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## Development of Guided Discovery Learning Voltaic Cell E-LKPD for Class XII SMA/MA Students

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### ABSTRACT

This study aims to develop voltaic cell E-LKPD based on guided discovery learning. This research is research and development or Research and Development (R&D) which uses the Plomp development model. This development model consists of three stages including initial research, prototype formation, and the assessment stage. The research instrument was in the form of a questionnaire sheet. The E-LKPD was validated by 5 validators including 4 chemistry lecturers at FMIPA UNP and 1 chemistry teacher at SMA Negeri 1 Batang Anai. This data was analyzed using the Aiken'V scale to test validity, practicality test was analyzed using the percent formula, effectiveness test using the N-Gain formula. The results of the content validation test average value of 0.85 in the high category. Construct validation test results with an average value of 0.89 in the high category. Media validation test results with an average value of 0.82 in the high category. The practicality test results of students and teachers with aspects of ease of use, time efficiency, and benefits respectively with an average of 87% and 96% in the very practical category. The results of the effectiveness test were obtained with a value of 0.71 in the high category. The results of the answers to the voltaic cell E-LKPD based on guided discovery learning obtained an average of 84. Based on the results of the study it can be concluded that the developed voltaic cell E-LKPD based on guided discovery learning is valid, practical, and effective.

## 1. Introduction

Education is an important stage in realizing an intelligent and educated nation. The achievement of an educational goal if the curriculum applied is appropriate with the current teaching and learning process. The curriculum is a rule that includes objectives, content, and learning materials that are applied as a reference

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in learning activities to achieve an educational goal (Permendikbud No 35, 2018). One of the curricula currently used in the Indonesian education system is the 2013 curriculum. The 2013 curriculum is a curriculum that aims to prepare an Indonesian nation to have the ability to live and become citizens who are faithful, productive, creative, innovative and effective who are able to contribute to life, society, nation and state as well as world civilization (Permendikbud No 35, 2018). One of the implementations emphasized in the 2013 curriculum is a scientific approach.

The scientific approach is an approach that uses scientific stages in the learning process (Musfiqon, 2015). This approach can lead to student activity based on a scientific approach. This approach also contains good learning models and strategies in directing students' mastery of concepts (Simamora, 2021). The scientific approach applies several models to the learning process, one of which is the discovery learning model.

Discovery learning is a model that can advance the teaching and learning process and improve students' learning outcomes and thinking skills through self-concept discovery or in groups (Yerimadesi, 2017). Based on the results of the questionnaire analysis given to high school chemistry teachers in Batang Anai District, it was found that 100% of chemistry teachers in these high schools had applied the discovery learning model in learning. However, they have not implemented it according to the syntax in the discovery learning model because teachers do not understand the syntax of discovery learning. So that it affects the thinking ability of students. One of the developments of the discovery learning model that can expand students' thinking processes is the guided discovery learning model (Yerimadesi, 2017).

Guided discovery learning is a model that combines two learning processes, namely teacher centered and student centered, so that the teacher acts as a facilitator who directs students to gain knowledge and can improve students' thinking processes (Hastuti, 2018). Guided discovery learning is a process in which students are required to find a concept and principle from the problems given by educators (Yuliasari, 2017). The syntax of the guided discovery learning model consists of 6 stages, namely: (1) motivation and problem presentation; (2) data collection (data collection); (3) data processing (data processing); (4) verification; (5) Closure (closure/conclusion) (Yerimadesi, 2018). Based on the results of the questionnaire analysis given to high school chemistry teachers in Batang Anai District, it was found that 50% of the teachers did not know the guided discovery learning model and as many as 75% of the teachers did not use the guided discovery learning model.

According to Jerome Bruner (Yerimadesi, 2017) the advantages of applying this guided discovery learning model are: (1) the GDL model can improve the intellectuality of students, because students can find their own concepts from the problems given by educators who make long lasting memory so that it is difficult to forget; (2) increase students' intrinsic motivation, this means that there is encouragement in students to self-regulate and be responsible in learning; (3)

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prioritizing students' thinking processes; (4) directing students in processing the information received. The guided discovery learning model can be applied in the learning process and can be integrated into an E-LKPD teaching material, which is commonly called an E-LKPD based on guided discovery learning.

E-LKPD is an electronic learning material that can be used with digital media and is equipped with videos, pictures and animations (Nandya, 2016). E-LKPD is an interactive teaching material that is systematically arranged and designed using digital media that can be used as a learning tool. E-LKPD has advantages including being able to take advantage of digital media in the form of applications and being able to display videos that help students visualize learning material that is abstract in nature (Nanang Supriadi, 2015). Based on the results of a questionnaire analysis obtained from high school chemistry teachers in Batang Anai District, 75% of teachers stated that the teaching materials used were still unattractive and as many as 75% of teachers had not used E-LKPD as teaching materials. E-LKPD can be implemented in chemistry material, one of which is the voltaic cell material studied by high school class XII students.

According to Suwanto (Febyanti, 2020) states that most of the concepts of chemical matter are abstract in nature such as atoms, molecules, ions which make it difficult for students to imagine the existence of the material. This is the same as the results of the questionnaire analysis obtained at high schools in Batang Anai Sub-District where as many as 75% of teachers stated that student learning outcomes were still low and 52.3% of students also stated that voltaic cell material was difficult to understand.

Based on the description above, it is necessary to develop E-LKPD based on guided discovery learning to improve learning outcomes in voltaic cell material using the liveworksheet website. Therefore, researchers conducted research with the aim of developing a voltaic cell E-LKPD based on guided discovery learning for class II SMA/MA students that is valid, practical and effective.

## **2. Methodology**

The type of research used in this research is research and development or Research and Development (R&D). Research and development is a step taken to produce a product that is tested for validity and practicality, as well as its effectiveness (Sugiyono, 2013). This study uses the Plomp model which consists of three stages: (1) Preliminary research, (2) prototyping stage, (3) assessment phase (Plomp, 2013). The product produced in this study is a voltaic cell E-LKPD based on guide discovery learning for class XII SMA/MA students.

Content and construct validity are considered validity by testing the feasibility or relevance of the content. This technique is based on Aiken's V. Aiken (1985) scale based on the results of research from a panel of experts as many as n people on an item in terms of the extent to which the item represents a contract being measured. The scale of an Aiken is based on the following equation.

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$$V = \frac{\sum s}{[n(c-1)]}$$

Information:

- V : Validity
- s : r – lo
- lo : The lowest validity assessment score
- c : Score of the highest validity assessment
- r : The score given by the validator
- n : Number of validators

Aiken's value coefficient ranges from 0-1. If the results obtained are close to 1, then the validity value is higher. Conversely, if the results obtained are close to 0, then the validity is lower. The level is determined based on Aiken's V table in Table 1.

Table 1. Validity Level Based on Aiken's V Scale

NO	Aiken's V Scale	Validity
1	$V \leq 0,4$	Low
2	$0,4 < V < 0,8$	Currently
3	$V > 0,8$	High

(Retnawati, 2016)

The results of the practicality assessment were obtained from a questionnaire given to teachers and students, after which the results obtained were analyzed using the formula:

$$NP = \frac{R}{SM} \times 100\%$$

Information

- NP : Expected percent value
- R : Raw score obtained
- SM : The ideal maximum score of the test

If a percentage has been obtained, then grouping is carried out, according to Table 2.

Table 2. Practicality Decision Criteria

NO	Value	Retes Aspect
1	86%-100%	Very Practical
2	76%-85%	Practical
3	60%-75%	Quite Practical
4	$\leq 54\%$	Impractical

Sumber: (Lestari, 2018)

The results of the effectiveness assessment were obtained from the results of the pretest and posttest given to students. After that, the results obtained were analyzed using the formula g factor (N-Gain) according to Hake (1999):

$$g = \frac{\% \text{ skor posttest} - \% \text{ skor pretest}}{\text{skor ideal} - \% \text{ skor pretest}}$$

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The criteria for evaluating the N-Gain score are presented in Table 3.

Table 3. Score Acquisition Category

No	Limitation	Category
1	$g > 0,7$	High
2	$0,3 \leq g \leq 0,7$	Currently
3	$g < 0,3$	Low

Sumber: (hake, 1999)

### 3. Results and Discussion

The research has produced a product in the form of a voltaic cell E-LKPD based on guided discovery learning for class XII SMA/MA students which can be accessed on the link. This study uses the Plomp development model which consists of 3 stages, with the results described as follows.

#### Preliminary Research

Preliminary research is carried out in several stages, namely needs analysis, context analysis, literature study, and conceptual framework development. The results obtained at the initial research stage are described as follows.

##### Needs Analysis

The distribution of the questionnaire addressed to 38 class XII students at SMAN Batang Anai District showed that (1) 75% of teachers stated that student learning outcomes were still low and 52.3% of students stated that voltaic cell material was difficult to understand. So it can be concluded that students still have difficulty mastering voltaic cell material. (2) 50% of teachers do not know the guided discovery learning model and as many as 75% of teachers do not use the guided discovery learning model. So it can be concluded that the guided discovery learning model has not yet been implemented in the SMA. (3) 75% of teachers stated that the teaching materials used were still not interesting and as many as 75% of teachers had not used E-LKPD as teaching materials. So it can be concluded that the teaching materials used are still not interesting and the E-LKPD has not been fully used in learning.

#### Analysis Context

Context analysis resulted from an analysis of the syllabus in the 2013 revision of the 2020 curriculum in the form of an analysis of Basic Competency (KD) 3.4 and 4.4. The basic competencies of KD 3.4 and 4.4 are as follows.

3.4 Analyze the processes that occur in voltaic cells and explain their uses.

4.4 Designing a voltaic cell using surrounding materials.

Based on KD 3.4 and 4.4, the competency achievement indicators are described as follows.

3.4.1 Understanding the reactivity of a metal

3.4.2 Analyzing the processes that occur in a voltaic cell through a series of voltaic cell reactions

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- 3.4.3 Explain the concept of electrochemical cell.
- 3.4.4 Write the voltaic cell notation of a reaction.
- 3.4.5 Determine the cell potential based on standard reduction potential data.
- 3.4.6 Determine the type of reaction in a voltaic cell.
- 3.4.7 Explain the use of voltaic cells and the application of voltaic cells in everyday life.
- 4.4.1 Drawing a voltaic cell and its functions.
- 4.4.2 Designing a voltaic cell using ambient materials.

### **Study Of Literature**

The results obtained from the study of literature are as follows.

1. The E-LKPD component used as a reference in this study is referred to from Andi Prastowo's book (2015).
2. The contents of the developed E-LKPD are adopted from university books.
3. The guided discovery learning model is adopted from books, scientific articles, and other sources.
4. The E-LKPD development model used is the Plomp model referred to from Tjeerd Plomp's book (2013) and scientific articles.

### **Conceptual Framework Development**

The results obtained in the development of the conceptual framework are the main concepts that must be mastered by students, namely: voltaic cells, primary cells and secondary cells, standard cell potential, standard reduction cell potential, electrodes, cathodes, anodes, oxidation reactions, reduction reactions. The results of the concept analysis are described in the form of a concept analysis table seen in Appendix 1, from the concept analysis table a concept map is obtained.

### **Prototyping Stage**

The prototyping stage consists of four prototypes which are evaluated using the formative evaluation of each prototype. The results obtained in the prototype formation are described as follows.

#### **Prototipe I**

The prototype stage I is designing or designing a voltaic cell E-LKPD based on guided discovery learning. The results obtained in prototype I are to determine a component in the E-LKPD. The components obtained are referred to in Andi Prastowo's book (2015) which consists of six components, namely: title, instructions for use, competencies to be achieved, supporting information, tasks/work steps, assessment.

#### **Prototipe II**

Prototype II stage is the result of prototype I which was evaluated by self-evaluation (self-evaluation). This test was carried out using a check list system for the points contained in the Guided Discovery Learning Based Voltaic Cell E-

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LKPD. The results obtained in the self-evaluation are that there are revisions to the pictures that still use pictures in English, videos that are still not equipped with music, subtracting and adding questions, as well as completing learning objectives and adding sources listed in Appendix 5.

### **Pototype III**

Phototype III stage is the result of prototype II which has been evaluated by expert review and one-to-one evaluation. The following are the results obtained at the prototype stage III.

Expert Riview

The results of the prototype that has been assessed by the reviewer are validated by five validators. The validity test carried out contains three tests, namely content validity test, construct validity test, and media validity test.

### **Content Validity**

The results of the data analysis of the validity of the voltaic cell E-LKPD content based on guided discovery learning with two aspects of assessment. The average value of the voltaic cell-based E-LKPD content validation based on guided discovery learning for each aspect that has been assessed by the validator can be seen in Table 4.

Table 4. Average Content Validation Score

<b>NO</b>	<b>Rated Aspect</b>	<b>Average Value</b>	<b>Category</b>
1	Suitability of E-LKPD with guided discovery learning syntax	0,86	High
2	The suitability of the contents of the E-LKPD for chemical scientific content	0,84	High
<b>Average</b>		<b>0,85</b>	<b>High</b>

Based on the results of the content validation analysis of the voltaic cell E-LKPD based on guided discovery learning, the result was 0.85 in the high category. The results of this analysis indicate that the suitability and correctness of the content of the developed E-LKPD is valid.

### **Construct Validity**

The results of the data analysis of the voltaic cell E-LKPD construct validation based on guided discovery learning with three assessment aspects, namely the linguistic component, the presentation component, and the graphical component. The average value of the voltaic cell E-LKPD construct validation based on guided discovery learning for each aspect that has been assessed by the validator can be seen in Table 5.

Table 5. Average Construct Validity Score

NO	Rated Aspect	Average Value	Category
1	Linguistic Component	0,92	High
2	Presentation Component	0,85	High
3	Graphic Component	0,92	High
<b>Average</b>		<b>0,89</b>	<b>High</b>

Based on the results of the content validation analysis of the voltaic cell E-LKPD based on guided discovery learning, the result was 0.89 in the high category. The results of this analysis indicate that the construct validation of the developed E-LKPD is valid.

### Media Validity

The results of the data analysis of the voltaic cell E-LKPD construct validation based on guided discovery learning with two aspects of assessment, namely the appearance aspect and the convenience aspect. The average value of voltaic cell based E-LKPD media validation based on guided discovery learning for each aspect that has been assessed by the validator can be seen in Table 6.

Table 6. Average Media Validity Score

NO	Rated Aspect	Average Score	Category
1	Appearance	0,83	High
2	Convenience	0,81	High
<b>Average</b>		<b>0,82</b>	<b>High</b>

Based on the results of the content validation analysis of the voltaic cell E-LKPD based on guided discovery learning, the results obtained were 0.82 in the high category. The results of this analysis indicate that the media validation of the developed E-LKPD is valid.

### One-to-One Evaluation

The one-to-one evaluation was carried out through interviews with 3 class XII students of SMA Negeri 2 Batang Anai who had high, medium and low abilities. Based on the results of the appendix, an analysis of the interviews was obtained. learning. Based on the attached data from the results of the one-to-one evaluation interview analysis, it was found that the appearance of the cover of the E-LKPD on the voltaic cell based on guided discovery learning was good, attractive, neat, so that it attracted readers' interest in using it and the pictures on the cover illustrate the material of the voltaic cell. The color design on the voltaic cell E-LKPD varies so that it attracts students' learning interest. The language used in the E-LKPD is clear and easy to understand, and the questions used can make it easier for students to find the concept of voltaic cell material. In addition, the video that completes the voltaic cell E-LKPD is clear and helps students discover the concept of the voltaic cell. E-LKPD voltaic cells based on guided discovery learning are easy to use, making it easier for students to learn.



## Prototype IV

The prototype stage IV is the small group trial stage. The small group trial aims to test the practicality and effectiveness on a limited scale for students with high, medium and low abilities. This stage was tested on prototype III which was valid and had been tested one-to-one (one-to-one evaluation). This small group trial was tested on 9 class XII students of SMAN 2 Batang Anai by distributing pretest questions, E-LKPD voltaic cells based on guided discovery learning, posttest questions, and distributing practical questionnaires, and distributing practical questionnaires to 3 chemistry teachers at SMAN 2 Batang Anai, to see the practicality of a voltaic cell E-LKPD product based on guided discovery learning. The following results were obtained at the prototype stage IV:

## Practicality

Practicality was tested to see the practicability of a voltaic cell E-LKPD teaching material product based on guided discovery learning. This practicality test assesses several aspects such as ease of use, time efficiency, and benefits. Following are the results of the description in Tables 7 and 8

Table 7. Conclusion Results of Practicality of Learners Trial Small Group E-LKPD Voltaic Cells Based on Guided Discovery Learning

NO	Rated Aspect	NP	Category
1	Ease of Use	86%	Very Practical
2	Time Efficiency	87%	Very Practical
3	Benefit	87%	Very Practical
<b>Average Aspect Score</b>		<b>87%</b>	<b>Very Practical</b>

Table 8. Conclusion Results of The Practicality of Small Group E-LKPD Voltaic Cell Teachers Based on Guided Discovery Learning

NO	Rated Aspect	NP	Category
1	Ease of Use	100%	Very Practical
2	Time Efficiency	90%	Very Practical
3	Benefit	98%	Very Practical
<b>Average Aspect Score</b>		<b>96%</b>	<b>Very Practical</b>

Based on Tables 7 and 8, the results of the practical conclusions of students and teachers with the three aspects of the assessment obtained from the small group test get the expected percent value (NP) of 87% and 96% in the very practical category.

## Effectiveness

The effectiveness was tested to see the effectiveness of a voltaic cell E-LKPD teaching material product based on guided discovery learning. To see the effectiveness of an E-LKPD voltaic cell based on guided discovery learning using the N-Gain test. The results obtained can be seen in Table 9.

Table 9. N-Gain Test Results

Number of Students	Average		N-Gain
	Pretest	Posttest	
9	33,89	81,67	0,71

Based on the results in Table 9, the N-Gain result is 0.71. According to Maltzer adopted in Ramadhani (2020) the results obtained are classified as high category. Therefore, E-LKPD voltaic cells based on guided discovery learning have been effective.

Following are some of the results of the voltaic cell E-LKPD revision before and after revision.

a. Cover

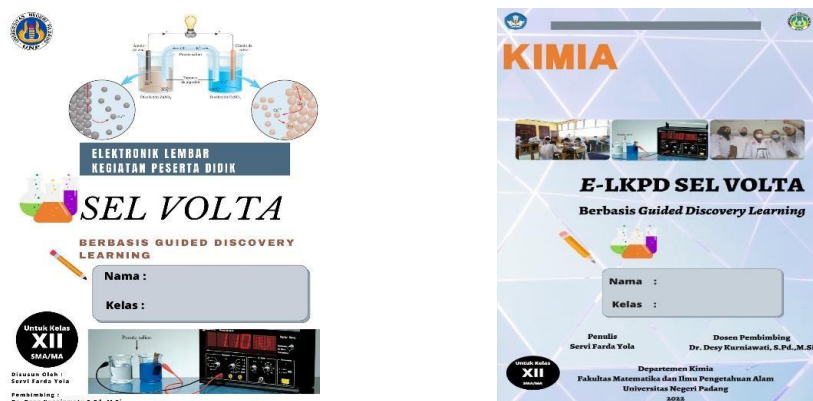


Figure 1. Display of Guided Discovery Learning Based Volta Cell E-LKPD Cover Before and After Revision

b. Instructions of Use

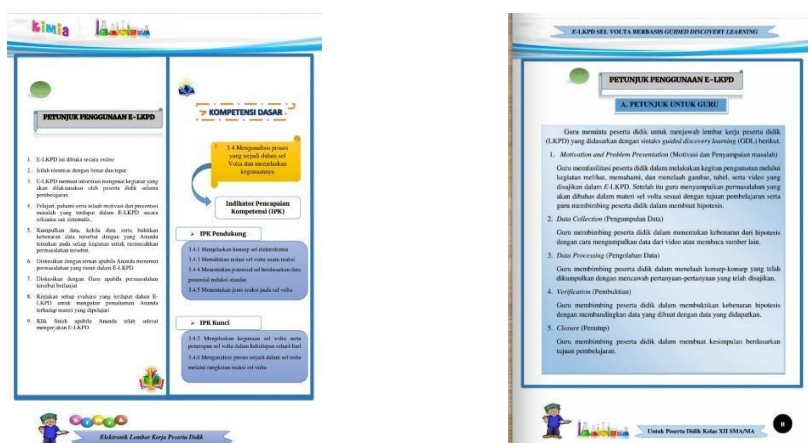


Figure 2. Instruction of use Guided Discovery Learning Based Volta Cell E-LKPD Cover Before and After Revision

Based on the results obtained, revisions were made to the aspects of the images, videos, and questions contained in the E-LKPD. Revisions made can improve the quality of the products made. The next stage was a validation test which was tested by five material experts and media experts. This validation was carried out by four chemistry lecturers from FMIPA UNP and one chemistry teacher from a high school in West Sumatra. This test aims to perfect and assess the feasibility of the product being made so that it becomes of high quality and can be useful for teachers and students. This validation test uses the Aiken's V scale. This validation consists of content, construct and media validation as explained above.

#### 4. Conclusion

Based on the results of research and data analysis that has been done, it can be concluded that.

1. E-LKPD voltaic cells based on guided discovery learning for class XII SMA/MA students have been successfully developed through development research using the Plomp development model.
2. The voltaic cell-based E-LKPD based on guided discovery learning for class XII SMA/MA students that has been produced can be classified as valid, practical, and effective.

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