International Journal of Educational Research

E-ISSN: 3047-6038
P-ISSN: 3047-6046

Research Article

Validity of Science Literacy-Oriented E-Lapd on Chemical Equilibrium Materials Using Problem-Based Learning Models

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Abstract: This study aims to obtain the validity of E-LAPD using the Problem Based Learning (PBL) model that can be used to improve science literacy on chemical equilibrium material. The design used is a 4-D model designed to improve students' science literacy skills. The valid E-LAPD was evaluated through a validation sheet filled in by the validator using a Likert scale. Validity consists of construct validity which includes presentation components, graphic components, suitability of models and indicators to be improved and content validation which includes the suitability of learning objectives with learning outcomes and the suitability of problems or phenomena with the material being taught. The validity of E-LAPD is declared valid if the score from the validator is at least 4 and does not have one score < 3 from the validator. The results showed that the E-LAPD developed had high validity indicating that the mode score of the validator ≥ 4. The developed E-LAPD was declared valid for use with a construct and content validation assessment which was described as valid with a score of 4, thus E-LAPD using the PBL model was declared valid for use to improve science literacy in chemical equilibrium material.

Keywords: Science literacy; E-LAPD; 4D; Problem Based Learning

1. Introduction

Science Literacy in the PISA Assessment and Analysis Framework refers to students' ability to engage with science-related issues, and with the idea of science, as reflective citizens. A science literate person is willing to engage in reasoned discourse about science and technology which requires competencies to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically [1].

The object of this research is science literacy-oriented E-LAPD using problem-based learning model that will be used in chemistry learning. In several studies that have been conducted, there are several methods, namely the Borg & Gall, 4-D, and ADDIE development methods that produce valid media used in learning. One of the advantages of the Borg & Gall method is that it produces products with high validity because each stage of development, from design to trial, involves validation by experts (media, material, language) and field trials. The systematic and comprehensive stages in this model can produce learning tools that are structured and measurable and can be modified according to the research context [2]. The use of this model connects theoretical research with the field. This model not only produces new knowledge, but also products that can be directly implemented in learning. The disadvantage is that it takes a relatively long time because the development procedure consists of many complex stages. The implementation of this model requires a large amount of money and human resources [3]. Each stage, such as expert validation, testing, and product revision, requires a lot of funds, energy, and time, making it less efficient for research with limited budgets. The research results cannot be generalized as a whole. The Borg and Gall model is more aimed at solving specific problems in a particular context or sample, so the results of E-LAPD development are

Received: April, 22 2025
Revised: May, 06 2025
Accepted: May, 20 2025
Published: May, 22 2025
Curr. Ver.: May, 22 2025

usually relevant only to the situation or group under study, not to a wider audience. [2].

The next method that is often used is the 4-D model from Thiagarajan. The model is often used because it is practical and flexible, the steps are systematic and simple and can produce E-LAPD with high validity[1]. The 4D model consists of four main stages (Define, Design, Develop, Disseminate) which are clear, systematic, and easy to understand, making it easier for researchers to develop LKPD without complicated procedures. This model facilitates the development of activity sheets based on various learning approaches (e.g. Problem Based Learning, Discovery Learning, HOTS), so that the resulting products are innovative and relevant to the development of education [4]. However, this model has limitations on the variables measured and the dissemination stage is limited. In another case, the quality of the results is highly dependent on the availability and quality of input from expert validators, so if the validation is less than optimal, the quality of the LKPD can also be less than optimal [2]

Another model is the ADDIE model which has a systematic and structured approach and supports development with complete competence. This model has the disadvantage of being time-consuming and requiring sufficient resources. Based on several considerations, the 4D development research model was chosen as the method used in this study [5].

This research is based on the low science literacy skills of students caused by several factors including learning that has not used electronic activity sheets so that it is less interesting and lack of student participation in learning because learning is monotonous and teacher-centered. This research is expected to be a reference for further researchers.

2. Literature Review

2.1. Scientific Literacy

Science understanding, better known as science literacy, is very important for students to master, because science literacy is the main goal of science learning today [6]. Science literacy is a knowledge or understanding of science concepts and scientific processes needed for personal decision making, civic and cultural participation, and economic productivity[1]. The definition explains that science literacy covers various aspects ranging from knowledge and understanding of science concepts, the processes a person needs to make decisions, and so on. Science literacy as a set of individual abilities and skills in reading, writing, speaking, calculating and solving problems needed in everyday life [7]. Therefore, a person is said to have practiced literacy if they have carried out the process of reading, thinking and writing.

2.2 Problem Based Learning

Problem-Based Learning (PBL) is one of the innovative learning models that can provide active learning conditions for students. PBL is a learning model that involves students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems [8].

Problem Based Learning can stimulate learners to analyze problems, formulate hypotheses, collect data, analyze data and conclude answers to the problems given. In other words, this model basically trains problem solving skills through systematic steps so that students will be more critical in finding solutions to problems[9].

Problem Based Learning is a strategy used to solve problems intensively under teacher supervision. At first glance, this method is almost the same as inquiry, but the difference lies in the role. In PBL, the teacher actively participates in guiding students to solve problems together. Teachers are required to be creative in managing the class so that students are motivated to learn on their own.

2.3 E-LAPD

Electronics-Learner Activity Sheet (E-LAPD) is a student woksheet that contains practice questions that can be done anywhere and anytime using electronic media such as computers or cellphones that have an internet connection. E-LAPD is not only a printed form but with a digital display that there are learning outcomes, material, learning videos, evaluation questions, attendance, assessment and learning resources. According to Nikmatur et al. (2023) with this LAPD can think like analyzing the data of the investigation results by increasing students' science literacy skills[10].

LAPD development is an activity of detailing and describing activities completely and clearly each component contained in an LAPD. The purpose of developing this LAPD is developed by formulating complete, clear and operational learning objectives with material components in the form of explaining concepts, giving examples, and with pictures .

3. Proposed Method

This research was conducted by following the 4D development research model which consists of Define, Design, Develop, Disseminate stages. In this study, the development was only carried out until the develop stage or limited trial. The research instrument used a validation sheet. Data analysis techniques in this research are quantitative and qualitative.

3.1. Define stage

This stage consists of front end analysis, learner analysis, concept analysis, task analysis, and indicator formulation.

3.1.1. Front-end analysis

Front-end analysis is a process used to understand the needs and context before the development or design of this E-LAPD. This analysis was conducted by distributing pre-research questionnaires to learners so that E-LAPD was developed. Students have difficulty in chemical equilibrium material because there are elements of memorization and calculation simultaneously. This makes students feel uninterested in learning so that the steps that can be taken are to develop electronic LAPD that can attract students to study chemical equilibrium material [4].

3.1.2. Students analysis

Students analysis is one of the main components in learning. This relates to the learning process involving students and their interactions. In this case, it is taken from the results of distributing questionnaires with students which show that 55.3% of students have difficulty in chemical equilibrium. Students usually learn using manual LAPD given by the teacher. The LAPD so far only trains students to be able to explain existing scientific phenomena but still cannot train students to design scientific research and interpret data and facts scientifically. The LAPD used also often does not connect existing material with real-world problems so that it makes students bored because they keep doing questions. Most students feel that it would be easy to do chemistry learning with a colorful LAPD that has interesting videos and pictures [11].

3.1.3. Task analysis

Task analysis begins with a deep understanding of the learning objectives to be achieved. In the context of chemical equilibrium, these objectives can include concepts such as the law of equilibrium, as well as factors that affect equilibrium in chemical reactions. In the PBL learning model, students conduct further study by solving the problem at hand so as to improve their ability to explain scientific phenomena, design experiments to solve the problem and interpret data and facts scientifically. Furthermore, it is important to consider learners' needs and backgrounds. Each class has different dynamics and levels of understanding on a daily basis. Thus, this task analysis becomes a strong foundation for creating a deep and meaningful learning experience, which in turn will help learners better master chemical equilibrium material [12].

3.1.4. Concept analysis

Concept analysis is carried out with a concept map that connects various concepts in chemical equilibrium which includes homogeneous and heterogeneous equilibrium, the Le-Chatelier Principle which discusses equilibrium shift factors and chemical equilibrium in industry [13].

3.1.5. Formulation of learning objectives

Formulation of learning objectives is done by analyzing learning outcomes and indicators of science literacy skills that will be achieved using the PBL learning model.

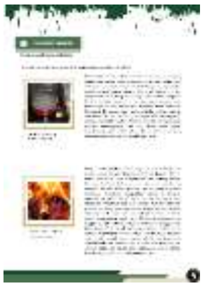
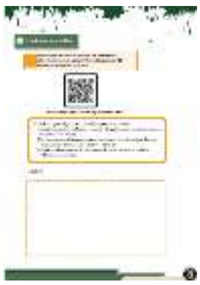
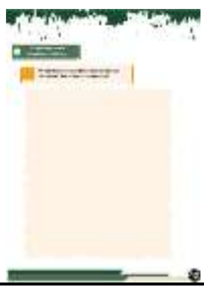
3.2 Design Stage

The design stage begins with the preparation of a draft LAPD which will later be reviewed with input and suggestions from experts. The suggestions and input are used to improve the draft LAPD to be better and more appropriate. The final product is in the form of two E-LAPDs for students on the subchapter of chemical equilibrium material.

3.3 Development Stage

After the draft of the preliminary product has been revised based on criticism and suggestions from the reviewer, then expert validation will be carried out by three validators. The results of this validation are in the form of data on the mode of assessment scores from a Likert scale and criticism and suggestions from validators.

Table 1. Final Product of E-LAPD.

Design	Syntax
	Orient students to the problem
	Organizing students to learn
	Guiding group investigations
	Presenting work

Design	Syntax
	Evaluate the problem-solving process

The product resulting from this development stage is a final draft which will then be assessed for validity. This research is only limited to product development and limited trials so that there is no disseminate of products. The final product later be assessed for validity using the validation sheet. Scoring based on Likert scale as shown in the table

Score	Statement
1	Very unfavorable
2	Not Good
3	Fairly Good
4	Good
5	Very Good

The validation result data is ordinal data that can be analyzed by determining the mode of each aspect of the assessment with the following conditions:

- If the assessed aspect has a mode ≥ 4 and there is no score 1 or 2 from the validator, then the aspect is declared valid.
- If the assessed aspect has a mode score < 4, then the aspect is declared invalid, so that revalidation is needed [14].

4. Results and Discussion

Validity consists of construct and content validity, each of which will be validated by three validators. Content validity includes the suitability of E-LAPD with material, indicators and learning outcomes and objectives. E-LAPD is designed to align with the learning outcomes and objectives analyzed during the define stage, which involves formulating learning objectives. The learning objectives are structured based on the skills to be achieved and the learning model employed.

Table 2. Result of Content Validity

No.	Aspects assessed	Assessment Score by Validator			Mode Score	Criteria
		V1	V2	V3		
Content Validity						
1	Suitability of learning objectives with learning outcomes of the curriculum					
	LAPD 1	4	4	4	4	Valid
	LAPD 2	4	4	4	4	Valid
2	Suitability of problems and phenomena with chemical equilibrium material					
	LAPD 1	4	4	5	4	Valid
	LAPD 2	4	4	5	4	Valid

The validation results based on content are described as valid with a mode score of 4. The E-LAPD material chosen is chemical equilibrium in phase F. The E-LAPD design was developed according to the intellectual level of students. E-LAPD is designed to improve science literacy skills with selected indicators of science competence which include explaining scientific phenomena, interpreting data and facts scientifically, and designing scientific experiments. These indicators are combined with a problem-based learning model that can develop students' ability to solve problems that occur in individual lives [15].

Construct validity includes components of presentation, language, grammar as well as the suitability of E-LAPD with the learning model and skills that are oriented to be aimed at.

The validity of the LAPD is obtained from the validator's score using a validation sheet. Validators consisted of two chemistry lecturers and one chemistry teacher, the validation results from three validators were declared valid if they obtained a mode score of 4 and there was no one score ≤ 3. Validation is assessed from content validity and construct validity which consists of presentation components, graphic components, PBL syntax, and skills to be improved, namely science literacy.

The results of validation are ordinal data which are analyzed using the mode in each aspect of the assessment. The assessment aspects of E-LAPD are said to be valid if they have a mode ≥ 4 and do not have values categorized as invalid, namely 1 and 2.

Table 3. Result of construct validation

Component	Mode Score	Criteria
Presentation	4	Valid
Graphics	4	Valid
Science Literacy Indicators	4	Valid
Problem Based Learning Model	4	Valid

The presentation component in the LAPD developed is described as valid with a mode score of 4. In this case, the presentation component includes the systematics of the E-LAPD, the suitability of presentation between components, the motivation of students towards the E-LAPD, and the activeness of students in E-LAPD. The score obtained is 4 indicating that the LAPD is suitable for use but still requires revision in several parts.

The layout design is crafted in color, featuring illustrations and photos on the cover, with problem orientations aligned to the sub-chapters discussed. Colorful designs are also applied to each activity column, tailored to students' preferences for vibrant colors, images, and fresh learning atmospheres. The font used is simple, easy to read yet engaging, ensuring readers can easily grasp the content and instructions without growing bored. Font size is adjusted to meet the needs and visual capabilities of typical readers. The layout is neatly and simply arranged to facilitate students' reading. A score of 4 indicates that the E-LAPD is suitable for use with some revisions.

The results of construct validation based on presentation components, graphic components, syntax and science literacy indicators are described as valid with a mode score of 4. With these validation results, E-LAPD is declared valid for use in learning on chemical equilibrium material to improve students' science literacy skills.

5. Comparison

Similar research was conducted by Hafidzah and Nurhaliza in 2021 with the research title “Implementation of Problem-Based Learning (PBL) on Students' Science Literacy Skills” with research results showing that PBL can improve students' science literacy skills because with the PBL learning model, students gain problem-solving skills and science process skills related to the issue of natural and surrounding phenomena. In the study did not use a specific activity sheet so the researcher intends to innovate by developing a valid E-LAPD used in learning to improve science literacy skills.

6. Conclusions

Science literacy-oriented E-LAPD was declared valid based on aspects of content validity and construct validity, which obtained a mode score of 4 with valid criteria. Thus, E-LAPD is declared valid to improve students' science literacy skills on chemical equilibrium material.

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