International Journal of Multidisciplinary Research and Growth Evaluation.

Validity of PBL "LION" E-Worksheets Integrated Ethno-STEM Monel Crafts to Improve Students' Critical Thinking Skills

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Article Info

ISSN (Online): 2582-7138
Impact Factor (RSIF): 8.04
Volume: 07
Issue: 01
Received: 16-11-2025
Accepted: 20-12-2025
Published: 23-01-2026
Page No: 649-652

Abstract
The problem in this study is the demand for critical thinking skills that must be possessed by students along with the development of the 21st century which is increasingly digital by maintaining an understanding of the chemical concepts taught. The purpose of this study is to determine the validity of the Electronic Student Worksheet (E-LKPD) to improve critical thinking skills in the material of chemical nomenclature and chemical reaction equations. This study uses a Research and Development (R&D) approach with a research flow adopting a 4D development model (define, design, develop, and disseminate) but only carried out up to the 3D stage, namely define, design, and develop. The feasibility of E-LKPD is seen from the results of the validation of material experts obtaining 92.39% and the results of the validation of media experts obtaining 99.17% with a "very feasible" category. Furthermore, the results of the validation of material experts and media experts were analyzed using the Gregory Matrix method obtaining 1 which means "very valid". So that, the developed E-LKPD is declared feasible according to experts with a very feasible category for use in learning.

Keywords: E-Worksheets, Critical Thinking Skills, PBL LION

1. Introduction

Teaching materials, often known as learning media, are tools capable of providing learning stimuli to students. These media aim to improve thinking skills. Furthermore, media can often provide encouragement and motivation to learn a subject (Fuadati & Wilujeng, 2019; Hanik, 2020; Suwastini *et al*., 2022) [1, 2, 3]. Student worksheets can serve as learning guides, facilitating both students and teachers in learning activities. Student worksheets can facilitate student understanding of the material. Learning activities using student worksheets effectively improve student learning outcomes, knowledge, attitudes, and skills (Suwastini *et al*., 2022) [3]. Technological advances have led to the development of student worksheets into electronic media, known as electronic student worksheets (e-worksheets). E-worksheets typically feature audio, video, and images that can engage students and make learning interactive. This media is called interactive because users interact with the teacher and actively participate in the learning process (Suwastini *et al*., 2022) [3].

Student worksheets typically contain a learning model. One of the existing learning models is Problem Based Learning (PBL). PBL can be considered a suitable learning model for improving chemistry learning outcomes. This is because this learning model encourages students to actively contribute to learning by solving problems (Saputra *et al*., 2023; Selviani, 2019) [4, 5].

The problems to be solved in the Problem-Based Learning (PBL) model are real problems. These real-world problems can be taken from local wisdom, known as ethnoscience. Ethnoscience is the activity of transforming indigenous science (knowledge that develops in society) into scientific science that can take the form of customs, culture, language, and morals (Nuralita, 2020; Sudarmin *et al*., 2019) [6, 7]. The demands of global progress and the industrial revolution 4.0, as well as concerns about the loss of culture among the younger generation today, have led to the integration of STEM and ethnoscience, known as ethno-STEM (Idrus, 2022) [8].

The ethno-STEM approach integrated with the PBL model is expected to enable students to become more familiar with their own local wisdom, be able to face global progress, and train and improve students' mindsets while still understanding the chemistry concepts taught. In addition to conceptual understanding, 21st-century skills are no less important. The 21st century, characterized by openness and globalization, requires students to have skills that can help them cope with globalization. These 21st-century skills are known as 4C, namely communication, collaboration, critical thinking, and creativity (Aswanti & Isnaeni, 2023; Fitria *et al*., 2023; Mardhiyah *et al*., 2021; van Laar *et al*., 2020) [9, 10, 11, 12]. These critical thinking skills are important for students to have in science education, especially chemistry. Chemistry concepts are highly applicable in everyday life, so students must have well-developed critical thinking skills to be able to apply these concepts in real life (Ariani, 2020; Chusni *et al*., 2022; Darmaji *et al*., 2020; Larsson, 2017; Tanti *et al*., 2020) [13, 14, 15, 16, 17].

In addition to critical thinking skills, there are several other important skills in learning. Listening is one of the communication skills, besides speaking, reading, and writing. Listening is an active and focused process of understanding what we hear. People who listen not only process what they hear but also connect it with other information stored in their brains (Nunan, 1998) [18]. Listening skills support the development of critical thinking skills. This is because critical listening skills enable listeners to not only be passive recipients but also to analyze what they hear, question its validity, and evaluate other points of view (Baki, 2025) [19]. The activity of interpretation is indirectly carried out when a person listens to understand and infer meaning from the sound waves, they receive. Interpretation can be defined as the activity of understanding and expressing meaning from various experiences, situations, data, events, assessments, beliefs, customs, procedures, or criteria (Ningrum & Ratman, 2021) [20]. Interpretation is part of higher-order thinking and can improve critical thinking skills (Iryani *et al*., 2023; Sa'adah *et al*., 2020; Wahdah *et al*., 2023) [21, 22, 23]. Organizing the results of interpreting what has been heard is also an important activity. The results of interpretation need to be reconfirmed and organized so that it is easier to understand the information obtained. Noting is also an important activity that needs to be done to better understand the information obtained. This is because the rapid development of technology has made students prefer typing or even just taking photos of learning materials. Mueller & Oppenheimer (2014) [24] stated that students who take notes by typing have worse factual content and conceptual understanding test results than students who take notes by hand.

2. Method

This study uses a Research and Development approach with a 4D model (define, design, develop, and disseminate). However, in this study, the 4D stages were only carried out up to the 3D stage (define, design, and develop). In the define stage, performance analysis, student analysis, fact analysis, and learning objective analysis were carried out. In the design stage, the main product to be created and its supporting tools were designed. In the final stage, develop, product validation was carried out. The product was validated by two subject matter experts and two media experts. The validation results were analyzed descriptively and using the Gregory Matrix method.

3. Results and Discussion

The define stage of the research showed the need for interactive student worksheets that incorporate local wisdom, the need to improve students' critical thinking skills, and the existence of several skills that support the process of improving critical thinking skills. The results of the define stage were used to carry out the next stage, namely design, to design the product to be made. This research produced a main product in the form of E-LKPD with the PBL LION model, which is integrated with the ethno-STEM monel craft with the aim of improving students' critical thinking skills. The subject matter used in this research was nomenclature and chemical reaction equations. In addition to the main product, supporting products in the form of teaching modules were also created at this stage.

Once the main product and supporting products were ready, the next stage was developed. This stage involved validation by subject matter experts and media experts. The purpose of validation was to determine the validity or accuracy of the products produced. The results of the subject matter experts' validation can be seen in Table 1. Meanwhile, the results of the scoring of each aspect by subject matter experts are presented in Table 2.

Table 1: Results of Subject Matter Expert Validation

Expert	Institution	Percentage (%)	Criteria
Expert 1	Magister Chemistry Education, UNNES	93.48	Highly Feasible
Expert 2	Magister Chemistry Education, UNNES	91.30	Highly Feasible
Average (%)	—	92.39	Highly Feasible

Table 2: Results of Subject Matter Expert Validation on Each Aspect

Aspect	Percentage (%)	Criteria
Content Quality	87.50	Highly Feasible
Presentation Quality	100	Highly Feasible
Language Quality	94.64	Highly Feasible
PBL LION	87.50	Highly Feasible
Ethno-STEM Monel Crafts	79.17	Feasible

The results of the subject matter expert validation then further analyzed using the Gregory Matrix method to gain a stronger understanding of the validity of the E-Worksheets developed in terms of subject matter. The results of the Gregory Matrix method analysis are presented in Table 3.

Table 3: Results of Subject Matter Expert Validation Analysis of the Gregory Matrix Method

Expert 2 \ Expert 1	Irrelevant	Relevant	Validity Coefficient	Criteria
Irrelevant	0	0		
Relevant	0	23	1	Highly Valid

The results of subject matter expert validation show that the E-Worksheets product developed is classified as highly feasible in terms of subject matter. This is indicated by the average score from subject matter expert validators of 92.39%. The presentation quality received the highest score of 100%. This indicates that the presentation in E-Worksheets is highly feasible. However, the ethno-STEM aspect of monel crafts received a score of only 79.17%, which is in the feasible category. Research conducted by Hasanah *et al*. (2022) [25] shows that the use of local wisdom in chemistry learning makes learning more representative. The monel craft ethno-STEM used in this study, although already feasible, needs to be improved further to make learning more representative and enhance student understanding.

In addition to the average score from the subject matter expert validators, which indicates a feasible category, the results of the analysis using the Gregory matrix method also show a validity coefficient of 1. A Gregory Matrix method validity coefficient of 1 indicates high validity or very valid (Retnawati, 2016) [26].

The E-Worksheets product was also validated by media experts. The results of the media expert validation and the scoring of each aspect are presented in Table 4 and Table 5, respectively.

Table 4: Results of Media Expert Validation

Expert	Institution	Percentage (%)	Criteria
Expert 1	Magister Chemistry Education, UNNES	98.34	Highly Feasible
Expert 2	Magister Chemistry Education, UNNES	100	Highly Feasible
Average (%)			Highly Feasible

Table 5: Results of Media Expert Validation on Each Aspect

Aspect	Percentage (%)	Criteria
E-Worksheets Size	100	Highly Feasible
Cover Design	100	Highly Feasible
Content Illustrations	95.83	Highly Feasible
E-Worksheets Design	100	Highly Feasible

In the same way as the results of subject matter expert validation were reanalyzed using the Gregory Matrix method, the results of media expert validation were also reanalyzed using the Gregory Matrix method. The results of this analysis can be seen in Table 6.

Table 6: Results of Subject Matter Expert Validation Analysis of the Gregory Matrix Method

Expert 2	Expert 1		Validity Coefficient
	Irrelevant	Relevant	
Irrelevant	0	0	
Relevant	0	15	1 (Highly Valid)

The results of media expert validation indicate that the E-Worksheets developed is 99.17% valid in terms of media and is classified as highly feasible. In more detail, the weakness of the E-Worksheets developed in terms of media lies in the content illustrations. Research conducted by Sagita *et al*. (2024) [27] shows that illustrations play an important role in making teaching materials interesting. The selection of illustrations in the developed E-LKPD is already in the highly feasible category, so it can be said that the illustrations in the E-Worksheets make it interesting for students to learn. The results of the Gregory Matrix method analysis in media validation produced a validity coefficient of 1, so in terms of media, this E-LKPD can be said to be highly feasible.

4. Conclusion

The results of validation by subject matter experts and media experts show that E-Worksheets is categorized as very suitable in terms of subject matter and media. These results can be used as a reference that the E-Worksheets that have been created are suitable for use in learning activities in the classroom. These E-Worksheets can be one of the media for improving students' critical thinking skills.

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How to Cite This Article
Zulfiana UL, Wardani S, Harjono. Validity of PBL "LION" e-worksheets integrated ethno-STEM Monel crafts to improve students' critical thinking skills. Int J Multidiscip Res Growth Eval. 2026;7(1):649-652.