(JIML) JOURNAL OF INNOVATIVE MATHEMATICS LEARNING
Volume 7, No. 4, December 2024
P-ISSN 2621-4733
E-ISSN 2621-4741
https://dx.doi.org/10.22460/jiml.v7i4.p22586

THE DEVELOPMENT OF LIVEWORKSHEETS-ASSISTED DISCOVERY LEARNING MODEL WORKSHEETS FOR IMPROVING STUDENT'S CRITICAL THINKING ABILITY

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ARTICLE INFO

Article history:

Received Mar 11, 2024
Revised Apr 30, 2024
Accepted May 22, 2024

Keywords:

Critical Thinking Ability
Discovery Learning
Liveworksheets

ABSTRACT

Student Worksheets (LKS) are an interactive bridge between teachers and students, this is also related to measuring student learning outcomes. The use of worksheets affects the level of effectiveness in working on test questions. Stimulating students' cognitive critical thinking can be obtained, including from learning mathematics with the right approach method. One of the students' learning goals is to be innovative and creative in solving problems with solutions. The aim of this research is to develop a LKPD (Learner Worksheet) model of discovery learning assisted by a live worksheet to make it more effective and efficient and have the potential impact of growing students' cognitive level of critical thinking. The research method used is a design research model which is divided into two parts, namely preliminary (preliminary study and LKPD-Liveworksheet design) and formative evaluation including self-evaluation, prototyping (expert review, one-to-one, and small groups) research field tests as well revision. Research data was analyzed quantitatively and qualitatively. The research results show students' critical thinking abilities for Liveworksheet LKPD teaching materials with exponents and logarithms in the "Legal" and "Easy" categories according to experts and practitioners. The results of the research show that the LKPD developed is feasible, effective and influences students' critical thinking skills using the discovery learning model. The activities in this research have resulted in a product being developed in the form of a critical thinking worksheet using a discovery learning model assisted by a live worksheet which creates productive learning.

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How to Cite:

Apriani, NS., Nurdin, IT., Yuliani, A. (2024). The Development of Liveworksheets-Assisted Discovery Learning Model Worksheets for Improving Student's Critical Thinking Ability. *JIML,* 7(4), 424-437.

INTRODUCTION

John Dewey (in Fisher, A., & Scriven, M. 2001) argues that the way for someone to be reliable , firm in their convictions , and have an accurate assessment regarding a principle or any form of science that is accepted, is then to look at various sources of arguments that support and formulate it. called critical thinking . As stated by Ennis: " *critical thinking is reasonable reflective thinking that is focused on deciding what to believe or do* " (Ennis, R. H. 1993). That the basic meaning of critical thinking is plural, for example; to provide considerations and interpretations, evaluations, analysis, demanding detailed explanations, methodological, conceptual-theoretical, criteria logical, as well as conclusions and considerations depending on the underlying thing. Logical thinking means critical thinking , this is combined with maintaining a disposition, which consistently produces deep and useful meaning, so that it can become the rational and democratic basis of a society (Elder, L., & Paul, R. 2001).

The basic need in facing a global situation that is full of complexity and rapid changes in this digital era is critical thinking. In such a situation, someone who is able to survive is who is able to sort out what is good or not, among the many realities that are faced with him. On the other hand, those who are not selective will drift amidst change and become objects in it. Thus, critical thinking is a life skill that enables people to maintain their existence in a lasting way in the present.

Indonesia is ranked in the bottom 7 among 72 other countries in the mathematics category based on the results of the Program for International Student Assessment study (Human Development Report. 2022). The results of this study provide the conclusion that students in Indonesia are still at a low level for high-level thinking abilities , where one of the high-level thinking abilities is critical thinking ability.

The achievements of the educational process, especially mathematics education at school, focus on students being able to have the ability to think logically, rationally, critically and creatively which are included in high-level thinking abilities. This cannot happen by itself, but is obtained through a teaching technique. Minister of National Education Regulation No. 16 of 2007 (Pendidikan, B. N. S. 2007), explains that mathematics teacher competence includes four things, including: 1). Pedagogy which includes teachers' abilities and knowledge in carrying out the learning process using learning methods, educational learning theories, curriculum development and student potential as well as the use of learning media. Then more interactive, effective and efficient learning will be developed and students' potential can be more optimal, 2). Behavior that is in accordance with the applicable rules is a student who has a good personality and a teacher who is a role model for students, 3). Becoming a social human being, namely being able to communicate both within the educational environment and outside the educational environment, and 4). A professional figure, meaning having the ability to master material, competency standards and basic mathematics competencies, being proficient in technology for developing mathematics learning, as well as developing personal abilities. Minister of National Education Regulation no. 41 of 2007 (Pendidikan, B. N. S. 2007), that one way to achieve competency in teaching and learning activities is to create Student Worksheets (LKS) that suit the characteristics of students in the subject.

Liveworksheet is a software system that can be used to create Student Worksheets (LKS) that are connected to material or teaching materials through online media on the web (Rohmah, M. 2022). The features in live worksheets can have a greater influence on students' critical thinking abilities, because in this application there is audio-visual media, making it easier for

students to understand material that is required to be innovative and creative for solving a problem with a solution.

Using the LKPD Liveworksheet application is very good for motivating students because it is interactive, and for teachers this application can save time and paper so they can still protect the environment. Several advantages of using Liveworksheet LKPD: 1) Unlimited space and time (flexible), 2) Students have their own learning environment and experience, 3) *Student Worksheet* (LKS/LKPD) becomes a learning resource and learning medium depending on the learning activities designed, 4) There is interactive media in the form of audio and video, maybe even games and simulations, 5) Students can find out the final score after working on the Liveworksheet LKPD, 6) Practice a variety of questions, not just multiple choice and descriptions.

A comprehensive student understanding is the ultimate goal expected from mathematics learning. Students' substantive understanding alone is deemed insufficient if it is only to fulfill mathematics learning objectives, but is also expected to provide a parallel effect from the learning. The parallel effects of mathematics learning according to (MKPBM, T. 2001) are: 1) Understanding the relationship between mathematics topics and each other; 2) Aware of the importance of mathematics in relation to other fields; 3) Understand the function of mathematics in everyday life; 4) Can apply critical, logical and structured thinking; 5) Innovative and creative in solving a problem with a solution; and 6) Can pay attention (*Aware*) to the surrounding environment.

Objective from study This is develop LKPD (Student Worksheet) model *discovery learning* assisted by *live worksheets* so that more effective And efficient as well as own impact potential to grow students' cognitive *level* of critical thinking.

METHOD

Design Research is pattern development For designing And developintervention in process Study, like program teaching, method, And material learning (Plomp, T. 2013) . Furthermore according to Prahman, that Which intended withintervention in study design is create scheme program, strategy teaching, and learning materials that can be applied to overcome obstacles in the process learning or education in general scientific (Risdiyanti, I., & Prahmana, R. C. I. 2020).

Study This is the research design development, Development studies is principles activity design For field benefit practical Which developed. There are two stages of development research, namely the initial evaluation stage and the evaluation stage formative evaluation (Mardhiyanti, D., Ilma, R., & Kesumawati, N. 2013) . Subject study This is student class X high school in the district Bekasi. Worksheet Development Student Critical Thinking Mathematics s (LKPD) with a m o del approach Assisted *Discovery Learning Liveworksheet* Exponents and logarithms material become principal discussion from this research. According to (Tessmer, M. 1994) there are two stages in development research: 1. Preliminary research and 2. Evaluation formative. Stage studies Introduction is divided into: stage analysis (analysis student, curriculum, And material teach), stage design (prototyping), And stage formative evaluation Which consist of evaluation self, prototyping (expert reviews, one-to-oneor small group), as well as field testing (Hidayat, W., Rohaeti, E. E., Ginanjar, A., & Putri, R. I. I. 2022)(Kurniawan, H., Putri, R. I. I., & Hartono, Y. 2018).

1. Initial Design

Researcher arrange location, subject study, And other, including timetable study. The subjects of this research were 36 class X high school students in Kab. Bekasi, with adjustments

to the allocation of mathematics learning time for the 2023/2024 school year. Stage The prototype I developed was tested on several students separately one student with another student (*one-to-one*), Prototype II was developed in *expert review* was tested on 6 (six) students per group for small group tests, After receiving comments and suggestions from the students and experts, LKS revised For produce prototype III Which tried out to 1 class student class X. Test wide the intended For effect potential, It means that LKPD *The live worksheet* developed can be used to improve critical thinking student mathematics.

2. Design Formative Evaluation

The steps in this design consist of three sub-stages, namely: self-evaluation, design prototype, and test field.

2.1 Self-Evaluation

Self-evaluation consists of two stages, namely the analysis stage and the design stage. Stage Analysis is the first stage in developing research. The analysis stage, namely for study connection between objective learning And results learning, evaluate curriculum to determine core competencies and basic competencies as a basis for decide the learning objectives that will be accumulated in the form of teaching materialswill be designed. What will be analyzed by students is analyzing abilities students in learning mathematics obtained from pretest questions. In this analysis It is hoped that researchers will obtain information about students' initial ability levels. On design stage, the researcher designs the product to be developed, namely development critical thinking student worksheet assisted by LKPD live worksheet discovery learning model. Planning worksheet student done with make prototype use 5aspect appropriateness. (Look Table 1): (1) technique; (2) appearance; (3) text; (4) picture; (5) videos.

Table 1. Development indicators LKPD Liveworksheet

No.	Aspect	Indicator
1	Technique	a. Convenience in use media
		b. Media can help participant educate understand material
		c. Media can motivate participant educate in Study
2	Appearance	a. Quality appearance
		b. Appearance screen
		c. Appearance covers
3	Text	a. Use type letter
		b. Use size letter
		c. Use space on writing
		d. Use sign read
4	Picture	a. Use picture in material teach digital supports learning
		b. Use picture which are interesting
		c. Use picture with life real
5	Videos	a. Use videos support understanding material
		b. Use that video interesting
		c. Voice And picture in videos quality tall

2.2 Designing a Prototype

There are three stages in designing this prototype, namely expert review, one-to-one test, and small group test. The developed Liveworksheet LKPD must be tested, reviewed, and evaluated.

2.2.1 Expert Review

Assessment, evaluation, and validation stages of student worksheets that have been designed and will be developed by researchers by experts considering comments, suggestions and input, so that you can find out the advantages and disadvantages of the worksheet student the so that done revision for creation prototype Which sustainable.

Table 2. Criteria and Level Validity

No.	Criteria Validity	Validity Level
1	$80\% < V \leq 100\ \%$	Very Legitimate (can used without revision)
2	$60\% < V \leq 80\ \%$	Legitimate (can used without revision)
3	$40\% < V \leq 60\ \%$	Enough Legitimate (can used However need revision)
4	$20\% < V \leq 40\ \%$	Not enough Legitimate (recommended No used)
5	$0\% < V \leq 20\%$	No Legitimate (No can used)

Formula Description : (Hidayat, W., Rohaeti, E. E., Hamidah, I., & Putri, R. I. I. 2023)

V = Final Value

F = Earned Value $\qquad V = \frac{F}{n} \text{x } 100\ \%$

n = Maximum Value

2.2.2 One-on-one Test

A testing phase was carried out on students, namely one by one heterogeneous students separately, with students' initial ability levels being high, medium, and low.

2.2.3 Small Group

This stage aim For know so far where level practicality LKPD Liveworksheet Which developed after revised by para expert. Student which has studying material on exponents and logarithms will participate in this stage. At stageThis there is as much 6 (six) student per group that originate from class X senior high school in Regency Bekasi. The data collection technique used was giving a questionnaire (questionnaire). Practicality is then analyzed to be revised and retested, parallel to the LKPD Previous Liveworksheet so that it can be developed and get more effective. Data values questionnaire use formula (Mustami, M. K., Shamsudduha, S., Safei, S., & Ismail, M. I. 2019).

Table 3. Level Practicality Product

No.	**Mark**	**Category**
1	$80\% < P \leq 100\ \%$	Very Easy
2	$60\% < P \leq 80\ \%$	Easy
3	$40\% < P \leq 60\ \%$	Quite easy
4	$20\% < P \leq 40\ \%$	Not enough Easy

5	$0\% < P \leq 20\%$	No Easy

$$P = \frac{\sum f}{N} \text{x } 100\%$$

Information :
P : Mark end
$\sum f$: Amount obtained
N : Maximum value

2.3 Field Test

The next process is the final stage, namely extensive testing of prototype III on 1 (one) Class X students consist of 36 (thirty six) students, using SPSS software, descriptive analysis of inferential statistics which functions to explain and compare average two sample pair to see effect potential LKPD *Liveworksheet* Which developed.

Product Which tested on stage test field must is product Which meet quality criteria. There are three quality criteria, namely valid (from experts), practical (easy to use) and can be used to develop thinking skills critical student mathematics (effect potential).

Before LKPD implemented, design beginning researcher is LKPD Which developed. Input from material, curriculum and media experts as well as practitioners is included into *the draft* at the formative revision stage, this is intended as material for consideration in process development LKPD next (parallel).

RESULTS AND DISCUSSION

Results

1. Initial Design

Activity First Which done on study This is do studies introduction to see aspects that cause misalignment between goals and objectives learning outcomes. To obtain information, researchers conducted interviews with Wrong One Teacher senior mathematics. Then data collected And information Which obtained is entered into in assessment performance.

There is a number of factor Which become reason imbalance performance learning. Matter This covers situation process learning in field between other : use lkpd, method approach learning, media learning, competence Teacher, the level of students' mathematical abilities and other main causes that are interrelated. Can We view from table as follows :

Table 4. Study Introduction

Actual Situation	Ideal Learning	Factor Reason
LKPD / Teaching Materialsused standard, fixedonly to rule government and still simple	Application LKPD based ICT	Competence Teacher Which Stilla lot is left behind in terms of use technology

Learning methods Conventional Which not enoughinteractive, because it is centered only just to the teacher	Learning methods provide experience for student, in accordance characteristics, centered on students and problem solving, so that understand importance mathematics correlation with reality life	Insufficient facilities and infrastructure adequate, class which No conduciveBecause many amount student, focus on finish material Don't focus on ability student
Student not enough capable building ideas and apply draft essentialmath, so no understand and experience difficulty in learning mathematics	Illustrated concept so understand And capable applyessential mathematical formulas through experience Study mathematics which is presented by Teacher	Lack of experience learning Which felt or cansaid to be inconsistent with the characteristics,so you don't hone your skills critical thinking mathematics student
Learning media used Not yet connectedwith utilization technology advanced	Utilization of learning media valid, practical, effective digital and efficient everywhere its development customized by Teacher	Technical guidance for methods learning with training Whichnot enough adequate, likewise Also the same goes for existing platforms Still No adequate

The table above shows the school situation during learning Still use LKPD simple And pegged only on source Study from government only. The learning method is still conventional through lectures and questions answer, only centered on the teacher. Lack of perceived learning experience through digital learning media that suits students' characteristics so that their thinking abilities critical mathematics student No honed.

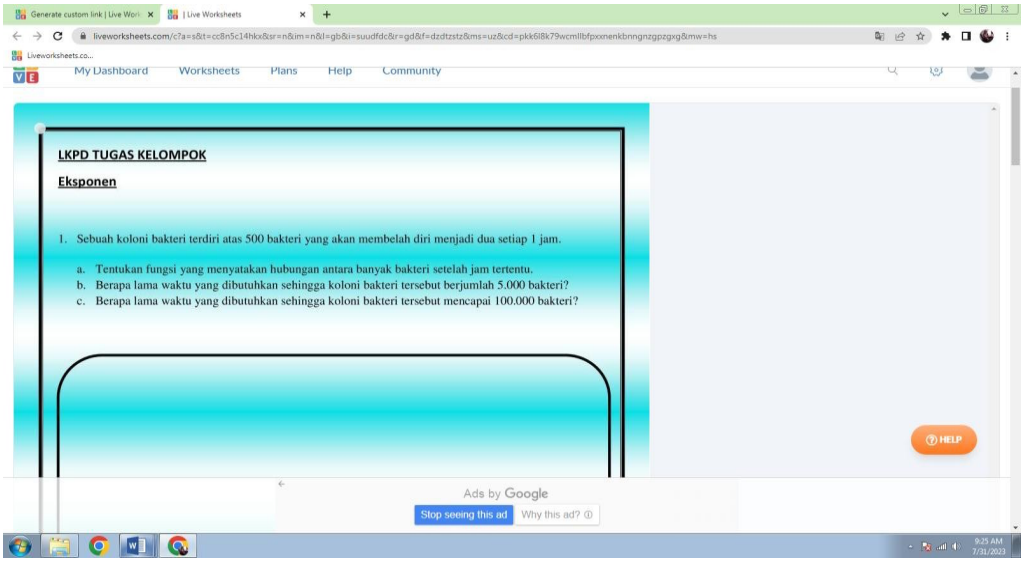
2. *Formative Evaluation Design*

2.1 Self-evaluation

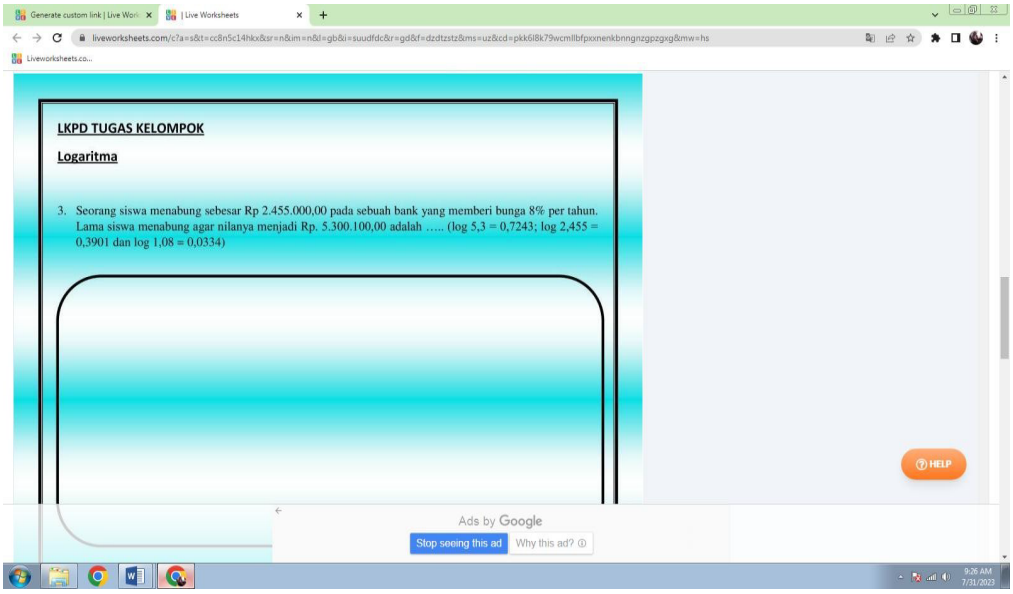
After knowing the factors that cause inequality between goals and objectives results learning in school Which Also stated on performance learning in studies introduction, so need exists solution For solution problem in on, so that The researcher designed the LKPD which was developed with the help of Liveworksheet with hope LKPD Liveworksheet the capable own effect potential For learning in the future.

Picture 1. Appearance LKPD help liveworksheet task individual – material exponent and logarithm

Picture 1 describe LKPD which made help liveworksheets for individual task that aim to see students' initial ability with one-to-one test technique.



Picture 2. Appearance LKPD help liveworksheet task group - material exponent And logarithm (exponent)



Picture 3. Appearance LKPD help liveworksheet task group – material exponent And logarithm (logarithm)

Picture 2 And 3 describe LKPD Which made help *liveworksheet* For Group assignments on exponents and logarithms for purposes other than *expert review* , Also For improvement prototype Which his activities served through *small groups*(group small) with method learning *discovery learning* Where role Teacher onlydirect or as a guide/mentor (*adviser*) only.

2.2 Designing a Prototype

2.2.1 Expert Review

Individual trials (one to one), small groups (small groups), and large field trials done No other is For get validity. Pilot test used For know appropriateness LKPD

assisted by Liveworksheet with material exponent And logarithm use approach d discovery learning.

Table 5. Input of the experts

Aspect Observation	Comment And Suggestion	Score
Appropriateness Fill Material	1. Customize the material with objective learning	3
	2. Presentation question adjust the story with life real (depth material)	4
Suitability Curriculum	1. Fix it question which is presented (must in accordance with model indicators learning)	1
Planning Media Professional	1. Add instruction use.	2
	2. Make it sub media involving interaction Teacher And student (like exists simulation)	2
	3. LKPD Liveworksheet customize with indicator Discovery Learning	4
	4. Forms roll call and possible assessment direct accessed and seen by	4

Based on Table 5, results expert validation has been analyzed with value acquisition The total average percentage for all aspects is 57.14286% with the criteria "sufficient legitimate". This means that the product being developed can be used but with necessary notes revision linkages a number of aspect like which is visible on table on, and after revisions were made to the developed Liveworksheet LKPD, there were changes The total average percentage score obtained for all aspects is 80% with criteria "legitimate/valid", so that LKPD Liveworksheet the can For implemented.

2.2.2 One-on-one Test

At this stage, trials were carried out on one to one class X high school students in the district. Bekasi Which shuffled in a way heterogeneous with level ability tall, currently And low.Following response student to level practicality LKPD Liveworksheet.

Table 6. Results trial one-to-one test

No	Indicator	Percentage
1	Clarity of content material	83 %
2	Stimulation videos media LKPD	80 %
3	Interest towards the media	70 %
4	Motivation	77 %
5	Interactive	73 %
6	Experience	87 %
		78 %

Based on the test results above, the average percentage of student responses to the LKPD developed was 78% in the "Practical" category.

2.2.3 Small Group Test

In stage This as much 6 (six) student per the group, Which has learnmaterial on exponents and logarithms from class X SMA in Kab. Bekasi to complete the test group assignment, then a questionnaire will be given to respond to the material presented through LKPD Liveworksheet. Results trials can be seen in the table. 7.

Table 7. Results trials small groups test

No	Indicator	Percentage
1	Clarity of content material	73%
2	Stimulation videos media LKPD	77%
3	Interest towards the media	80%
4	Motivation	73%
5	Interactive	70%
6	Experience	77%
		75%

Based on the test results, the average percentage for student responses to The LKPD Liveworksheet developed is 75%, still on level category "Practical".

2.3 Field Test

Field trials are the final step of formative evaluation, to find out The beneficial effects of the LKPD developed using *the live worksheet* method approach learning *discovery learning* Which influential on think critical mathematics student, so data *pre-test* And *post-test* Which got, processed with use SPSS to do normality test. (results stated on table 8).

Table 8. Results test normality

	Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Pre_test	,318	36	,000	,814	36	,000
Post_test	.173	36	,008	,933	36	.031

a. Lilliefors Significance Corrections

You can see the output table in the Shapiro-Wilk section for the pre-test value of 0.000 and post-test. test 0.031. Mark both of them more small from 0.05, so can concluded second mark the not distributed normal, with thereby condition For test paired t-test No fulfilled, For alternative test t-sample pair furthermore done test non- parametric wilcoxon , with problem formulation as following:

H_0 : No there is difference results Study student after use LKPD Liveworksheet with previously.

H_a : There is difference results Study student after use LKPD Liveworksheet with previously.

Table 9. Results test statistics Wilcoxon

Test Statistics [a]

	Post_test - Pre_test
Z	-5,262 [b]
Asymp. Sig. (2-tailed)	,000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Results output on table 9, is known Asymp Sig (2-tailed) as big as 0,000 < 0.05, so H_0 rejected and H_a accepted, so it is stated that there is a difference in results student learning after learning using LKPD Liveworksheet rather than with learning previously.

It can be concluded that all processes of this research activity produce results development of critical thinking model student worksheets discovery learning assisted by LKPD live worksheet create learning productive. According to (Burhanuddin, A. 2014) Productive learning is learning that is structured by students based on ideas creative they, Which is results How method Study, so that achievement is created Which better. By general can be explained as following:

1. Participation active student focus on Study with practice in various activity for hone Skills And understanding they.
2. Create environment school use various tool help and methodas source learn to motivating student.
3. Learning Which in accordance characteristics student so that interested and pleasant.
4. Need exists order book and reading corner of materials and materials Which interesting.
5. Teachers apply cooperative and interactive learning, including learning group.
6. Teacher as mentor Which direct and push experience learning (discovery learning) student i.e identification and solve problems, express ideas, and play an active role in building a learning environment their school Alone.

Matter This in line on study (Hendriana, H. 2017) Which state mark average hardskills mathematics on student intermediate Which get learning productive (based mark And character) increase more Good compared to with student Which use learning previous (conventional), among others :

1. Success ability think innovative and critical student senior high school with method learning no direct more superior compared student with direct learning method.
2. Mathematical thinking and communication abilities of junior high school students with a values and character-based learning approach, it becomes more effective than students who accept approach learning traditional.
3. Performance understanding mathematical student through learning discovery learning versus backwards with performance method learning traditional.

Building digital LKPD will allow students to be actively involved, innovative, and independent in learning activities, enabling students to copeafraid in learn mathematics (Negari, N. A., Sabdaningtyas, L., & Nurhanurawati. 2021) . The LKPD that was developed was created to be audio-visually attractive, so that students would like it Study, makes it easier student in access it, so that can be efficient in its use and flexible on process his learning.

Discussions

The Discovery Learning Model demands independence, self-confidence, and the habit of acting as a subject. The aim of the discovery learning method is to improve students' thinking skills to be more active, creative and build a confident attitude in the learning process . Knowledge is long-lasting and easy to remember based on intellectual development learning experiences. Learning outcomes have a better transfer effect, improving students' reasoning and critical thinking skills, train students' cognitive skills to find and solve problems without the help of others in an innovative and creative way.

From the research results (Nurdin, I. T., Putra, H. D., & Hidayat, W. 2023) Apart from being declared effective, efficient, and categorized as quite valid, the prototype is in the form of digitally assisted teaching materials. This Google site also has a "Practical" level of criteria in its use, so that learning Mathematics has the potential to have an influence on improving students' critical thinking abilities.

In line with research (Hariyati, D. P., & Rachmadyanti, P. 2022) Developed live worksheet based interactive LKPD suitable for use in the learning process. The level of validity of the teaching materials obtained was obtained through validation test results. The validation results obtained reached 89% with very valid qualifications in the media percentage field, and a percentage of 95% with very valid qualifications was achieved for experts in the material field. Development in this research is the LKPD (Students Worksheet) model discovery learning assisted by live worksheets so that more effective And efficient as well as create productive learning, so that it has impact potential to grow students' cognitive level of critical thinking.

The level of validity obtained was obtained through the results of validation tests of teaching materials by experts in the research process, thus stating that the live worksheet- based interactive LKPD developed was suitable for use in the learning process. Validation results in the media field, the percentage obtained reached 80% with valid/valid qualifications, the response of class X SMA students for the results trial one to one and try it out small The group is very enthusiastic and active in operating the interactive LKPD that has been developed which respectively reached a percentage of 78% and 75% in the "practical" category. From this explanation, it can be concluded that live worksheet- based interactive LKPD teaching material products are suitable for use in the learning process of high school students.

CONCLUSION

From all over activity in study This has produce product Which developed form LKS think critical model discovery learning help liveworksheet with material exponent and logarithm in level category "Legitimate" as well as “Easy”, according to experts and practitioners. The research results show that LKPD The live worksheet developed is feasible, effective and has an impact on abilities students' critical thinking with the discovery learning model. Approach assisted by Google liveworksheet and get very effective results. This is obtained from the results pre-test and post-test as well as students' opinions in the questionnaire sheet (questionnaire) at each stage this research. It can be seen from the changes in learning outcomes in the post-test and the steps in the discovery learning model that students did not fail to take in their answers questions with the teacher as a guide who directs (shows focus on students, problem identification, data collection, data processing and proof until on interesting conclusion so that your abilities are stimulated think critical mathematics student). This is also an experience of learning discovery in the school environment which adapted to student characteristics.

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