration of implementation, and online practicum learning outcomes. Results and discussion obtained from research on the application of PhET as a medium for learning Acid - base solutions at SMA Taruna Terpadu Bogor are the results of learning, activities and student responses, with the following description :

Student Learning Test Results

Individual student learning outcomes were obtained from the posttest conducted

at the end of the meeting. The purpose of the Posttest is to determine the completeness of the learning outcomes of each student after carrying out teaching and learning activities by applying PhET media. on the material Acid- base solution. Posttest questions are arranged based on indicators of completeness of learning outcomes. The indicator of completeness of learning outcomes in this study consisted of 7 indicators with a total of 10 items in the form of multiple choice.

The analysis of student learning outcomes uses a percentage system that is seen from individual completeness and classical completeness must be 75%. In the pre-test, 28 students did not reach the standard of completeness , so it can be said that all students had not finished working on the pre-test questions.

After applying PhET as a learning medium, 21 students are included in the criteria for completion after working on the post-test questions so that it can be stated that 75% of students have completed classically. Students did not complete when working on the pre-test questions because students did not understand the acid -base solution material that had been taught. However, after students use PhET media and working on post-test questions , 12 students were declared complete with good predicates, ranging from 71% -85%. This is assisted by research which says that the factors that influence learning outcomes are internal factors including physiological and psychological factors, the two external factors include environmental factors and instrumental factors. PhET Media media is an instrumental factor or a factor that comes from outside whose existence and use are arranged in accordance with the desired learning outcomes

Student Activities

Observation activity participant educate done to 28 participants educateclass XI MIPA SMA Taruna Terpadu Bogor. The observations of these students present the activities during the process learning with using PhET . simulation mediaIn the study of acid - base solutions, observations were made for 2 x 45 minutes per meeting and were carried out 3 times meeting. The average presentation of student activities during learning activities takes place at 2 x 45 minutes is presented in Table 5 as follows.

Table 5 . Average Percentage of Student Activities

No. Student Activities	Average Percentage Student Activity Time	
	Frequency	Activity(%)
1. Students listen and pay attention to the teacher's explanation	4	14.81
2. Students read the material in the LKPD and manuals	3	11.11
3. Students focus on completing the tasks in the LKPD	2	7.41
4. Students discuss the answers to the questions in the LKPD in groups	2	7.41
5. Students present their group learning results	4	14.81
6. Students ask questions to the teacher or group who are presenting	2	7.41
7. Learners use PhET media according to procedures	5	18.52

8. Students understand the procedures for using PhET media media	3	11.11
9. Irrelevant student activities	2	7.41
Total Activity Relevant	25	92.59
Total Irrelevant Activity	2	7.41

There are two aspects of the assessment of student activities observed, namely relevant activities and irrelevant activities. Relevant activities get a high percentage of 92.59 %, while those that are not relevant have a percentage 7.41%. Based on the comparison of these percentages, the activities of irrelevant students are lower than relevant activities, so that classical student activities are categorized as very active during learning activities. This is in accordance with research which states the activities of students during learning activities using PhET . media declared high because students are able to draw conclusions at the end of the lesson correctly and appropriately. PhET Media media included in visual learning while student worksheets include verbal learning. Learning given in verbal and visual forms will be easily remembered by students in the long term . Irrelevant activities are students doing learning that is not in accordance with the observation sheet suchas playing HP, talking to myself, sleepy. Having a very small percentage of 7,41 %, this happens because students do not understand the actions taken during class learning.

One of the factors that cause students to lack understanding is because students are not used to doing teaching and learning activities using PhET media . Students who are not used to learning with PhET media cause low grade activities and students are still hesitant to express their own opinions to solve problems . Meanwhile, if it is seen from the student responses, it shows significant data. Students are active in carrying out learning using PhET simulations in class. The results of student responses and activities can be seen in table 6 as follows:

Table 6 . Student Response Results

No.	Statement	Amount	Positive response (%)
1.	PhET Media media attractive (+)	28	100
2.	PhET media appearanceattractive (+)	26	92.8
3.	PhET media appearanceboring (-)	10	35.7
4.	Instructions for use are easy to understand (+)	23	82.1
5.	The language used is difficult to understand (-)	12	42.8
6.	Material in media PhET hard to understand (+)	25	89.2
7.	Methods/procedures for using media are difficult to use (-)	10	35.7
8.	PhET Media media make I'm more interested in studying chemistry (+)	26	92.8

9.	PhET Media media lowered my enthusiasm to study chemistry (-)	16	57.1
10	I like learning chemistry using PhET	26	92.8

Based on Table 6, the results of the response and activeness of students get an average positive response of 91.6 %, while the negative response of students is 6.8%, it states that the PhET media can be said to be good to apply in chemistry learning because it can provide convenience and interest for students. Thing This is supported by research that has been done by researchers who say that the effect of using PhET . media on electrolyte and non-electrolyte solution material can provide motivation and convenience to students. During learning activities using learning media can build new curiosity, and generate stimulation and motivation during learning, and even affect psychology on students .

• CONCLUSION

Based on the research data described above, it can be concluded that the application of PhET . simulation as a learning medium Acid-base solution at SMA Taruna Terpadu Bogor is proven successful with the following details : Complete learning outcomes are obtained students were declared complete from a total of 28 students, this stated that 75% of students were declared classically complete. This shows that the use of PhET . media Acid-base solution completes student learning outcomes educate. The activities of students are very active classically, this is evidenced by the percentage of relevant student activities of 92.59 % while those that are not relevant are 7.41%. The positive response of students has an average of 91.6 % while the negative response of students has an average of 6.8 % . Thing This proves that the positive response of students to the use of acid - base solution learning media in class XI MIPA SMA A Taruna Terpadu Bogor is said to be good.

There are several suggestions that researchers want to convey, namely: The Cognitive Domain contained in the questions of students only uses level C1 to C4, it is hoped that further researchers can use questions those with higher grades C5 to C6. PhET Media media is an online simulation platform based on virtual laboratories that can replace some real laboratories. Therefore the PhET . medium very good to apply, and can be used as an alternative in learning chemistry practicum.

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