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Validity of Electronic Student Worksheets to Improve Students' Metacognitive Skills Through PBL on Petroleum Materials

Iga Putri Subandi & Rusly Hidayah
Chemistry Education Study Program, FMIPA, Surabaya State University, Indonesia
* Corresponding Author e-mail: ruslyhidayah@unesa.ac.id

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Abstract
This study aims to develop Electronic LKPD to improve students' metacognitive skills through problem-based learning model on petroleum material with validity criteria. The procedure used in the research is 4D by Thiagarajan and in the limited test a onegroup pretest-posttest research design was carried out. The development of teaching materials in the study refers to Thiangarajan's 4D model (1974) which consists of 4 stages, namely Define, Design, Develop, and Disseminate, but because in this development research using limited product trials, the research stages are carried out in sequence until the Develop stage (Thiagarajan, Sammel, & Sommel, 1974). This trial design used a one group pretest-posttest design. In this design, two tests were carried out, namely before being given treatment called pretest and after treatment called posttest. The instrument used is a media validation sheet for the validity of Electronic LKPD. In one of the public high schools in Mojokerto, metacognitive skills are very low at 20%. Based on interviews with chemistry teachers, it was found that the chemistry learning model in class often applies lecture models, discussions, so that students are less actively involved in learning and teachers have never tested students' metacognitive skills. This has an impact on the metacognitive skills of students in chemistry lessons are less than satisfactory, especially in petroleum material. The results of product validation consist of the mode on the content criteria getting validity 4 and the mode on the construct criteria getting validity 4 with both criteria being very valid. So that the Electronic LKPD developed is valid to improve students' metacognitive skills through the Problem Based Learning (PBL) model on Petroleum Material.

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INTRODUCTION

Chemistry uses several supporting methods in its learning so that it can be absorbed and understood by students. This is important, because some students consider chemistry to be a difficult subject to understand. Therefore, it is important for teachers to know and implement learning using appropriate and fun methods (Faizi, 2013).

Petroleum is a material that requires more concept understanding, if students do not understand the concept they will have difficulty in learning the material. In this material there are also many things related to everyday life (Nursa'diyah, 2015). However, students do not know the relationship between the material and everyday life, they are only guided by the teaching materials provided by the teacher. This limits knowledge and makes students quickly bored during lessons (Septiyani, 2016). Therefore, an alternative learning is needed based on the scientific approach with the help of LKPD on petroleum material which is

expected that students have the ability to explore information through observing, questioning, trying, reasoning, and communicating activities.

Electronic LKPD is the best means to develop science process skills, because it can provide opportunities for students to understand or work on existing problems online. The advantage of Electronic LKPD is that teachers can design the content of the Electronic LKPD according to the methods and materials that will be delivered in classroom learning activities because it directs students in carrying out the learning process. Electronic LKPD is prepared to facilitate the learning process and can be accessed easily online (Rusman, 2018).

The use of a proper learning model is expected to help students understand chemistry material and apply it in everyday life so that it can improve students' metacognitive skills. PBL is one of the learning models applied in Curriculum 2013. This learning model uses real-life problems as something that students learn to help them understand chemistry and its application. Problems raised from phenomena around are expected to increase reasoning in finding alternative solutions to each problem (Purnaningsih, 2019).

Based on previous research that the use of PBL can improve student learning outcomes in Hydrocarbon material which has petroleum sub-material with high learning outcomes (Karepesina & Manuhutu, 2023).

In the problem-solving process, learners need to be taught how to solve problems that train thinking skills. The steps that learners use in the problem solving process include planning, monitoring, and evaluating activities. In addition to using these steps, learners also use metacognitive skills to help overcome errors and deficiencies that are usually made by learners because metacognition is a regulator and controller of cognitive processes in learning and thinking. Thus the learning and thinking process carried out by learners will be more effective and efficient (Schraw & Dennison, 1994).

The lack of metacognitive skills of students and still having difficulty in understanding the concept of petroleum. Therefore, The purpose of this study was to describe the feasibility of teaching materials in the form of PBL-based Electronic LKPD developed based on criteria only limited to the validity aspect. It is expected that the Electronic Learner Worksheet that has been developed can be used as teaching material for class XI chemistry to improve students' metacognitive skills on petroleum material.

METHOD

The research was conducted in the even semester of the 2022/2023 academic year with the research target being 36 grade XI students in one of the Mojokerto State Senior High Schools. The type of research used is Reseach and Development research which refers to the 4D model consisting of define, design, develop, and disseminate stages (Thiagarajan et al., 1974). This research only reached the develop stage. This study produced electronic student worksheets to improve students' metacognitive skills based on Problem Based Learning.

This research after going through the stage of review by one reviewing lecturer then continued with validation conducted by three validators, namely two validators from lecturers and one validator from high school chemistry teachers (Aprilia & Lutfi, 2023). Research data obtained using a validity questionnaire. The eligibility guideline on the developed Electronic Learner Worksheet is validity. The instrument used is a validation sheet for validity which looks at the content validity and construct validity of the Electronic Learner Worksheet developed by the researcher (Sugiyono, 2018).

The data analysis technique that aims to test the validity of teaching media products is data analyzed using descriptive quantitative by taking into account the research score criteria listed in the Likert scale found in Table 1 (Riduwan, 2015).

Table 1. Likert Scale

Rating	Scale Score
Very Invalid	0
Less Valid	1
Fair	2
Good	3
Very Valid	4

Because the data obtained is ordinal data which has the nature that mathematical operations cannot be performed (added, subtracted, multiplied, and divided), the determination is made by mode. This means that the decision is made on the largest number (Lutfi, 2021). From this mode, a score will be obtained and can be re-identified according to the categories on the Likert scale Table 1. The product is declared valid if it gets a minimum mode score on a scale of 3.

RESULTS AND DISCUSSION

The development procedure in the study according to Sivasailam Thiagarajan (Arikunto, 2002). The development using the 4D development model consisting of define, design, develop, and disseminate, but in this study it is limited to the develop stage only, namely until the validation stage. The development stages are described as follows:

Define

In this define, it has the aim of collecting information and data related to the analysis of the background of the Electronic Learner Worksheet to be developed by the researcher, analyzing the research subject, namely the characteristics of students who are the target in the development of Electronic Learner Worksheets. Problem identification was carried out by direct interviews with chemistry teachers who stated that the chemistry learning model in class often applied lecture, discussion models (Muswa, Erna, & Abdullah, 2023). In addition, during learning in the classroom teachers rarely apply the PBL learning model. So, it has an impact on the lack of metacognitive skills of students in chemistry lessons, especially in petroleum material and teachers rarely apply the right learning media to support the improvement of students' metacognitive skills.

In the analysis of learners, observations will be made to find out characteristics of the learners so that the Electronic LKPD developed is in accordance with students. The method used is that students are given a pre research in the form of an MAI (Metacognitive Awareness Inventory) questionnaire so that the ability of students' metacognitive skills can be known. MAI is a test instrument containing 52 items which are divided into two parts, namely knowledge of metacognition and regulation of metacognition. The Metacognative Awareness Inventory (MAI) has been developed for a long time (Schraw & Dennison, 1994). In this study, researchers used the MAI (Metacognative Awareness Inventory) instrument developed by Schraw & Moshman (1994) but only focused on 3 aspects of metacognitive skills activities, namely planning, monitoring understanding and evaluation. Guidelines for identifying metacognitive skill activities include: planning, monitoring, and evaluating (Arikunto, 2009).

The results of administering the MAI (Metacognitive Awareness Inventory) questionnaire to students at one of the State High Schools in Mojokerto found that the planning cognition

regulation component obtained a result of 46%, monitoring understanding obtained a result of 42% and evaluation obtained a result of 42% with a sufficient category. This is of course the metacognitive skills of students are considered very lacking to solve a problem in classroom learning.

Design

The design is carried out product design on Electronic Learner Worksheets in accordance with the development of teaching material products to be produced and carried out according to the initial planning regarding the media and learning devices that will be used in the study. What is done at the design stage is the preparation of material, selecting the right media to use, selecting the format of the Electronic LKPD, and making initial media designs (Thiagarajan et al., 1974). The following four stages are carried out, namely:

Preparation of material

At the stage of preparing this material, researchers are looking for a phenomenon related to everyday life related to to the earth's mint material in everyday life to compile student worksheets based on LKPD components, namely learning instructions for competencies to be achieved by students and the formation of concepts. This test is a measuring tool that aims to measure the improvement of students' metacognitive skills after using the developed Electronic LKPD. In this research, researchers used a test sheet in the form of metacognitive skills questions given before and after using the developed Electronic LKPD. Metacognition skills are defined as evaluating students, planning, monitoring, and evaluating their learning process so that the realization of the dimensions of metacognitive skills can appear during the learning process (Pulmones, 2007).

Format selection

Format selection is done by reviewing and selecting format of an existing device and then developing it. Selection of The selected Electronic LKPD format is an Electronic LKPD based on Problem Based Learning to improve metacognitive skills. Problem Based Learning to improve metacognitive skills consisting of title, Core Competencies, Basic Competencies, indicators and objectives to be achieved, instructions for using Electronic LKPDs, tasks that must be done by students. Electronic LKPD is presented by displaying phenomena and problems so that students can use the knowledge they have gained during the learning process at school in solving it, as well as a bibliography. Phenomena presented in the Electronic LKPD in the form of paragraphs/images/data tables/videos that are useful for providing clarity and motivating students to learn. provide clarity and provide motivation for students to learn. to the developed Electronic LKPD (Anderson & Krathwohl, 2001).

Learning design

Electronic LKPD developed based on indicators metacognitive skills and phases contained in the syntax of Problem Based Learning. Problem Based Learning (PBL) learning model learning model is a strategy in learning where students are confronted with a real-world problem that is ill-structured. with a real-world problem that is ill-structured. With problem, learners will try to make the problem clear and wellstructured. the problem becomes clear and wellstructured. Learners will formulate several possible hypotheses and solutions based on information from various reading sources (Arends, 2012). PBL can be considered as both an idea as well as a model for approaching learning. PBL is supported in many ways by theorie in the learning sciences ranging from constructivism and cognition to problem solving (Tan, 2009). This stage is carried out to design the learning process in the classroom in accordance with the problem-based learning model.

Initial design of the device

At the initial design stage of this device, the Electronic LKPD developed is designed using a computer application, namely Ms Word, and Canva. The following is the cover of the Electronic LKPD developed:

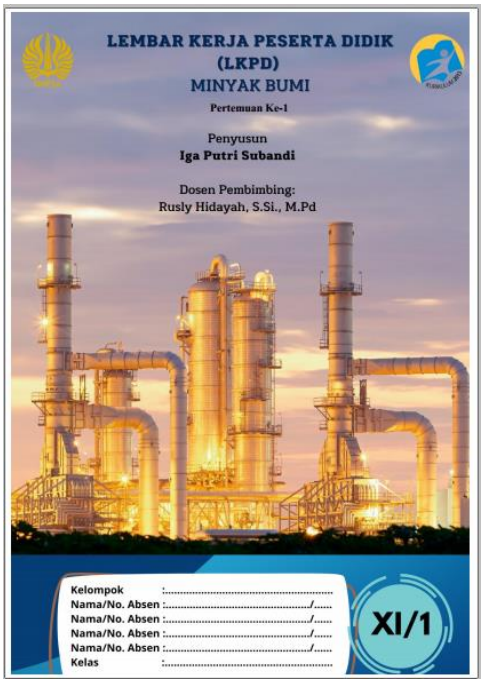
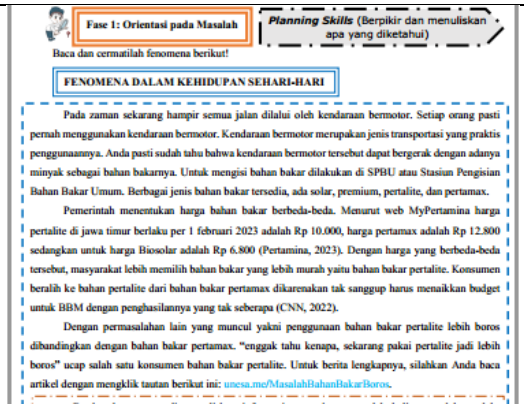


Figure 1. Cover view of electronic LKPD

The Electronic LKPD that has been designed then results in draft I then reviewed by a chemistry expert lecturer to provide suggestions and comments before continuing the validation stage. After reviewing and making revisions to produce draft II to proceed to the validation process of the devices that have been developed (Ibrahim & Wahyusukartiningsih, 2014). The revised results of the Electronic LKPD review can be seen in Table 2 as follows:

Table 2. Revision Results

Suggestion	Revision
The LKPD added indicators of metacognitive planning skills in each phase of PBL.	Before the revision  After the revision

Suggestion	Revision
The LKPD added indicators of metacognitive monitoring skills in each phase of PBL.	 Fase 1: Orientasi pada Masalah Planning Skills (Berpikir dan menuliskan apa yang diketahui) Baca dan cermatilah fenomena berikut! FENOMENA DALAM KEHIDUPAN SEHARI-HARI Pada zaman sekarang hampir semua jalan dilalui oleh kendaraan bermotor. Setiap orang pasti pernah menggunakan kendaraan bermotor. Kendaraan bermotor merupakan jenis transportasi yang praktis penggunaannya. Anda pasti sudah tahu bahwa kendaraan bermotor tersebut dapat bergerak dengan adanya minyak sebagai bahan bakarnya. Untuk mengisi bahan bakar dilakukan di SPBU atau Stasiun Pengisian Bahan Bakar Umum. Berbagai jenis bahan bakar tersedia, ada solar, premium, pertalite, dan pertamax. Pemerintah menentukan harga bahan bakar berbeda-beda. Menurut web MyPertamina harga pertalite di jawa timur berlaku per 1 februari 2023 adalah Rp 10.000, harga pertamax adalah Rp 12.800 sedangkan untuk harga Biosolar adalah Rp 6.800 (Pertamina, 2023). Dengan harga yang berbeda-beda tersebut, masyarakat lebih memilih bahan bakar yang lebih murah yaitu bahan bakar pertalite. Konsumen beralih ke bahan pertalite dari bahan bakar pertamax dikarenakan tak sanggup harus menaikkan budget untuk BBM dengan penghasilannya yang tak seberapa (CNN, 2022). Dengan permasalahan lain yang muncul yakni penggunaan bahan bakar pertalite lebih boros dibandingkan dengan bahan bakar pertamax. "enggak tahu kenapa, sekarang pakai pertalite jadi lebih boros" ucap salah satu konsumen bahan bakar pertalite. Untuk berita lengkapnya, silahkan Anda baca artikel dengan mengklik tautan berikut ini: unesa.me/MasalahBahanBakarBoros. Before the revision Data Pengamatan Monitoring Skills Tulislah hasil pengamatan video Anda pada tabel dibawah ini! No | Jenis Bahan Bakar Minyak | Bilangan Oktan 1 | Premium | ..... 2 | Pertalite | ..... 3 | Pertamax | ..... 4 | Pertamax Turbo | ..... After the revision Data Pengamatan Monitoring Skills (Mengonsultasikan bahan referensi) Tulislah hasil pengamatan video Anda pada tabel dibawah ini! No | Jenis Bahan Bakar Minyak | Bilangan Oktan 1 | Premium | 2 | Pertalite | 3 | Pertamax | 4 | Pertamax Turbo |
The LKPD added indicators of metacognitive skills evaluating skills in each phase of PBL.	Before the revision Fase 5: Menganalisis dan Mengevaluasi Masalah Evaluating Skills Periksa kembali jawaban kelompok Anda yang telah diperoleh dan buatlah kesimpulan dari kegiatan yang telah dipelajari! .... After the revision Fase 5: Menganalisis dan Mengevaluasi Masalah Evaluating Skills (Memeriksa kembali setiap langkah yang telah dikerjakan) Periksa kembali jawaban kelompok Anda yang telah diperoleh dan buatlah kesimpulan dari kegiatan yang telah dipelajari!

Develop

Product Validation

The product validation section aims to assess the validity of the Electronic LKPD products that have been developed. The feasibility of a learning device can be seen in one criterion, namely validity (Nieveen, Akker, Bannan, Kelly, & Plomp, 2010). Product validation was

carried out by two Surabaya State University Chemistry Education Study Program lecturers and one high school chemistry teacher, where in this product validation process using a validation sheet instrument. Validation has two criteria, namely content criteria and construct criteria. The results obtained on product validation are in Table 3 below:

Table 3. Validation Results

Validity	Modus		Categories
	LKPD 1	LKPD 2	
Contents	4	4	Very valid
Construct	4	4	Very valid

Based on the data recapitulation, the results obtained mode 4 on LKPD 1 and mode 4 on LKPD 2 for content feasibility with very valid criteria. Mode 4 on LKPD 1 and mode 4 on LKPD 2 for construct feasibility with very valid criteria as well. Based on the overall results of validation data on the development of Electronic LKPD, it is declared very valid for use by students. This is in accordance with research Ramdoniati, Muntari, & Hadisaputra (2019) regarding the development of problem-based chemistry teaching materials based on Problem Based Learning to improve metacognition skills metacognition skills. The results obtained in this study are the average score of the feasibility of teaching materials amounted to 3.18 with a decent category.

Content Validity

Content validity is a feasibility test on Electronic LKPD developed by researchers seen based on aspects of suitability of basic competencies, indicators, 2013 curriculum material, problem-based learning syntax, and doamin metacognitive skills which include aspects of planning skills, monitoring skills, evaluating skills (Pulmones, 2007). The validation results can be seen in Table 4 below:

Table 4. Content Validity Results

No	Validity	Modus		Categories
		LKPD 1	LKPD 2	
1	Basic Competencies	4	4	Very valid
2	Indicator	4	4	Very valid
3	2013 curriculum materials	4	4	Very valid
4	Problem Based Leraning Syntax	4	4	Very valid
5	Domain of metacognitive skills (planning skills, monitoring skills, evaluating skils)	4	4	Very valid

In making materials, it must be in accordance with the basic competencies, indicators and learning objectives made (Hulu & Dwiningsih, 2021). In addition, making materials also needs to pay attention to the suitability of the influence given to students to train students' metacognitive abilities and follow the PBL learning model (Mitasari & Hidayah, 2022). Based on the feasibility test above, it shows that the Electronic LKPD developed to improve PBL-based metacognitive skills obtained mode 4 in each component of content validity in LKPD 1 and LKPD 2 so that it is in a very valid category.

Construct Validity

The construct validity of Electronic LKPD is related to the translation of theory into measuring instruments (Widodo, 2006). If the results of the construct validity assessment are still in the invalid category, it must be corrected until it gets a valid category so that the measuring instrument used is suitable for use in the research process (Ihsan, 2015). The construct validity test analysis is reviewed from several aspects including aspects of

suitability of appearance, presentation, language. The following is Table 5 is the result of construct validity:

Table 5. Construct Validity Results

No	Validity	Modus		Categories
		LKPD 1	LKPD 2	
1	Display	4	4	Very valid
2	Presentation	4	4	Very valid
3	Language	4	4	Very valid

The display component consists of a cover that represents the content of the text; phenomena that arouse the curiosity of students; images that can help students understand concepts; Presentation of material allows students to cooperate and interact with friends, teachers, and / or other learning resources that support and are in accordance with learning materials (Sujarwo & Oktaviana, 2017).

The presentation component consists of an assessment of the attractiveness of the cover. This component presents the content of the Electronic LKPD; the use of fonts (type and size), which makes it easier for students to use the Electronic LKPD; the suitability of the Electronic LKPD background with color and text; suitable images, and table layout; and well-written terms, symbols, and formulas (Yunus & Alam, 2015).

The language component which includes an assessment of language use after the spelling of Indonesian is improved; Electronic LKPD writing uses appropriate words and language that is easy to understand, conveys messages, and effective sentences PBL (Indrastuti, 2018).

Based on the validity test that has been carried out, it shows that the Electronic LKPD developed to improve PBL-based metacognitive skills obtains mode 4 on each component of construct validity on LKPD 1 and LKPD 2 so that it is in a very valid category.

This is in accordance with previous research that the validity of PBL-based E-LKPD to improve student learning outcomes on petroleum material in the era of independent learning obtained results that were very valid and feasible to develop by obtaining product validity results consisting of 94% content feasibility, 93% linguistic feasibility, and 93% presentation feasibility with the criteria of all three being very valid (Subandi, Sudzuasmais, Triana, & Hidayah, 2023).

CONCLUSION

Based on the results of the research and data analysis obtained, it can be concluded that the Electronic LKPD to improve the metacognitive skills of PBL-based students on petroleum material is declared valid and feasible to develop. This is supported by the results of the validity mode of PBL-based Electronic LKPD products consisting of content validity 4 and construct validity 4 with very valid criteria. Learning is not just limited to question and answer or discussion or discussion, but can be utilized website for online learning so that learners are facilitated and able to control learning success independently.

RECOMMENDATIONS

Suggestions for research can continue the trial stage with application to the learning process in knowing the effectiveness of the developed Electronic LKPD.

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