Validity of worksheet-based guided inquiry and mind mapping for training students’ creative thinking skills

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Abstract. The purpose of this study is to explain the validity of guided inquiry and mind mapping-based worksheet that has been developed in this study. The worksheet implemented the phases of guided inquiry teaching models in order to train students’ creative thinking skills. The creative thinking skills which were trained in this study included fluency, flexibility, originality and elaboration. The types of validity used in this study included content and construct validity. The type of this study is development research with Research and Development (R & D) method. The data of this study were collected using review and validation sheets. Sources of the data were chemistry lecturer and teacher. The data is analyzed descriptively. The results showed that the worksheet is very valid and could be used as a learning media with the percentage of validity ranged from 82.5%-92.5%.

1. Introduction
Learning media will make teachers easier to deliver messages or information, so that students can understand learning materials well and optimally. Based on the characteristics, learning media are classified into three types, namely audio, visual and audiovisual. Worksheet are sheets containing tasks that must be completed by students. A worksheet commonly contains hints and steps to complete a task. The advantages of worksheet for teachers is facilitating teachers in implementing learning, while for students is assisting them to learn independently and to understand an written task [1]. Thus, worksheet is needed to support learning activities.

Creativity comes from the interaction of gifted individuals and disciplines, other people in the environment that will make the judgments about quality and originality [2]. Creativity is actually owned by everyone, depending on the extent to which they explore the potential. There are four aspects of divergent thinking in creative thinking: (1) fluency, (2) originality, (3) flexibility, and (4) elaboration [2]. Teachers can help students to develop those skills by implementing the inquiry learning model.

In the inquiry learning, teachers are no longer the only source of learning, and their role has shifted more towards being a facilitator [3]. It shows that there is a shift from teaching paradigm to learning paradigm. In the learning paradigm, students become the center of the learning process. The learning model that is in line with the learning paradigm is inquiry. Inquiry refers to the activities students undertake to develop knowledge and understanding of scientific ideas as well as the understanding of scientists in the study of nature. The types of inquiry learning are guided inquiry, structured inquiry, and open inquiry [4]. Students’ creative thinking skills can improve by applying inquiry learning models [5-7]. Learning outcomes including knowledge, attitudes, skills, and creativity of students can improve until 15% or above using guided inquiry-based worksheet [6].
Mind mapping can train students’ creative thinking skills. Using mind mapping, students can articulate their creative ideas in designing an investigation and investigate and report the results of the investigation. Mind mapping is an effective and creative way of writing to explore students’ ability to think or learn [8]. According to de Poter and Hernacki [9], the benefits of mind mapping includes improving students’ focus toward learning, enhancing understanding and fun, and be flexible. Mind mapping strategies require students to use their creative thinking skills. Students should be able to determine the main idea of a material, appropriate keywords, using the right blend of colors and can also use symbols that can improve their memory. Students’ creativity can improve with the average score 85.44 and the completeness of learning on buffer and hydrolysis solution material that reach 91.17% by implementing mind mapping strategy [10].

Chemistry is a branch of science that studies everything about substances including composition, structure and properties, changes, dynamics and energetics of substances. Chemistry is a science based experiment, thus, the teaching of chemistry in schools must be accompanied by experimental works. Chemistry has special terms and contains abstract concepts. Although considered to have many advantages, chemistry is still regarded as a difficult lesson because some concepts rely on memorization, such as stoichiometry. Consequently, students have many misconception, especially in concepts of the limiting reagents, mole and reaction coefficient [11]. The guided inquiry model can be applied to help students learn stoichiometric concepts [11,12].

2. Research method

This study was a research & development (R&D) which consisted of three stages, namely preliminary field testing, development, and evaluation stages [13]. This study was carried out only at the stages of preliminary field testing and development, while the evaluation stage has never been conducted. The target of this research was the worksheet being developed. This validity test involves chemistry teachers and lecturer.

The data in this study were collected using questionnaires in the form of review and validation sheets. The validation results were analyzed descriptively based on the the criteria of content and construct aspects. The percentage of validation results was obtained by calculating the Likert Scale as shown in Table 1.

| Criteria     | Score |
|--------------|-------|
| Very Less    | 1     |
| Bad          | 2     |
| Enough       | 3     |
| Good         | 4     |
| Very Good    | 5     |

According to the Likert scale [14], students’ worksheet can be feasible to be used as an instructional media if the results of validation achieving ≥ 61%. The calculation of the percentage of each indicator uses the following formula:

\[ K = \frac{F}{N \times I \times R} \times 1 \% \]

**Note:**

K : the percentage of votes  
F : number of respondents  
N : the highest score in the questionnaire  
I : the number of questions in questionnaire
R : number of respondents

To determine the validity of the worksheet, the data was interpreted using the following criteria [14].

| Percentage (%) | Category  |
|----------------|-----------|
| 0% - 20%       | Very less |
| 21% - 40%      | Less      |
| 41% - 67%      | Enough    |
| 61% - 80%      | Good      |
| 81% - 100%     | Very Good |

3. Result and discussion

3.1. Review of worksheet

Reviewers gave suggestion on worksheet based on the criteria of content and construct. In general, the worksheet has been good because it has followed the syntax of guided inquiry instruction model and mind mapping strategy. Besides, the worksheet has also trained the four creative thinking skills. The reviewers also suggested to make clear that the worksheet was oriented to guided inquiry and mind mapping by labeling the title on its cover (see Figure 1).

![Figure 1. Cover of worksheet.](image)

Furthermore, one of reviewers suggested to change the phenomenon and adapt it to the students’ experimental activities and to add activities on reflection phase by asking the obstacles encountered during the learning and the solution of the obstacles before students writing down the keywords, and to make mind mapping. The worksheet has been reviewed and then revised for subsequent assessments by reviewers.

3.2. Validity of worksheet

The developed worksheet has been validated by validators. Validator comes from one chemistry teacher and two lecturers. The validity of the worksheet is assessed based on content and construct criteria. There were three worksheets that developed, “Basic Law of Chemistry”, “Mole Concept”, and “Stoichiometry of Reaction”. The details of worksheet validation results are presented in Table 3 below:
Table 3: Validation results of worksheet.

| Description                                                                 | Percentage (%) | Category       |
|----------------------------------------------------------------------------|----------------|----------------|
| **Content Criteria**                                                      |                |                |
| Truth content / material                                                  | 92.5           | Very Valid     |
| Compatibility of parts with Guided Inquiry and Mind Mapping models         | 92.5           | Very Valid     |
| Able to train students’ creative thinking skills                          | 92.5           | Very Valid     |
| Can improve the mastery of student concepts                                | 92.5           | Very Valid     |
| Clarity of material distribution                                           | 92.5           | Very Valid     |
| Clarity Numbering system                                                   | 92.5           | Very Valid     |
| Suitability Type and font size                                             | 92.5           | Very Valid     |
| The simplicity of sentence structure                                       | 92.5           | Very Valid     |
| **Construct Criteria**                                                    |                |                |
| Conformity of indicators and learning objectives                           | 82.5           | Very Valid     |
| The material is relevant to the indicators and learning objectives         | 82.5           | Very Valid     |
| Grouped in logical sections                                                | 92.5           | Very Valid     |
| Conformity of task to material order                                       | 92.5           | Very Valid     |

Based on the criteria of content, the results of validation of students’ worksheet that had been developed in this study was very valid in all aspects. For example, aspect compatibility of the worksheet is categorized as very valid because the worksheet adapted the phases of the inquiry learning model. The phases are (a) focusing student's attention and explaining the inquiry process, (b) presenting the inquiry problem, (c) formulating the hypothesis to explain the problem; (d) collecting data to test the hypothesis; (e) formulate explanations and / or conclusions, and (f) reflect on issues and thought processes [15]. This aspect is able to train students’ creative thinking skills because the worksheet contains question that enable students to practice the four creative thinking skills sequencely and gradually. Mind mapping made by student in the last phase (Figure 2) showed the special characteristic of worksheet that could train the creative thinking skill. Making a mind mapping can train all of the creative thinking skills, fluent in mentioning the appropriate keywords, flexible in connecting branches and twigs in all directions, unique in making blend colors and mind mapping images, detailed in making mind mapping [8]. The guided inquiry learning model involves a scientific process, an active exploration that uses critical, logical, and creative thinking skills during learning [20].
Figure 2. Mind mapping made by students.

The truth content / material aspect belongs to a very valid category because the worksheet contains a summary of material from a college-level book so as to provide a wider knowledge for the students. Summary of the material contains important concepts related to the objectives of the worksheet to be achieved. The worksheet is always equipped with references. Students’ understanding of the material will be stronger because the worksheet showed reference used for students to read more about the material [1]. Aspects of suitability type and font size get high ratings because the font used in the worksheet is simple and consistent, the size used is also the standard 12 so readers can read it easily. The terms, formulas, and symbols used are consistent, so that students will feel comfortable in using the worksheet and the students’ focus is not disturbed. The simplicity of sentence structure, entire worksheet that developed were categorized as very valid. It is caused all of the components in the student worksheet using Indonesian writing correct, clear, concise and easily understood by students. Accordance with one of the functions of worksheet is as a learning media that makes it easier for students to understand the material given [16].

The worksheet is also assessed in terms of construct validity. The construct validity refers to the suitability of the order of parts and tasks with the learning material. The worksheet have been grouped into logical sections and assigned tasks. The percentage of those aspects are 92.5% which is very valid category. This results is because the materials in the worksheet is in accordance with the syllabus of chemistry lessons. Students are given basic laws of chemistry in worksheet 1. The concepts are used to solve a problem in worksheet 2 which is related to the mole concept and in worksheet 3 which is about
stoichiometry of reaction. The coherent presentation of material can make the information meaningful, allowing students to process, store, and recall knowledge in the mind [18]. The appropriate division will make it easier for students to understand the material.

Based on the results of the content and construct validity assessment, the worksheet is categorized as very valid. Thus, the worksheet is able to be used in learning activities although some revisions are still required.

4. Conclusion
The conclusion of this study is the student worksheet that had been developed in this study is very valid, with the percentage of validity $\geq 61\%$.

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