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Development of Experimental LKPD Using Virtual PhET Lab Simulation Media to Improve Learning Outcomes and Students Enthuasiasim in Acid-Base Materials for Class XI In SMA

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Abstract: Development of Experimental LKPD Using Virtual PhET Lab Simulation Media to Improve Learning Outcomes and Students Enthusiasm in Acid-Base Materials for Class XI in SMA. *Media learning can stimulate the enthusiasm of participants raised in learning activities. This study is aimed at determining whether the LKPD learning media experiments with PhET virtual laboratory simulation media on developed acid and base learning eyes have met validity, practicality, and efficiency. The subjects of this study were 25 students of class 12 SMA Muhammadiyah 10 GKB Gresik using the 3D(define,design, dan develop) development model developed by Thiagarajan. The results obtained are, 1) Validity of the LKPD experiment declared valid on the validity of the contents and validity of the consecutive structure obtained a percentage of 87.5% and 84.3% with very worthy criteria. 2) The practicality of the LKPD developed is said to be practical by increasing the comfort response of participants when using the LKPD with an average percentage of 98.1% with very practical criteria. 3) Assessed from the increased enthusiasm of the participants against the experimental LKPD which obtained an average percentage of 99% with one effective criterion, and the student's learning value increased on basic acid which shows an increase, and specified in the effective category with an average percentage of N-Gain of 80%. And stated to have learned from its classic sequence.*

Keywords: LKPD experiment, *PhET* simulation, acid base.

Abstrak: Pengembangan LKPD Eksperimen dengan Media Simulasi Virtual Lab PhET untuk Meningkatkan Hasil Belajar dan Antusiasme Peserta Didik dalam Materi Asam Basa Kelas XI di SMA. *Media pembelajaran dapat membangkitkan rasa antusiasme peserta didik dalam kegiatan pembelajaran. Penelitian ini bertujuan untuk mengetahui apakah media pembelajaran LKPD eksperimen dengan media simulasi laboratorium virtual PhET pada mata pelajaran asam basa yang dikembangkan telah memenuhi validitas, kepraktisan, dan keefektifan. Subjek penelitian ini adalah 25 peserta didik kelas 12 SMA Muhammadiyah 10 GKB Gresik dengan menggunakan model pengembangan 3D (define, design, dan develop) yang dikembangkan oleh Thiagarajan. Hasil yang diperoleh adalah, 1) Validitas LKPD eksperimen dinyatakan valid pada validitas isi dan validitas struktur berurutan diperoleh persentase 87,5% dan 84,3% dengan kriteria sangat layak. 2) Kepraktisan LKPD yang dikembangkan dikatakan praktis ditinjau dari angket tanggapan kenyamanan peserta saat menggunakan LKPD dengan persentase rata-rata 98,1% dengan kriteria sangat praktis. 3) Ditinjau dari angket antusiasme peserta terhadap LKPD eksperimen diperoleh persentase rata-rata 99% dengan kriteria sangat efektif, dan hasil belajar peserta didik pada materi asam basa menunjukkan peningkatan, dan dinyatakan dalam kategori efektif dengan rata-rata persentase N-Gain sebesar 80%. Serta dinyatakan telah tuntas belajar dilihat dari ketuntasan klasikalnya.*

Kata kunci: *LKPD eksperimen,simulasi PhET, asam basa*

- **INTRODUCTION**

During the learning process in class, students need to have enthuasism in receiving and responding to the materials delivered. According to Sadirman (2011), enthuasism will push people to act and give direction to the activity of what needs to be done in accordance to the formula, and also to determine actions that need to be done harmonically to achieve certain goals by putting aside actions that wont help achieve the goals. During learning process, students need to have enthuasism and good spirit in learning in order to achieve a maximum learning result or achievement.

Learning process is bascially a form of communication process, in which the media used for the learning process is called learning media (Falahudin et al., 2014). The use of learning media during learning process can generate new desires and interest, enhance motivation and enthuasism in learning, even cause a psychological effects for the students. Besides that, the use of learning media eases the interaction between teachers and students, making the learning process become more effective and efficient (Karo et al, 2018). Media is physical or non-physical tool that is purposely designed to be used as a bridge between teachers and students to understand the materials taught (Kurniawan & Hidayah,2020). In general, the characteristics of learning media are able to be touched, to be seen, to be heard, and to be observed by the five sense (Supardi,2015).

Chemistry is a very abstract subject, this abstraction is what make chemistry feel difficult (Huda,2021). Chemistry learning is a learning that link up scientific theories with scientific experiments in order to support the theories. One of the learning media that can be used during chemistry learning is student worksheets or LKPD. According to Nurdin and Adriantoni (2016), LKPD is a worksheet used by the students as a guide in the learning process, consisting of the works done by the students in the form of questions and activities done by the students.

Based on the pre-research's result that were done by the 12th grade students at SMA Muhammadiyah 10 GKB Gresik, it is found several problems during chemistry learning whic are, 1) students assume that chemistry is difficutl, 2) students are less interested towards chemistry learning because the learnin media used before was monotone, 3) students dont like when teachers use lecture methode during chemistry learning, 4) students like practicum in chemistry learning because they feel they understand chemistry better. Interview results with chemistry subject teachers that was done at SMA Muhammadiyah 10 GKB Gresik were also obtained, it stated thta practicum in chemistry learning was rarely to be held, this was because of the limitations of tools and materials in the laboratory, as well as the limited allocation of the learning time. In addition, the average completeness of score of the students in the 11th grade of 2nd semester was also still low.

The low completeness of the average class scores achieved by the students casued by the lack of the students' interests and motivations as well as practicum activities that are rarely to be held. Whereas practicum is a learning that cant be separated from chemistry learning. According to Rahmawati et al., (2014), practicum is the best medium to develop the scientific process skill which can enhance the learning results because it gives a chance to students to experience or go through the experiences by themselves which later on could be managed fitting in with their cognitive skills.

One of the ways of prioritizing process and assignments is experiments and practicum, because it can discover scientific concept based on process, observation,

analysis, proof, and , analisis, conclusion making from the object (Istarani, 2012). Menurut Paul Suparno (2007), experiment method is a method used to gain knowledge and skill by observing, analyzing, and making conclusion based on data. In the experimental method, students are given the opportunity to experience themselves, participate certain process, observe a certain object, situation, or certain process, and draw conclusion.

Therefore, virtual laboratory is the right solution that can be used in learning process if direct offline practicum cant be held. Virtual laboratory is an electronic learning device that uses computer simulation (Razi,2013). In this virtual laboratory, students can do experiments in their computer or smartphone by continuing in carrying out the practicum tools function just like in offline practicum even though this simulation doesnt mean it can replace the functions of the real practicum tools. According to Imron (2012), Virtural laboratory is a laboratory that forms as a complete set of computer with applications specifically designed for laboratory activities. Virtual laboratory is included in the form of animation tools, materials, and interactive design for the experimental activities. So that the students can experiment on their own in accordance to the LKPD provided.

Teachers are expected to be able to adapt and increase their competency in various field of the technology in conceptualizing interesting, fun, and meaningful learning system for the students (Ulum,2021). One of the virtual laboratory that can be used in the chemistry learning media on acid-base materials is the Physics Education and Technology (PhET). PhET is a well-constructured computer program that follows with the learning technology improvement developed in University of Colorado, Boulder, the United States to provide learning simulation and virtual laboratory-based science learning that can make it easier for the students for the learning process in class (Neti Nafrianti et al, 2016).

PhET Interactive simulation runs with the flash player program and java program, and also can be run through web browser which is connected to the flash player and java. This simulation can provide and explain abstract things that cant be observed directly in real life, and give enough space to experiment, because variable provided can change flexibly fitting in with the need for investigations in learning (Neti Nafrianti et al, 2016). This PhET interactive simulation can also be operated by the students by using computer, laptop, or smartphone.

Based on the explanation of the problems above, it is necessary to do a research with a title of, "Development of Experimental LKPD Using Virtual PhET Lab Simulation Media to Improve Learning Outcomes and Student Enthuasiasim in Acid-Base Materials for Class XI In SMA". This purposes of this research are; 1) to discover whether the LKPD learning media with the virtual lab simulation media on acid-base materials developed has met the validity or not; 2) to discover whether experimental LKPD assisted by the PhET virtual lab simulation media can provide comfortness to the students while learning the Acid-base materials for the XI Grade students of second semester in the highschool; 3) to discover if experimental LKPD assisted by the PhET virtual lab simulation media can increase the students learning enthuasiasm on the Acid-base materials for the XI Grade tudents of second semester in the highschool; 4) to discover if experimental LKPD assisted by the PhET virtual lab simulation media can improve the students learning outcomes on the Acid-base materials for the XI Grade students of second semester in the highschool.

- **METHOD**

The type of this research is Research and Development. Research Research and Development method is a research method used to validate and develop a product (Sugiyono, 2017). The procedure of media development in this research uses a 4D model developed by Thiagarajan, Semmel & Semmel (1974) with a modification of simplification which originally concisted of 4 steps, namely define, design, develop, and disseminate. Becoming to a short version of 3 steps namely define,design, and develop.

The subjects of the research in this leraning media development research are the XII SMA Muhammadiyah 10 GKB Gresik students with a total of 25 students. Data, data collection method, and instruments used to support the development of PhET virtual laboratory-assisted experimental LKPD is shown in table 1.

Table 1. Data, Data Collection Method, and Research Instruments

Data	Data Collection Method	Instruments
LKPD Validity	LKPD Validation by experts	Validation sheets
LKPD Practicality	Questionnaire about the convenience of students when using LKPD	Student comfort response questionnaire sheet when using LKPD
LKPD Effectivity	Student tests and student enthuasiasm questionnaires	Evaluation quoestion sheet and student enthuasiasm questionnaire sheet towards LKPD

The steps taken in LKPD validation are to provide the experts on each components from the aspect of assessing the feasibility of LKPD. Each component of the assessment is assessed by validators who are experts in their fields. The results obtained later on analyzed by calculating the total score with the following formula:

$P = \frac{n}{N}$ x 100%

Description :

P : Eligibility percentage

n : total scores of the average assessment aspects

N : total maximum scores of the assessment aspects

According to Riduwan (2013), the criteria of assessment for the average score and percentage can be seen in table 2.

Table 2. Score Interpretation Criteria

Percentage (%)	Criteria
0-20	Very poor
21-40	Bad
41-60	Fair
61-80	Good
81-100	Very Good

LKPD developed can be said to be feasible if it meets the eligibility criteria with a percentage of $\geq 61\%$.

The process of score determining on the student convenience response questionnaire when using the LKPD is carried out by making the most fitting classification and category. The calculation is carried out by using the Guttman scale which measurements can be seen in table 3.

Table 3. Guttman Scale

No.	Statement	Description	Score
1	Positif	Setuju	1
		Tidak setuju	0
2	Negatif	Setuju	0
		Tidak setuju	1

Source: Adapted from Riduwan (2013)

Based on the score result with the Guttman scale, the next is to convert it to a percentage with the following formula:

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

Description :

P = percentage of the result

F = the total of answers that answered "Yes" for the positive statement or total of answers that answered "No" for the negative statement.

N = total respondents

Students response percentage is interpreted in Table 4.

Table 4. Score Interpretation Criteria

Percentage (%)	Criteria
0-20	Not practical at all
21-40	Less pratical
41-60	Pratical enough
61-80	Practical
81-100	Very practical

Source : Riduwan (2013)

Students worksheets can be said practical based on the interpretation criteria from table 4, if the percentage obtained is ≥ 61%.

Score determining process in the student enthuasiasm questionnaire was done by making the most fitting classification and category. Calculation was done by using the Guttman scale in which the measurements can be seen in table 3.

Based on the score result using the Guttman scale, next it will be converted into a percentage using the following formula:

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

Description :

P = percentage of the answers

F = the total of answers that answered "Yes" for the positive statement or total of answers that answered "No" for the negative statement.

N = total respondents

The percentage of the students response in the student enthusiasm questionnaire is interpreted into the table 5.

Table 5. Score Interpretation Criteria

Percentage (%)	Criteria
0-20	Very not effective
21-40	Less Effective
41-60	Somewhat effective
61-80	Effective
81-100	Very effective

Source : Adapted from Riduwan (2013)

Students worksheets can be said effective based on the interpretation criteria from table 5, if the percentage obtained is ≥ 61%.

On the pretest and the posttest sheet, there were 20 multiple choice questions consisting of cognitive level ranging from C1 to C4. Data obtained through the pretest and posttest sheet will be analyzed with the following ways.

$$Score = \frac{total\ scores\ obtained}{maximum\ score}\ x\ 100$$

Scores obtained will be tested with the normality test which later on if it contributes normally will be followed with the Paired Sample T-Test on SPSS in which if the value of sig.(2-Tailed) obtained is less than 0,05 so it can be concluded that there is difference between the pretest and the posttest results. This shows that there is a meaningful impact towards the difference in the treatment given. Learning outcomes data of the students in the realm of knowledge were obtained and analyzed from the pretest and the posttest scores which were analyzed using the N-Gain test.

$$gain\ score = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score}\ x\ 100$$

Learning can be said effective if the result of the N-Gain test achieved to the somewhat effective category or the effective category based on the category of effectiveness interpretation according to Hakke (1999) which can be seen in table 6.

Table 6. N-Gain Effectivity Interpretation

Presentase (%)	Tafsiran
< 40	Not effective
40-55	Less effective
56-75	Somewhat effective
>76	Effective

The final results in the good criteria if the final student results reach the classical completeness or at least 85% of the total number of students in class who reach the KKM. The minimum completeness criteria for acid-base material is 77. According to Trianto (2010), a class can be said have completed its learning (classical completeness) if in that class, there are 80% of the students who completed the learning.

- **RESULT AND DISCUSSION**

This part will be describing the results as well as the discussion about the reserach on the development of experimental worksheets with PhET to increase the learning outcomes and students enthuasiasm in acid-base materials. Students worksheet can be said worthy if three aspects are met, which are validity aspect, praticality aspect, and

effectivity aspect. Research method referes to the 4D development model which was developed by Thiagarajan, Semmel & Semmel (1974) with a modification of simplification which originally concisted of 4 steps, namely define, design, develop, and disseminate. Becoming to a short version of 3 steps namely define,design, and develop.

Define stage

The define stage aims to determine and define the needs during the learning process. In this stage, five main steps are carried out, which are, preliminary analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives.

Preliminary analysis aims to determine the basic problems faced in the chemistry learning especially for the acid-base materials in highschool including curriculum and field problems so that the development of learning is needed. With this analysis, an overview, facts, expectations, and alternative solutions to the basic problems that facilitate the selection of learning media and developed to put an end to the problems faced are obtained. Student analysis aims to analyze the students' characteristics and understand the learning media so that it could help the students during the learning process. Task analysis is a set of procedures to determine the content in the learning plan by detailing the task of the contents if the teaching materials in outline of the Core Competencies (KI) and Basic Competencies (KD) in accordance to the 2013 Curriculum. Learning material provided in the LKPD development is acid-base material. Concept analysis is the identification of main concepts that will be taught and conceptualized sistematically and will be detailed in relevant concepts. Acid-base material is the main concept that will be taught referring to the KD 3.10 which is explaining the concept of acid-base as well as its powers and its ioning equilibrium in solution. Formulation of learning objectives aims to formulate the learning objectives that will be achieved by the students.

Design stage

Design stage aims to produce prototype that will be produced namely experimental LKPD with PhET virtual lab solution media. Four steps taken in this stage are; 1) Instrument determination, 2) Media selection, 3) Format selection, 4) Preliminary plan conceptualization.

In the instrument determination, instrument that is arranged is in the form of learning tool and data collection instrument. Learning tool instrument is in the form of RPP, meanwhile the data collection instrument is in the form of a validation questionnaire that is used to assess the feasibility of the media, a questionnaire on the comfort of the students when using LKPD, evaluation question sheets and student enthuasiasm questionnaire sheets towards LKPD. Data selection step, is identifying relevant media to solve the surging problems, relevant media are based on the analysis results in the define stage which is experimental LKPD assisted by the PhET virtual lab. Format selection stage, is organizing and conceptualizing the content of experimental LKPD and making design including layout design, images, and text. Preliminary plan conceptualization is used to design and conceptualize experimental LKPD that will be developed before product testing is conducted, the initial LKPD that will be developed in this stage is called draft I.

Develop stage

Develop stage is a stage that produce product development. The goals in this stage are to produce learning media and tools after going through a revision based on the input from expert/practicioner validators and test result. This stage is conducted in three steps, which are; 1) expert validator assessment (expert appraisal) followed by reviison, 2) developmental testing.

Expert validation was carried out by two Chemistry Education lecturers in FMIPA UNESA in the initial draft and practical validation was carried out by a Chemistry teacher so that the validaiton result as well as comments and suggestions/feedbacks for learning media improvement can be obtained. Learning media and data collection instrument that have gone through validation step were fixed based on the suggestions and validators whcih later on would produce revision I.

Experimental LKPD that has been fixed based on the suggestions from validators (product revision I) later on to be tested to several students representating the target population. Students are from the XII class who were chosen randomly with abilities below the average, and above the average in their class, and that was done because the XII class have already gotten the acid-base material. In a limited field test, deficiencies and weaknesses will be met on the practicum worksheet that has been made and tested. These deficiencies and weaknesses later on are corrected in the product revision II so that the product produced is a new product that is in accordance with the students' abilities and is better as well as ready to be extensively tested.

LKPD Validity

Students worksheets developed were reviewed based on the validity criteria from Plomp & Nieveen (2010), which states that the criteria of certain product were seen from content validity and construct validity.

The content validity of the LKPD is reviewed from several aspects which are; 1) to discover the content validity of LKPD towards its conformity with the 2013 curriculum, 2) to discover the content validity of LKPD towards its conformity with the core competencies, basic competencies, indicator, and goals, 3) to discover the content validity of LKPD towards its conformity with acid-base materials in accordance with the right facts and concepts, 4) to discover the content validity of LKPD towards its effects given to the students, 5) to discover the validity of LKPD towards its conformity with the guided inquiry method, 6) to discover the validity of the syllabus and RPP, 7) to discover the validity on the pretest and posttes cognitive assessment worksheet, 8) to discover the validity of the students questionnaire sheet responses to the practicality of the LKPD practicum assisted by the PhET virtual laboratory on acid-base material, 9) to discover the validity on the students enthusiasism questionnaire sheet for the use of virtual laboratory-assisted practicum worksheets (PhET) to improve the learning outcomes on the acid-base materials. The results of the LKPD validity based on the content validity rached an average percentage of 87,5% with criteria of very feasible.

The validity of LKPD construct is reviewed from several aspects whcih are; 1) to discover the validity of LKPD towards the criteria of the presentation, 2) to discover the validity of LKPD towards the criteria of the language used, 3) to discover the validity of LKPD towards the criteria of the graphical used in the writings. The results of the construct validity reacehed an average percentage of 84,3% with a criteria of very feasible

LKPD practicality

Practicality criteria are reviewed based on whether or not the product is easy to use and understand by users (Plomp & Nieveen, 2010). LKPD practicality is seen from the questionnaire on the students comfort when using LKPD. The questionnaire sheet contains 17 statements in the form of positive and negative statements. This questionnaire is reviewed from two aspects, which are; 1) to discover the students interest towards the LKPD assisted by the PhET vritual laboratory, 2) to discover the level of ease of use of LKPD assisted by the PhET virtual laboratory as a learning medium for the acid-base materials learning. In the first objective, there are 9 statements thata reached an average percentage of 97,7%. In the second objective, there are 8 statements that reached an average percentage of 98,5%. The total average percentage of the LKPD practicality is up to 98,1% with criteria of very practical, so that experimental LKPD assisted by the PhET virtual laboratory is feasible to use.

LKPD effectivity

LKPD effectivity is measured based on the questionnaire of the students enthusiasim towards the experimental LKPD assisted by the PhET virtual laboratory and the test score on the acid-base materials. The students enthusiasim questionnaire consists of 20 statements in the form of positive and negative statements. This worksheet is reviewed from several aspects, which are; 1) to discover the students responses towrads the LKPD assisted by the PhET virtual laboratory on the acid-base materials, 2) to discover the students enthusiasism towards the LKPD assisted by the PhET media, 3) to discover the students responses towards the language used in the LKPD assisted by the PhET laboratory on the acid-base materials, 4) to discover the students responses towards the materials presented in the LKPD assisted by the PhET laboratory on the acid-base materials. In the first objective, there are 3 statements with an average percentage of 100%. In the secon objective, there are 6 statements with an average percentage of 100%. In the third objective, there are 2 statements with an average percentage of 98%. In the fourth objective, there are 9 statements with an average percentage of 98,2%. The total average of percentage of the students enthuasism questionnaire towards the experimental LKPD assisted by the PhET virtual laboratory up to 99% with criteria of very effective.

LKPD effectivity is measured based on the test scores on the acid-base materials. Pretest was carried out to discover the preliminary knowledge before using LKPD. Postest was carried out to understand the final knowledge of the students after using the developed LKPD. Normality test that has been carried out states that pretest and posttest distribute normally. And then followed by the Paired Sample T-Test on SPSs and reached a value of sig.(2-Tailed) which is less than 0,05 so that it can be concluded that there is difference between the pretest and the posttest results. Furthermore, it is analyzed with N-Gain test which aimed to discover how big the learning outcomes improvement of the students after using the developed LKPD. Those students worksheets are stated into the effective category with an average precentage 80% of the N-Gain value. And in that class, it is stated that the learning had been completed seen by the classical completeness of the posttest score which there were 21 out of 25 students that have successfully reached the KKM score of 77.

- **CONCLUSION**

Based on the analysis result and discussion regarding this research and development is stated that it is feasible seen from the validityaspect, practicality aspect, and effectivity

aspect, it can be concluded that; **The validty** of experimental LKPD assisted by the pHET virtual laboratory for the acid-base material was declared valid for its contents validity and respectively constructs validity successfully reached a percentage of 87,5% with a criteria of very feasible and 84,3% with a criteria of very feasible. **The practicality** of LKPD developed can be said practice enough reviewed from the questionnaire on the convenience of students when using LKPD with an average percentage of 98,1% with criteria of very practical. The effectivity of LKPD developed can be said effective reviewed from the questionnaire on the students enthusiasm towards the experimental LKPD assisted by the PhET virtual laboratory reaching an average percentage up to 99% with criteria of very effective, and the scores of the students learning outcomes on acid-base material which shows an increase, and is stated in the effective category with an average percentage of N-Gain value of 80%. And also declared to have completed the learning seen from the classical completeness.

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