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Validity of Green Chemistry Student Worksheet Based on Project-Based Learning for Phase E at SMAN 9 Padang

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Abstract: Validity of Green Chemistry Student Worksheet Based on Project-Based Learning for Phase E at SMAN 9 Padang. This study aims to determine the validity category of project-based learning-based green chemistry student worksheets for phase E at SMAN 9 Padang that have been developed. This type of research is Educational Design Research (EDR) using the Plomp development model. Plomp's development model consists of the stages of preliminary research, prototyping, and assessment, but in this study, it is limited to the prototype III stage. The validity instrument used was a questionnaire consisting of content and construct validity. The results of the validity in this study obtained an average V value of 0.85 with the valid category. Based on these results, it can be concluded that the student worksheets developed are valid.

Keywords: Validity, Student Worksheet, Green Chemistry, Project Based Learning.

Abstrak: Validitas Lembar Kerja Peserta Didik (LKPD) Green Chemistry Berbasis Project Based Learning untuk Fase E di SMAN 9 Padang. *Penelitian ini bertujuan untuk menentukan kategori validitas LKPD green chemistry berbasis project based learning untuk fase E di SMAN 9 Padang yang dikembangkan. Jenis penelitian ini merupakan Educational Design Research (EDR) dengan menggunakan model pengembangan Plomp. Model pengembangan Plomp terdiri dari tahapan penelitian pendahuluan, pembuatan prototipe dan penilaian, namun pada penelitian ini dibatasi sampai tahap prototipe III. Instrumen validitas yang digunakan berupa angket yang terdiri atas validitas isi/konten dan konstruk. Hasil validitas pada penelitian ini diperoleh nilai rata-rata V sebesar 0,85 dengan kategori valid. Berdasarkan hasil tersebut, maka dapat disimpulkan bahwa LKPD yang dikembangkan sudah valid.*

Kata kunci: *Validitas, LKPD, Green Chemistry, Pembelajaran Berbasis Proyek*

▪ INTRODUCTION

Chemistry studies matter and the changes that come with it (Chang, 2003). Many students think that chemistry is a difficult, complex, and abstract subject that requires special intellect to be able to understand it. One of the reasons for this is that the teacher uses a conventional learning model with the lecture method and is given the task of summarising the material (Cardellini L, 2012). This results in students not taking an active role, lacking critical thinking skills, and being unable to find their knowledge. In

addition, chemistry learning is still minimally applied in the context of everyday life so the learning process is less relevant and interactive (Khoirurrijal et al., 2022).

Relevant and interactive chemistry learning can be implemented through making projects. Such learning will make students more interested and can develop issues that develop in the environment (Khoirurrijal et al., 2022). Therefore, a learning model that can encourage students to think more critically, actively, innovatively, and creatively is needed. One of the learning models that can be used is project-based learning.

Project-based learning is learning by using the project method (Thomas, 2000). This project-based learning process uses a learning cycle that consists of starting with essential questions, designing the project, creating the schedule, monitoring the students and the progress of the project, assessing the outcome, and evaluating the experience (George Lucas Educational Foundation, 2005). In line with research conducted by Suradika and Nasution (2023) related to the application of project-based learning can increase creativity, independence, involvement, confidence, logical thinking, and critical and evaluative analysis in students.

The project-based chemistry learning process can be achieved by studying phenomena in the surrounding environment. This approach ensures that students are interested and actively involved in solving problems given by the teacher related to chemical concepts (Jannah et al., 2020). One of the chemistry materials, especially in phase E, that can connect chemical concepts with phenomena that exist in everyday life is green chemistry. Green chemistry is related to the development of safe and effective solutions to various problems that arise in the surrounding environment. Chemistry teachers actively engage learners and make them aware of practical steps to eliminate waste and maintain a safe environment. (Nahlik et al., 2023). Therefore, one way to realize this goal is to implement project-based learning so that students not only read and discuss green chemistry materials but also apply them in a project (Ratnawati & Praptomo, 2023). In addition, to achieve these goals, teaching materials are needed which support the teaching process.

One of the teaching materials that can support the project-based learning model on green chemistry material is student worksheets. The study of the development of project-based learning-based chemistry student worksheets with green chemistry insights for high school has been conducted before, among others on the material of electrolyte and non-electrolyte solutions (Anisa & Mitarlis, 2020), acid-base (Ulandari & Mitarlis, 2021) and reaction rate (Nurrahmah et al., 2023). However, the development of student worksheets regarding green chemistry principles has not been widespread. Meanwhile, in this development research, student worksheets will be developed specifically on the application of green chemistry principles to prevent the formation of waste and atomic economy.

The implementation of the independent curriculum in West Sumatra, particularly in Padang City, has been implemented in senior high schools. Interviews conducted with 3 chemistry teachers at SMAN 9 Padang, SMAN 15 Padang, and SMAN 3 Padang revealed that teachers have implemented learning models according to the demands of the independent curriculum, but the project-based learning model has not been maximally applied, one of which is on green chemistry material. In addition, the teaching materials used have not facilitated students to directly apply learning materials to produce real products in the form of project results. The teaching materials have not been fully maximized in guiding students to increase their creativity, innovation, independence, activeness, and critical thinking. The teaching materials used by students

include printed books, modules, and student worksheets. However, project-based student worksheets have not been used on green chemistry materials.

Based on the description above, there is no project-based learning-based green chemistry worksheet that can be used in the learning process, one of which is at SMAN 9 Padang. Therefore, it is necessary to research to develop green chemistry student worksheets based on project-based learning for phase E at SMAN 9 Padang. This study aims to determine the validity category of the developed student worksheet.

▪ METHOD

This type of research is Educational Design Research (EDR). In this research, the development model used is the Plomp Model. The development stages of the Plomp model consist of preliminary research, prototyping phase, and assessment phase (Plomp, 2013). This research was conducted at SMAN 9 Padang in the July-December semester of the 2023/2024 academic year. The subjects in this study were 3 chemistry lecturers from FMIPA UNP and 2 chemistry teachers from SMAN 9 Padang.

This research was developed using the Plomp model which includes preliminary research and development or prototyping phase. In the preliminary research phase, stages such as needs analysis, context analysis, literature review, and conceptual framework development were conducted. Meanwhile, the development or prototyping phase was only completed until prototype III.

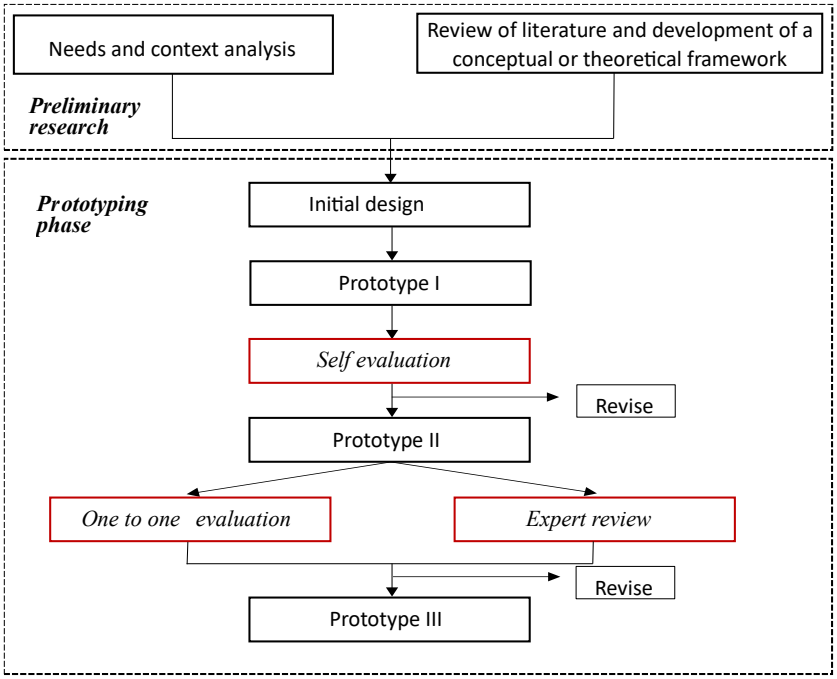

Figure 1. The Research Procedures (Plomp, 2013)

The validity instrument in this study is a questionnaire. The validity analysis of the student worksheets developed was reviewed from content validity and construct validity (Heale & Twycross, 2015). The validity analysis technique for content validity and construct validity in this study uses Aiken's V with the following formula.

$$V = \frac{\Sigma s}{n\,(c-1)}$$
$$s = r - I_0$$

n : number of raters
c : number of rating categories
r : total rating score
lo : lowest rating for validity

Validators (n) in this study were 5 people and 5 assessment categories (c) so that to get a valid value category with a 5% probability of error (p), a V value of 0.80 must be obtained (Aiken, 1985).

▪ RESULT AND DISCUSSION

Preliminary Research

Needs Analysis

The needs analysis stage was conducted through interviews with E-phase chemistry teachers at SMAN 9 Padang, SMAN 15 Padang, and SMAN 3 Padang, and questionnaires were given to students. Based on these results it is known that: (1) The project-based learning model that encourages students to solve problems and produce work in answering contextual problems posed related to green chemistry has not been applied optimally so most students do not understand the concept of green chemistry. (2) There is no alternative teaching material in the form of project-based Student Worksheets for green chemistry material, one of which is at SMAN 9 Padang.

Context Analysis

The context analysis stage was carried out by analyzing the curriculum. Analysis of the curriculum was carried out to determine the learning objectives (TP) and the flow of learning objectives (ATP) by the learning outcomes (CP) on green chemistry material for phase E.

Review of Literature

The literature review stage was carried out to collect information and sources relevant to this research. The results of the literature review found that the project-based learning model can improve students' learning outcomes in green chemistry material (Ratnawati & Praptomo, 2023). In addition, supporting teaching materials are needed, such as student worksheets. Student worksheets are printed teaching materials in the form of sheets that contain material, summaries, and instructions for completing tasks that must be carried out by students based on the learning outcomes and learning objectives that must be achieved (Prastowo, 2014).

Conceptual framework

The conceptual framework stage aims to identify and analyze various concepts that are important in this research based on the initial investigation that has been carried out. The conceptual framework for this study is shown in Figure 1.

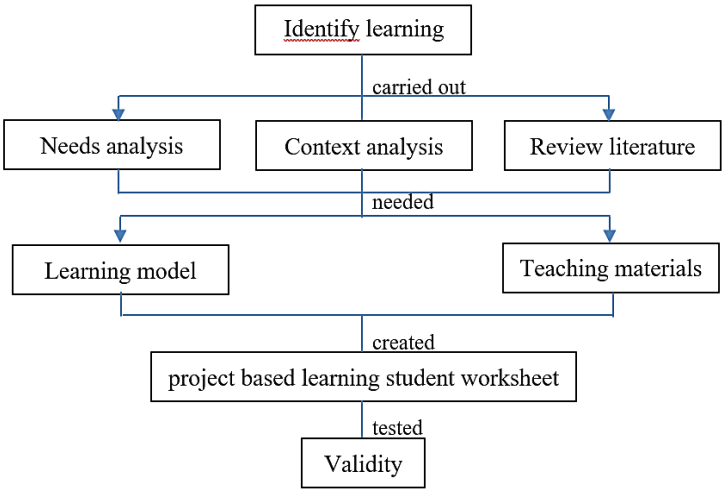

Figure 2. Conceptual framework

Development or Prototyping Phase

Prototype I

The prototype I stage is the result of the design of green chemistry student worksheets which are arranged based on project-based learning syntax. The student worksheet is designed with the main components consisting of a title, learning instructions, learning outcomes or subject matter, supporting information, tasks or work steps, and assessment (Prastowo, 2014). In addition, this student worksheet is designed by the project-based learning syntax. The following is a description of the results of the design of project-based learning-based student worksheets developed.

a. Start with the essential question

At this stage, problems related to real life are presented as well as essential questions that aim to provide assignments for students to carry out projects. This stage is shown in Figure 2 below.


LKPD Green Chemistry Berbasis Project Based Learning

KEGIATAN PROYEK 1 : PEMBUATAN *ECO-ENZYM*

Tujuan Pembelajaran (TP)

Peserta didik diharapkan dapat melakukan kegiatan yang mendukung prinsip kimia hijau menggunakan LKPD berbasis proyek dalam rangka memecahkan masalah kontekstual dengan baik dan benar.

Alur Tujuan Pembelajaran (ATP)

1) Peserta didik mampu mengidentifikasi pertanyaan/permasalahan terkait prinsip kimia hijau dalam pembuatan eco-enzym menggunakan bahan yang ada di lingkungan sekitar.
2) Peserta didik mampu menghubungkan pertanyaan/permasalahan dengan pengetahuan terkait prinsip kimia hijau dalam pembuatan eco-enzym menggunakan bahan yang ada di lingkungan sekitar.
3) Peserta didik mampu menentukan rancangan proyek terkait prinsip kimia hijau dalam pembuatan eco-enzym menggunakan bahan yang ada di lingkungan sekitar.
4) Peserta didik mampu melaksanakan proyek terkait prinsip kimia hijau pada pembuatan eco-enzym menggunakan bahan yang ada di lingkungan sekitar.

1) Penentuan Pertanyaan Dasar

Silahkan ananda perhatikan gambar di bawah ini!

Gambar 3. Kulit Pepaya

Gambar 4. Kulit Jeruk

Sumber: google.com

Gambar di atas merupakan contoh limbah yang sering ditemukan di sekitar kita. Bagaimanakah jika limbah kulit pepaya dan kulit jeruk tersebut dibiarkan bertumpuk? Adakah suatu cara untuk mencegahnya dan adakah kaitannya dengan prinsip green chemistry?

FASE E

3

Figure 3. Start with the essential question

b. Design project

At this stage, the teacher and learners plan collaboratively so that learners will feel that they are doing a real project. This stage is shown in Figure 3 below.

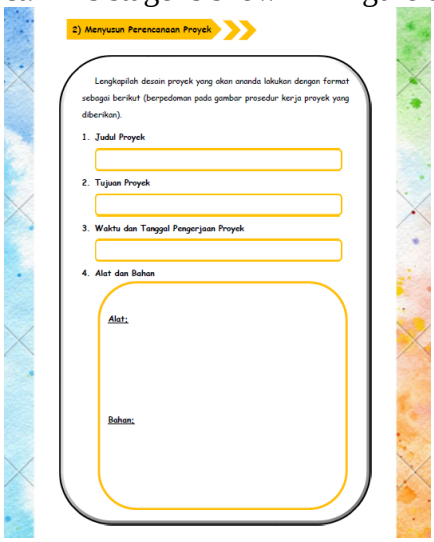

Figure 4. Design project

c. Create schedule

At this stage, learners are asked to make a schedule to complete the project and direct them to draft project activities according to the agreed time. This stage is shown in Figure 4 below.

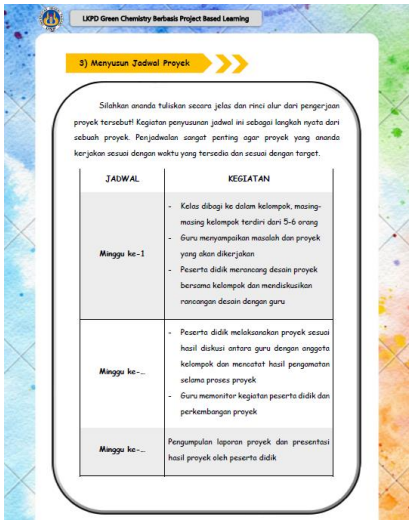

Figure 5. Create schedule

d. Monitoring the students and the progress of the project

At this stage, the teacher will act as a mentor in the learners' activities. Meanwhile, students are asked to make a table of observations and documentation. This stage is shown in Figure 5 below.

Figure 6. Monitoring the students and progress of project

e. Assess the outcome

At this stage learners are asked to present the results of the project then other groups give feedback. This stage is shown in Figure 6 below.

Figure 7. Assess the outcome

f. Evaluation the experience

At this stage, learners are asked to reflect on the project activities and results. This stage is shown in Figure 7 below.

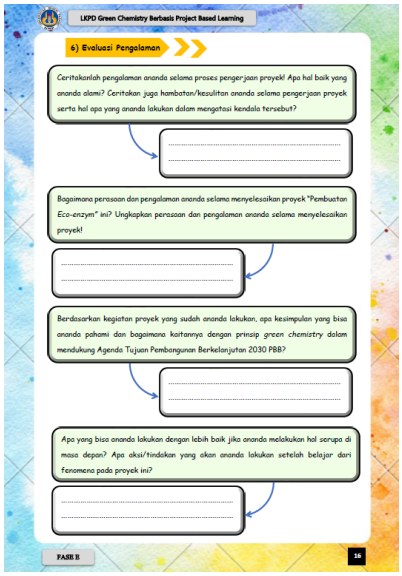

Figure 8. Evaluation the experience

Prototype II

The prototype II stage is a formative evaluation activity in the form of the self-evaluation of the prototype I. This activity aims to find out the shortcomings and errors in the student worksheet that has been developed. This activity aims to find out the shortcomings and errors in the student worksheets that have been developed. The results of the self-evaluation showed that the components of the student worksheet are complete based on Prastowo (2014), namely title, learning instructions, learning outcomes or subject matter, supporting information, tasks or work steps, and assessment.

Prototype III

The prototype III stage is a formative evaluation activity in the form of an expert review and one-to-one evaluation of prototype II.

a. Expert review

The expert review stage was validated by 5 validators consisting of 3 chemistry lecturers FMIPA UNP and 2 chemistry teachers SMAN 9 Padang. The validity analysis in this study includes four aspects, namely content, presentation, language, and graphic components. The results of the validity of the student worksheets that have been developed obtain an average V value of 0.85 with a valid category. The validity analysis for each aspect is shown in Figure 8.

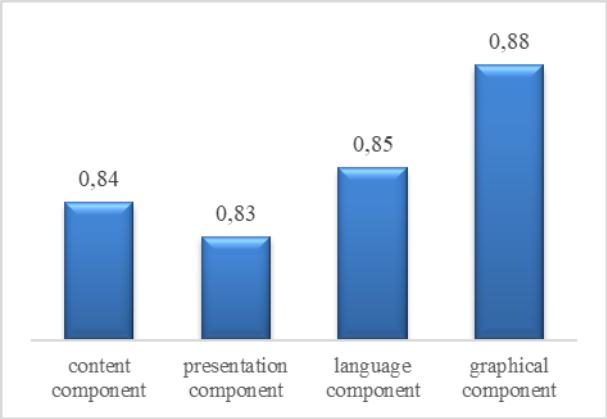

Figure 9. Validity score

The validity of the content component in this study has a V value of 0.84 with a valid category. This shows that the student worksheets developed are by the curriculum used. The learning model used is by the characteristics of the material. The concept of green chemistry presented is by the theory and the project contained in the student worksheet is related to one of the principles of green chemistry which is contextual. The content component refers to the assessment of the product developed based on the relevant curriculum as well as a strong theoretical rationale (Sari & Iryani, 2019).

The validity of the presentation component in this study has a V value of 0.83 with a valid category. This shows that the student worksheets developed have been arranged systematically (Habiba & Iryani, 2022). In addition, classroom activities based on the project-based learning syntax arranged on the student worksheets are appropriate.

The validity of the language component in this study has a V value of 0.85 with a valid category. This shows that the language used in the student worksheet is

communicative and uses good and correct Indonesian language rules (Andromeda et al., 2018).

The validity of the graphic component in this study has a V value of 0.88 with a valid category. This shows that the appearance of the student worksheets developed is attractive. The assessment of the graphic component is related to the overall product design such as layout, symbols, and images that are presented accordingly and attractively (Nengsih & Yusmaita, 2019).

b. One-to-one evaluation

The one-to-one evaluation stage is an activity that aims to find out how students respond to the student worksheets developed. The results of this evaluation show that the design, color, type of writing, and cover of the student worksheets developed are attractive. In addition, the language and learning steps on the student worksheets are easy for students to understand.

▪ CONCLUSION

Based on the research that has been done, it can be concluded that the green chemistry student worksheet based on project-based learning for phase E at SMAN 9 Padang is valid with an average V value of 0.85. In addition, future researchers are advised to continue this research to the practicality stage to determine the extent of the benefits, ease, time efficiency of use, and benefits of the student worksheets and also the effectiveness test to measure the success rate of using student worksheets in improving student learning outcomes.

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