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The making of metal coating props oriented chemical representation

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Abstract. The purpose of this research is to produce metal coating props that oriented to chemical representation and find out the results of validation and feasibility of the props that has been made. This research used research and development method with stages of analysis, design and development. Based on the results of this research, the product is obtained in the form of metal coating props with the characteristics of combining macroscopic, submicroscopic and symbolic representations with guidebooks and worksheets. Validation results indicate that the product is valid with the acquisition of the value of rcount on props of 0.93. The results of feasibility tests conducted on 3rd grade of 27 Senior High School Bandung showed that props are very feasible with the percentage of successive value of 97%. High validation and feasibility values are caused by props that have met the criteria as a good medium and in accordance with metal coating material. The impact, the resulting props can be used as a medium that can help students gain a complete understanding of the concept of metal coating.

1. Introduction

Submission of chemistry in the field of education has several characteristics including based on experiments [1], as well as involving chemical representations of macroscopic, submicroscopic and symbolic representations [2]. One chemical material that is ideal to be conveyed through experiments and involves three levels of chemical representation is metal coating material [3].

The metallic coating is an application of electrolysis in electrochemical material [4]. Generally, students find it difficult to understand the concept of the metal coating as a whole. At the macroscopic level students need to observe the electrolysis process of the metal coating through experimental activities. At the submicroscopic level students need to study the direction of movement of atoms, ions and electrons during the electrolysis process. At the symbolic level, students need to transfer the process into a form of chemical equation [3] .

The effective way to carry out metal coating learning activities that oriented to chemical representation is through experimental activities combined with the use of submicroscopic media, then connected with equations and chemical formulas at the symbolic level [5]. However, the facts in the field indicate that the use of media capable of visualizing submicroscopic levels is still limited [6], the implementation of experimental activities is also often constrained by the unavailability of relatively expensive laboratory equipment [7]. Metal coating props that oriented to chemical representations are suitable media to overcome this. The props consist of two components, namely macroscopic props and

submicroscopic-symbolic props which are made into a set and equipped with a guidebook and worksheet.

These props use simple materials, inexpensive and can be easily made [8]. Macroscopic props are an alternative laboratory instrument in order to carry out experiments as a characteristic of chemistry [9]. The submicroscopic-symbolic props include the type of kinesthetic media that give students more opportunities to be involved in doing something [10].

This study aims to produce and find out the appearance of metal coating props that oriented to chemical representation, and to find out the results of validation and feasibility of the props that has been made.

2. Method

This study uses the Research and Development method [11]. There are three stages in this research, namely analysis (identification of props needs), design (props design) and development (making props, validation, limited testing). The instruments used in this study are flowcharts, user manuals, metal coating experiment worksheets, validation questionnaires and student response questionnaires. Flow charts and user manuals are made by researchers to provide an overview of the appearance of chemical representation-oriented metal coating props. Metal coating experiment worksheets are used as a guide for students in practical activities and explore the relevance of material content. The validation questionnaire is a checklist with a Likert scale filled by three expert lecturers as validators. Questionnaire student responses in the form of a checklist with a Guttman scale which contains a statement and choice of answers "Yes" or "No" filled by students by assessing the feasibility of the product. The analysis phase until validation is held at the Sunan Gunung Djati UIN Integrated Lab Bandung from 15 February 2018 until 3 April 2018, while the limited test phase is held at 27 Senior High School Bandung on April 4, 2018, to 20 students of class XII.

3. Result and discussion

3.1. The appearance of metal coating props oriented chemical representation

The initial stage of determining the appearance of metal coating props oriented chemical representation is the identification of needs. First, an analysis of the relationship between macroscopic representations, submicroscopic representations and symbolic representations on metallic coating material as outlined in Table 1 is carried out.

Table 1. Analysis of chemical representation on metallic coating material.

No	Concept	Representation		
		Macroscopic	**Submicroscopic**	**Symbolic**
1.	Coated metal	Metal coating experiments	-	-
2.	Metal coating		-	-
3.	Electrolyte solution		-	-
4.	Direct current source		-	-
5.	Cation	-	Simulation of the movement of atoms, cations, anions and electrons	Symbolization of each atom, cation, anion and electron
6.	Anion	-		
7.	Electron	-		
8.	Reduction reaction	-	-	Chemical equation
9.	Oxidation reaction	-	-	

Based on representation analysis on the concept of metal coating there are concepts relating to the representation of macroscopic, submicroscopic representations and symbolic representations. Therefore, at the design development stage, two props were made, first for macroscopic levels, second

for submicroscopic-symbolic levels. The appearance of the props produced was an alloy of two macroscopic props (Figure 1) and a submicroscopic-symbolic props (Figure 2).

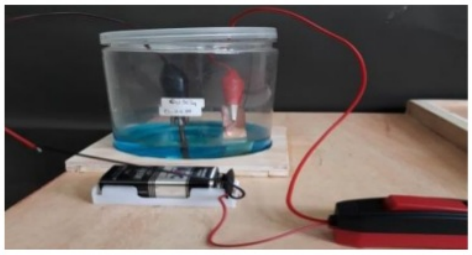

Figure 1. The appearance of macroscopic props.

Figure 1 shows the appearance of macroscopic props, there are several components that are changed from the original laboratory components, including the power supply replaced by stone batteries and chemical cups replaced by transparent plastic jars. Batteries are used as a direct current source, and transparent plastic jars are used because they are safe and do not hinder students in the observation process. The selection of tools and materials used for this props is based on simple principles, affordable costs and does not reduce the value of the function from the original laboratory equipment [12].

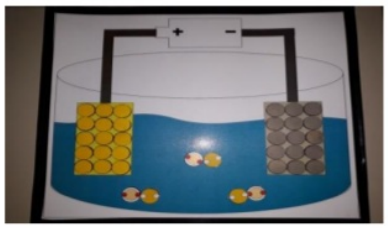

Figure 2. The appearance of submicroscopic–symbolic pros.

Figure 2 shows the appearance of a submicroscopic-symbolic props to illustrate the abstract concept of the movement of atoms, ions and electrons using magnets attached to the zinc sheet [13].

Macroscopic props and submicroscopic-symbolic props were then designed to be KIT models (Integrated Instrument Components) as shown in Figure 3.

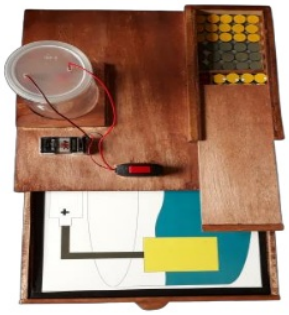

Figure 3. A series of props that have been neatly arranged in a KIT.

Figure 3 shows a series of props that have been neatly arranged in a KIT packing box. KIT has several advantages such as the use of props to be more practical and can alleviate the work of teachers in the preparation of practicum [14].

3.2. *The result of validation*

Technical validation is done by showing the props products that have been made along with the instruments. The results of the validation of the props can be seen in Table 2.

Table 2. The result of validation of the props.

No	Aspect of assessment	r_{count}	r_{count} Average	Conclusion
1	Physical appearance of metal coating props	0,92	0,93	Valid
2	The functioning of metal coating props	0,94		
3	Manufacture and use of metal coating props	0,92		
4	Relevance with metal coating material	0,87		
5	Time efficiency	0,96		
6	Resistance of metal coating props	0,96		
7	Safety for students	0,96		

Overall, the results of the validation of props are declared valid with high eligibility criteria because they have r_{count} average value of 0.93 which is greater than r critical 0.3 [11].

3.3. *The results of limited test and feasibility test*

The results of Zn metal coating experiments by copper metal using props during the limited test are presented in Figure 4 and Figure 5.

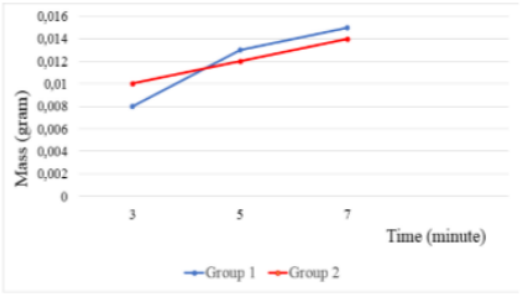

Figure 4. Graphic of the effect of time on the mass of metal coating results.

Figure 4 shows the results of experimental groups 1 and 2 concerning the effect of time on the mass of metal coating results. According to Figure 5, the increasing time spent for coating, the resulting layer mass increases. This is because the longer the coating time, the transfer of Cu ions to the cathode is greater [15].

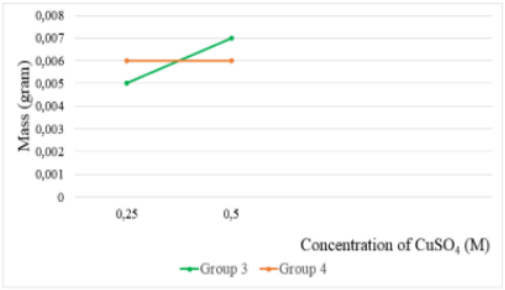

Figure 5. Graphic of the effect of concentration on the mass of metal coating results.

Figure 5 shows the experimental results of groups 3 and 4 concerning the effect of concentration on the mass of metal coating result. Based on group 3 data, the higher the concentration of solution used, the larger the resulting layer mass. However, in there is a technical error that causes the mass of the resulting layer is equal in group 4. According to the theory, the concentration of the solution affects the activity of metal ions. If the salt concentration is high, the current density is higher and the coating speed increases [15]. If the solution concentration is low and not enough to precipitate, a layer which burns at a low current will occur [16]. Based on the experimental results data, qualitatively the metal coatings oriented chemical representation can function well. Then, the results of the feasibility test of props can be seen in Table 3.

Table 3. The results of the feasibility test of props.

No	Aspect of assessment	Percentage	Average	Conclusion
1	Physical appearance of metal coating props	98.3%	97%	Very eligible
2	Use of metal coating props	98.7%		
3	Usefulness of metal coating props	95%		
4	Conditions of interest and student motivation	98.3%		

Based on Table 3, the highest average percentage value of 98.7% is found in aspects of the use of metal coating props. This aspect includes several assessment indicators that are easy to operate, the construction, the function of props in converting electrical energy into chemical energy, and the suitability of learning time. The high percentage value in this aspect indicates the props have met the practical, easy-to-use, harmless [7], functioning as a good electrolysis device [17] and are successful in helping smoothness to complete learning over time [18].

The second highest average percentage value of 98.3% was obtained in two aspects, namely the aspect of physical appearance of props and aspects of conditions of interest and student motivation. This same average percentage gain due to these two indicators affecting each other. The display of interesting learning media will be able to provide changes in the stimulus of thoughts, feelings, attention and interest in information retrieval [19]. A large percentage value in the aspect of interest and motivation conditions caused by the use of props can avoid verbal learning so that it is not monotonous and gives more opportunities to students to actively participate in learning [20].

The lowest average percentage values found in the aspect of the usefulness of the props include the ease in understanding the metal coating at the macroscopic, submicroscopic and symbolic levels, the ease of connecting the three chemical representations, providing an enjoyable in learning and props as an alternative to the use of laboratory equipment. However, despite obtaining the lowest percentage value, the 95% number still gets highly eligible criteria. The large average percentage value in each aspect of the use of props shows the props made in accordance with the concept and can support the learning needs.

Overall, the average percentage value for the results of the feasibility of teaching aids is 97% of respondents giving a positive value to the assessment aspects given in the questionnaire assessment. The figures obtained show the props included in the criteria very feasible and ready for use as a learning medium.

4. Conclusion

Metal coating props oriented chemical representation are produced through several stages starting from identification of needs, designs, manufacture of props and supporting materials such as user manuals and worksheet, validation, revision of props and feasibility tests of props. The props produced are modifications to the electrolysis device and props simulating the movement of atoms, ions and electrons in the type of kinesthetic media which are arranged into the KIT model. The result of validation shows I_{count} average for props is 0.93 so the product can be declared valid with high feasibility category. The results of the feasibility test of the props show an average percentage value of 97% so the product including the category is very feasible to use as a medium or a tool in learning chemistry.

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