The making KIT micro scale electrolysis experiments using lithium batteries based on green chemistry

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Abstract. This research makes alternative learning media that aims to assist teachers or students in studying electrolysis. Micro-scale electrolysis KIT is made using research and development methods. The results showed that the stages of the manufacture of micro-scale electrolysis KIT includes the step of analysis, design, development, implementation, and evaluation has been well done. The results of the feasibility test of micro-scale electrolysis KIT were declared valid with an average value of $r$ count of 0.91. This shows that the micro-scale electrolysis KIT media that is made has a quite enough interesting, economical and practical appearance. Media presented with guided inquiry stages can help students learn electrolysis material.

1. Introduction

Chemistry is the science that studies the structure of matter and changes that occur in natural processes and experiments [1]. Knowledge of chemistry is obtained through the fruit of thought and investigation of scientists carried out by experimenting using scientific methods [2]. Chemistry is not just a collection of knowledge in the form of facts, concepts or principles but this chemistry is a process of discovery [3]. One of them is on electrolysis material, electrolysis is one part of electrochemistry, a process that uses electrical energy to encourage redox reactions that are declared non-spontaneous can occur [4]. The concept of electrolysis is a concept that states a process that is presented by practicum, so that in the learning process students not only get knowledge but students can also be directly involved in practicum [5]. Practicum carried out in the field of chemistry provides opportunities for students to acquire skills through scientific research and has the potential to significantly improve learning, development and conceptual understanding [6]. It can also increase students' critical attitudes so that students have a positive attitude and provide opportunities for students to develop skills regarding cooperation and communication [7]. Based on research conducted by Kamata and Yajima in Japan, it was found that when entering electrolysis material some teachers had difficulty with expensive tools and materials and inadequate school facilities [5]. In addition to teachers, students are also constrained because of lack of developing skills in practicum [8], while the concept of electrolysis is one of the chemical concepts that will be more easily understood when practicum [5]. This can be overcome by one alternative, namely reducing the size of the tool or often called the micro scale. Micro scale is an alternative way to overcome some problems that occur in lab work [9]. Micro-scale KIT can be interpreted as green chemistry KIT, which is wise in using chemicals, environmentally friendly and does not have a negative impact on health [10]. micro-scale advantages, namely tools that are used practically, easily, safely, using little chemicals, high quality, the accuracy of the experiment is not disturbed and the teacher can use it as a
new design tool in practical activities [11]. The micro-experimental device is almost the same as the original, although the size is different [12]. This study does not require complex components such as an ampere meter, de supply, or Hoffman cell, trials will be easy and inexpensive, it will be very helpful in developing countries and schools that have limited funding sources [13]. This also makes it easier for teachers to obtain and prepare lab tools and materials, besides the time needed to obtain the results is less than 5 minutes with clear results [5]. The micro scale is used as a study on the concept of electrolysis, namely using lithium batteries of coins and filter paper. In general, a tool that is often used by many people and the tool can convert chemical energy into electrical energy which can eventually be used by an electronic device, namely a battery [14]. Lithium batteries have better capacity than other secondary batteries such as Nickel Cadmium (NiCd) Nickel Metal Hydride (NiMH) up to three times [15]. This research is different from previous research. There are supporting media to support the learning process so that it is more structured and easy to evaluate learning activities, students need experimental worksheets and manuals [16]. Experimental worksheets and manuals direct students from the process of observing to the lab process [17]. This is adjusted to the graduate competency standards and 2013 curriculum content standards in Indonesia, namely learning using a scientific approach that aims to improve the domain of students' attitude and process skills [18].

2. Method
This study uses the Research and Development method with the ADDIE model, aimed at producing products that are then tested for the effectiveness of these products [19]. The products produced are KIT micro-scale electrolysis experiments using lithium batteries in the electrochemical chapter electrolysis sub-chapter. The development of this media is a limited trial. The target was taken only 14 students of class XII MIA SMAN 4 Karawang.

The instrument used for this study is:

2.1. Questionnaire
Questionnaires or questionnaires used to determine the feasibility of KIT micro-scale electrolysis experiments conducted by validators or material experts to produce a form of visualization in the form of a validation sheet. The questionnaire used for validation is a check list with a Likert scale arranged in the form of a statement and followed by response choices that indicate the level of assessment results [19]. Likert scale statement can be seen in table 1.

| Scale Value Assessment | Likert Value |
|-----------------------|--------------|
| Strongly agree        | 4            |
| Agree                 | 3            |
| Disagree              | 2            |
| Strongly Disagree     | 1            |

Based on Table 1, validation is obtained by using the formula:

\[ r = \frac{x}{N \cdot n} \]

Information:
\[ r \] = Value of eligibility
\[ x \] = Weight of the respondent's answer
\[ N \] = Number of items
\[ n \] = Number of respondents
The interpretation of the magnitude of the feasibility value (r count) is presented in Table 2.

**Table 2. Interpretation of feasibility values [19].**

| No | Value Feasibility (r) | Interpretation |
|----|-----------------------|----------------|
| 1. | 0.80 ≥ r ≤ 1.00       | High           |
| 2. | 0.60 ≥ r ≤ 0.80       | High enough    |
| 3. | 0.40 ≥ r ≤ 0.60       | Rather low     |
| 4. | 0.20 ≥ r ≤ 0.40       | Low            |
| 5. | 0.00 ≥ r ≤ 0.20       | Very Low       |

Questionnaire for the feasibility of the results of the target students totaling 14 people was processed using the formula.

\[ Value = \frac{\sum n}{N} \times 100\% \]

Information:
Σn = The number of students
N = Total number of students

**Table 3. Eligibility criteria for KIT products [20].**

| Percentage (%) | Qualification | Conclusion                                                                 |
|----------------|---------------|-----------------------------------------------------------------------------|
| 90 – 100       | Very Worthy   | KIT products are ready to be used as learning media                          |
| 80 – 89        | Worthy        | KIT products are ready to be used as learning media                          |
| 70 - 79        | Fair enough   | KIT products can be used by adding something that is lacking according to the advice of an expert lecturer, and does not make a major revision. |
| 60 – 69        | Less Worthy   | Revise and re-examine the products to be used, examine the weaknesses that are contained in KIT |
| <60            | Very inappropriate | KIT products failed, could not be used and had to be revised on a large scale. |

3. Result and discussion
At the initial product development stage, the designed KIT electrolysis media was validated to several validators or expert tests. Validation was carried out in order to determine the feasibility level of the electrolysis KIT developed. The results of the validation carried out by each validator on the KIT media electrolysis microscale are presented in table 4.

**Table 4. Results of electrolysis KIT media validation.**

| No | Indicator Rating                        | r Average Calculation | Conclusion |
|----|-----------------------------------------|-----------------------|------------|
| 1. | Physical appearance of micro scale tools| 0.92                  | Valid      |
| 2. | Tool Efficiency                         | 1.00                  | Valid      |
| 3. | Tool function                           | 0.88                  | Valid      |
| 4. | Level of Implementation of Practicum Design | 0.92            | Valid      |
| 5. | Security aspects                        | 0.92                  | Valid      |
| 6. | Conformity with Learning                | 0.88                  | Valid      |
| 7. | Economic aspects                        | 0.86                  | Valid      |
| 8. | Environmental aspects                   | 0.92                  | Valid      |

Based on the results of the evaluations of the three validators listed in table 4, it can be seen that all aspects assessed by the validator show criteria until high feasibility. If the price calculated is greater than rkritis 0.30 is said to be valid and if r count is less than rkritis 0.30 it is said to be invalid [19]. The results of data analysis obtained r average calculation of all aspects of 0.91, so that KIT electrolysis media can
be said to be valid and proceed to the next stage after being revised. Feasibility tests on micro-scale electrolysis KIT media were carried out on 14th grade students of SMAN 4 Karawang randomly chosen. Students are divided into 3 groups and will get one KIT for each group. Students will conduct two experiments, namely electrolysis of a solution of KI and Na2SO4. The picture of the second series of electrons can be seen in Figure 1.

![Figure 1. (a) Electrolytic KIT circuit KI (b) Electrolytic KIT circuit Na2SO4.](image)

Analysis of the data from the results of the feasibility test shows the response of students with a very feasible percentage of 90%. The results of the feasibility test can be seen in table 5.

### Table 5. Results of the feasibility test for KIT electrolysis media.

| No  | Indicator Rating                              | Average Percentage | Conclusion    |
|-----|----------------------------------------------|--------------------|---------------|
| 1.  | Physical appearance of micro scale tools     | 90%                | Very Worthy   |
| 2.  | Tool Efficiency                              | 96%                | Very Worthy   |
| 3.  | Tool function                                | 92%                | Very Worthy   |
| 4.  | Level of Implementation of Practicum Design  | 91%                | Very Worthy   |
| 5.  | Security aspects                             | 92%                | Very Worthy   |
| 6.  | Conformity with Learning                     | 89%                | Worthy        |
| 7.  | Economic aspects                             | 90%                | Very Worthy   |
| 8.  | Environmental aspects                         | 91%                | Very Worthy   |

The results of the validation carried out by each validator on micro scale electrolysis KIT media produced suggestions and comments, suggestions and comments can be seen in table 6.

### Table 6. Comments or suggestions from the validator.

| Suggestion                        | Improvement Aspects                                                                 |
|-----------------------------------|-------------------------------------------------------------------------------------|
| Functioning of KIT components     | Add a bottle of solution of at least 3 bottles in KIT micro scale electrolysis       |
| Cover the user guide              | Fixing the supporting image must be the same as what we examined                    |
| Physical appearance of KIT        | Fix the color of the KIT lid, make it plain                                          |
Based on the results of the analysis of comments or suggestions from the validator, the revision of the electrolytic KIT media is done by replacing the cover, the lid on the KIT box and adding the solution bottle to the KIT. The final revised KIT can be seen in Figure 2.

![Figure 2. Final results of micro-scale electrolysis KIT revisions.](image)

4. Conclusion
Based on the results and discussion it can be concluded that through micro-scale electrolysis experiments KIT uses lithium batteries. The results of limited trials in the KIT micro-scale electrolysis experiments using lithium batteries as a whole have highly feasible qualifications to be used as learning media with a percentage of 90%. The results of the KIT validation test through questionnaire assessment obtained r count of 0.91.

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