



Pengembangan Media Pembelajaran Berbasis *Problem Based Learning* Pada Materi Sistem Periodik Unsur Berorientasi Minat Belajar Murid

(*Development Of Problem Based Learning Media On Periodic System Materials Oriented To Students' Learning Interests*)

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ABSTRACT. This research aims to produce Problem Based Learning-based learning media on the periodic system material of elements. This research is a developmental research using the Lee & Owens development model. The research instruments include interview sheets, validation questionnaires for material experts and media experts, teacher assessment questionnaires, and student response questionnaires. The product developed was validated by material experts and media experts, then assessed by teachers and tested in one-on-one trials and small group trials. The data analysis techniques used are qualitative data analysis and quantitative data analysis. The results of the study showed that the learning media based on Problem Based Learning on the periodic system material obtained a percentage of validation of material experts of 92% and media experts of 93.2% with the category of "Very Feasible". The teacher's assessment showed a percentage of 98.67% with the category "Very Feasible", while the students' response in the one-on-one trial obtained a percentage of 95% and the small group trial obtained a percentage of 96.8% with the category "Very Good". Based on these results, Problem Based Learning-based learning media is suitable for use as a chemistry learning medium and has the potential to grow students' interest in learning.

INTRODUCTION

Education has an important role in improving the quality of human resources through a meaningful learning process. In the Implementation of the Independent Curriculum, learning is directed to develop critical, creative, collaborative thinking skills, and encourage students to actively build knowledge through daily learning experiences [1]. The curriculum is one of the main elements in the education system because it is a guideline in the implementation of the learning process in schools. The Independent Curriculum also emphasizes active, student-centered learning, in line with the skills needs of the 21st century [2]. However, the success of learning is greatly influenced by the strategies, models, and media used by teachers, especially in chemistry subjects that have many abstract concepts so that they are often considered difficult by students [3].

One of the chemical materials that requires an understanding of concepts and interest between topics is the periodic system of elements. This material requires students to understand the patterns and tendencies of elemental properties based on the atomic structure and periodic electron configuration of elements [4]. In fact, the learning process of the periodic system of elements often takes place conventionally such as simple lectures and discussions, so that students tend to be passive, easily bored, and less interested in delving into the material [5]. This has an impact on low student involvement and less than optimal learning outcomes and students' interest in learning material on the periodic system element.

Based on the results of interviews with chemistry teachers and observations at schools, the learning that takes place has not fully provided an active and interactive learning experience. In addition, the results of the needs questionnaire showed that students were more enthusiastic if teachers used new learning media, and gave a positive response to innovative learning media that could increase student involvement in learning. The findings indicate that students need media that not only conveys material, but is also able to create an interesting, challenging, and fun learning atmosphere.

Learning media as a supporting means to facilitate the delivery of material, help visualize concepts, and increase students' interest in learning [6]. The use of interactive digital media is also considered effective to support learning because it is able to combine text, images, videos, and evaluation activities in one easily accessible system. Therefore, the development of digital-based learning media is needed so that chemistry learning can take place more effectively and in accordance with the characteristics of current students.



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One of the relevant learning models to be applied in chemistry learning is Problem Based Learning. Problem Based Learning emphasizes contextual problem-based learning that encourages students to analyze problems, seek information, discuss, and build concepts independently [7]. Problem-Based Learning can also improve critical thinking skills, problem-solving, and student involvement in the learning process. Thus, the application of Problem Based Learning is considered appropriate to support the learning of the periodic system of elements so that students not only memorize, but are able to understand concepts in depth and meaningfully on a daily basis [8].

One of the innovative alternatives to support the implementation of the Problem Based Learning model is to utilize digital learning media through Google Sites and Wordwall. Google Sites can be used as a digital learning medium to present Element Periodic System materials, activity guides, and Problem Based Learning stages in a structured and easily accessible manner at any time. Through an attractive display, students can learn more independently and follow the problem-based learning process in a more targeted manner [9]. Meanwhile, Wordwall is used as an interactive media based on educational games for practice and evaluation, so that students are more motivated, actively participate, and get direct feedback. The integration of these two media is expected to be able to create more interesting, interactive, and increase students' interest in learning [10].

Based on this description, this study aims to develop a learning media based on Problem Based Learning on the Elemental Periodic System material that is oriented to students' learning interests. Media is developed in the form of interactive digital media that combines the presentation of materials, problem-solving activities, and evaluation exercises to increase student involvement in learning. The novelty of this research lies in the integration of Problem Based Learning steps into interactive digital learning media that is specifically designed on elemental periodic system materials and focused on aspects of students' learning interests, so that the media not only functions as a conveyor of information, but also as an active learning tool that encourages students to be involved in the process of thinking and problem solving. Thus, the media developed is expected to be suitable for use in chemistry learning and has the potential to grow students' interest in learning more optimally.

RESEARCH METHODS

In this study, the type of research and development (Research and Development) was used. The goal is to produce products and test them. The study adopts the development model of Lee & Owens, which includes the stages of analysis, design, development, implementation, and evaluation. A more detailed development procedure can be seen in **Figure 1**.

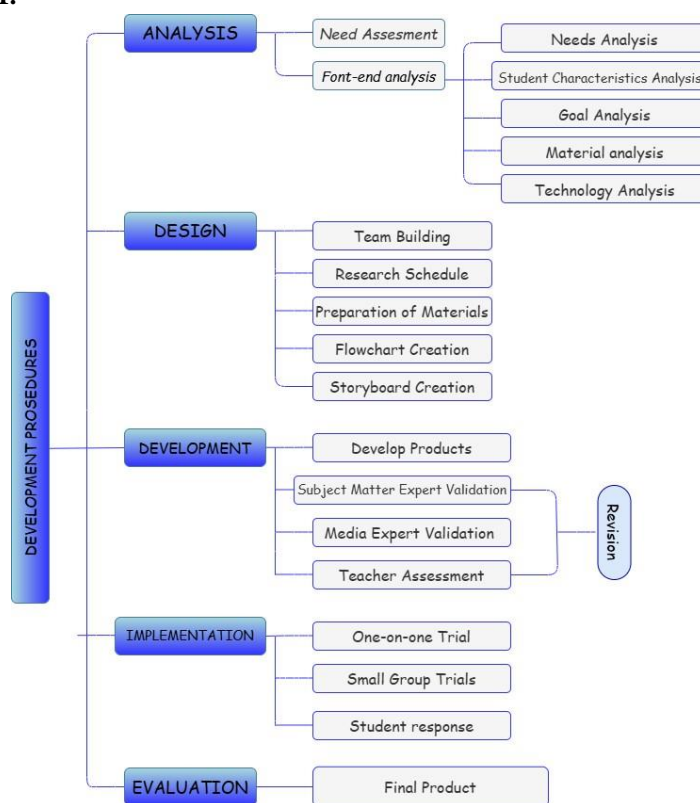


Figure 1. Development Procedure.

At the analysis stage, the researcher conducted a study of problems in chemistry learning at SMA Negeri 14 Jambi City, which includes: (1) needs analysis, (2) student characteristics analysis, (3) objective analysis, (4) material analysis, and (5) educational technology analysis. This stage is carried out to understand the situation and conditions in the field, so that proper analysis is needed. Furthermore, at the design stage, the main goal is to design the learning media to be developed, so that Problem-Based Learning-based learning media is produced on elemental periodic system materials. The design stage includes several activities, such as forming a development team, determining a research schedule, preparing product specifications, designing material structures, and making flowcharts and storyboards for learning media. At this stage, an initial evaluation of the product design is also carried out before entering the development stage.

At the development stage, making learning media according to the design that has been prepared. Media is developed using Google Sites with the integration of various learning components such as text, images, videos, and interactive activities. Exercise activities and educational games are created using Wordwall to increase student engagement. After the product is completed, validation is carried out by material experts and media experts to assess the suitability of content, appearance, language, and the feasibility of using media. Suggestions and inputs from validators are used as the basis for product revisions until suitable media is obtained. Trials for students are carried out at the implementation stage. Furthermore, the product implementation stage was carried out for students in class X Phase E2 at SMA Negeri 14 Jambi City. The chemistry teacher first assesses the developed media. Furthermore, a one-by-one trial was carried out to determine the ease of use of media. After that, a small group trial was carried out to see the familiarity of the media in learning and to obtain student responses to the learning media developed.

The final stage is evaluation, this stage is carried out formatively at each stage of analysis, design, development, and implementation as the basis for product improvement. Evaluation at the analysis stage ensures the suitability of students' needs with classroom conditions, at the design stage assesses the alignment of the media design with learning outcomes and Problem Based Learning syntax, and at the development stage examines the appearance, content of materials, activities, and media functionality before implementation. At the implementation stage, the evaluation refers to the level 1 (reaction) of the Lee & Owens model to determine the students' responses. The evaluation aims to determine the level of feasibility of learning media based on the results of validation of material experts, media experts, teacher assessments, and student responses. The results of the evaluation are the basis for the final revision so that learning media that is suitable for use in chemistry learning is obtained.

The test subjects in this study were students of class X E2 SMA Negeri 14 Jambi City. The trial was carried out in a limited manner through two stages, namely a one-on-one test involving 3 students and a small group test involving 9 students. Subjects were randomly selected taking into account differences in cognitive abilities (high, medium, and low) based on the chemistry teacher's recommendation. The trial was carried out to obtain data on students' responses to the developed Problem-Based Learning-based learning media, so that the results can be used as a basis for product improvement and improvement.

This research produced two types of data, namely qualitative data and quantitative data. Qualitative data was obtained through interviews with chemistry teachers as well as validation sheets from subject matter experts and media experts with comments and suggestions for improvement. Meanwhile, quantitative data was obtained from assessment scores given by material experts, media experts, teachers, and student response questionnaires after the use of learning media. Both types of data are used as a basis for assessing the feasibility and quality of the learning media developed.

Data collection in this study was carried out through interviews and questionnaires that were selected because they complemented each other. Interviews were conducted with chemistry teachers to obtain qualitative data related to learning needs, obstacles faced, and the use of learning media in the classroom. Meanwhile, the questionnaire was used to collect quantitative data in the form of assessment scores from material experts, media experts, teachers, and student responses after using learning media, as well as qualitative data in the form of comments and suggestions. The combination of the two techniques provides more comprehensive information as the basis for the development and improvement of the developed Problem Based Learning learning media. The data collection instruments in this study were compiled to obtain data at each stage of development. The instruments used include interview guidelines to explore the initial learning needs, validation sheets for material

experts and media experts to assess the feasibility of products, and teacher assessment questionnaires. In addition, the student response questionnaire was used to find out the students' responses and experiences after using the developed Problem Based Learning-based learning media. The data that has been collected is then analyzed based on assessments on the instruments of student needs and characteristics, validation of material experts, media, and teachers, and student responses. The calculation of the analysis of the needs and characteristics of the students is carried out using the rating scale through the calculation:

$$\% \text{ Score} = \frac{\text{Total score obtained}}{\text{Total score}} \times 100\%$$

The data obtained from the analysis of the validation sheets of media experts, materials, and teacher assessments are quantitative. The validation categories by expert and teacher are based on the average answer score, which is calculated through the following formula:

$$\text{Average} = \frac{\text{Total score}}{\text{Number of items}}$$

Furthermore, the data obtained was then analyzed and processed descriptively into interval data using the Likert scale. The scale that has higher variability, is good and complete is the scale of five. The criteria of the scale five used are as follows:

Table 1. Categories of Assessment Validation and Teacher Assessment.

No	Average Score	Validation Criteria
1	>4,2-5,0	Very Feasible
2	>3,4-4,2	Feasible
3	>2,6-3,4	Less Feasible
4	>1,8-2,6	Not Feasible
5	1,0-1,8	Highly Infeasible

[11]

After getting the teacher's assessment, the product was then tested on students through one-on-one and small group trials. Student responses were analyzed according to the average score on the Likert scale and the percentage of eligibility to determine the extent to which the product is feasible to use.

To calculate the percentage of one-to-one trials, the percentage of feasibility is used with the following formula:

$$\text{Percentage}\% = \frac{\text{Total score}}{\text{Maximum score}} \times 100\%$$

To calculate the percentage of response from small group students, the percentage of eligibility is used with the following formula:

$$\text{Percentage}\% = \frac{\text{Total data collection scores}}{\text{Maximum score} \times \text{Number of questions} \times \text{Number of respondents}} \times 100\%$$

Table 2. Categories of Assessment of One-On-One Test Instruments and Small Group Student Responses.

No	Value Scale	Validation Criteria
1	81%-100%	Excellent
2	61%-80%	Good
3	41%-60%	Less Good
4	21%-40%	Not Good
5	1%-20%	Very bad

[12]

RESULTS AND DISCUSSION

In this section, the results and discussion of the development of Problem-Based Learning-based learning media on elemental periodic system materials and their comprehensive discussion are presented. The results of the research were obtained through material expert validation, media expert validation, teacher assessment, one-on-one trial and small group trial as the basis for product feasibility assessment and user response to learning media.

3.1. Subject Matter Expert Validation

Validation of material experts is carried out to determine the feasibility of the content of the developed learning media, including the suitability of the material for the learning objectives, the accuracy of concepts, language, and the presentation of the material. Validation is carried out in two stages so that the media can be revised based on validator input until it reaches the expected feasibility category.

Table 3. Material Expert Validation Results.

Validation stage	Total Score	Average	Percentage (%)	Criteria
I	42	3,00	60	Less Feasible
II	65	4,64	92	Very Feasible

Based on Table 3, the validation of subject matter experts showed an increase from phase I by 60% (Less Feasible) to 92% (Very Feasible) in phase II. This improvement occurred after revisions were made according to the validator's suggestions, such as adjusting learning objectives using the ABCD format, the use of functional verbs in the cognitive domain C4-C6, and improving the presentation of tables/figures according to the rules of scientific writing. Thus, the learning media is declared feasible to continue at the trial stage. This is in line with the theory of learning media which states that good media must contain material that is accurate, relevant to the learning objectives, and presented clearly and structured in order to help students understand concepts optimally [13]. In addition, the feasibility of the material shows that learning media has been able to bridge abstract concepts in the periodic system of elements into more concrete through visual aids, contextual examples, and problem-solving activities. This condition is in accordance with cognitive theory which emphasizes that understanding concepts will be more effective if students receive visual aids and learning experiences that support the information processing process in their cognitive structure [14].

3.2. Media Expert Validation

The validation of media experts aims to assess the aspects of appearance, design, ease of use, and interactivity of Problem-Based Learning-based learning media using Google Sites which is integrated with Wordwall. Validation is carried out in two stages to ensure that the media has met the eligibility standards.

Table 4. Media Expert Validation Results.

Validation stage	Total Score	Average	Percentage (%)	Criteria
I	48	3,20	64	Less Feasible
II	70	4,66	93,2	Very Feasible

Based on Table 4, the validation of media experts increased from 64% (Less Eligible) in phase I to 93.2% (Very Eligible) in phase II. This improvement was obtained after improvements were made such as adjusting the appearance of the cover, adding an instruction button for use, using more appropriate colors, the duration of the inserted video needs to be shortened, and improvements to the illustration and size of the display components. The results show that the media has met the feasibility aspect and can be used for the trial stage.

Effective learning media must have an attractive appearance, be easy to operate, and be able to facilitate student interaction with learning materials [15]. In addition, the existence of interactive features such as videos and Wordwall-based exercises acts as a learning stimulus that encourages student involvement, in accordance with the theory of behaviorism that the right stimulus will produce a positive learning response [16]. The interactive media supports the characteristics of Problem Based Learning because students do not only read the material, but are directly involved in problem-solving activities, so that it has the potential to increase students' interest and interest in learning. Therefore, the media is declared suitable for use in the trial stage.

The display of Problem Based Learning-based learning media on the periodic system material of elements oriented to students' learning interests that has been validated by material experts and media experts is presented in **Figure 2**.



Figure 2. (a) Learning media cover (b) Learning media developer profile.

The learning media products in Figure 2 can be accessed through the following website link:

Link: <https://sites.google.com/view/sistemperiodikunsurnadia/cover>

3.3. Teacher Assessment

Teacher assessments are carried out as a validation of practitioners to determine the feasibility of media in terms of application in the classroom. The aspects assessed include the suitability of the material, clarity of presentation, ease of use, and the benefits of media for the learning process.

Table 5. Teacher Assessment Results.

Validation stage	Total Score	Average	Percentage (%)	Criteria
I	74	4,93	98,67	Very Feasible

Based on Table 5, the media obtained a feasibility percentage of 98.67% with the Very Feasible category. The teacher responded that the learning media developed in general was appropriate and could be continued for testing to students. This shows that the media is suitable for use as a support for learning chemistry in elemental periodic system material. Media is declared eligible when it meets the aspects of content, presentation, language, and ease of use [17]. The presentation of real problems in learning is in accordance with the principles of Problem Based Learning which places students as the center of learning. Problem-Based Learning increases student engagement because learning is associated with daily life problems. This engagement makes learning more meaningful and increases students' interest in the lesson so that interest in learning develops [18].

3.4. One-to-One Trial

A one-on-one trial was carried out on 3 students with different cognitive abilities to determine the ease of use of media and the students' initial response to learning media. This stage is done before the small group trial to ensure the media can be used by students with a variety of learning abilities.

Table 6. One-to-One Trial Results.

Trial Type	Number of Pupils	Percentage (%)	Criteria
One-to-one	3	95	Excellent

Based on Table 6, the results of the one-on-one trial obtained a percentage of 95% with the category of Excellent. Students responded that the media is easy to use and interesting, so it helps to understand the material of the Periodic System of Elements. Visual presentation, clear navigation, and Problem Based Learning activities

help students understand concepts through hands-on learning experiences. In line with [19] who explains that visual aids and learning experiences support the process of information processing in students' cognitive structures. Through the presentation of contextual problems, students build knowledge independently. Problem Based Learning encourages students' mental activity in analyzing and solving problems [20]. This condition supports the characteristics of Problem Based Learning because students not only receive information but are involved in learning activities. This involvement fosters students' interest and attention to learning, which is an indicator of the emergence of interest in learning [21]. Thus, the media is declared ready to be tested in small groups.

3.5. Small Group Trials

The small group trial was conducted on 9 students with diverse cognitive abilities. This stage aims to see students' responses to learning media, including the relevance, convenience, and benefits of media in learning.

Tabel 7. Small Group Trial Results.

Trial Type	Number of Pupils	Percentage (%)	Criteria
Small Groups	9	96,8	Excellent

Based on Table 7, the results of the small group trial showed a percentage of 96.8% with the category of Excellent. In addition, the results of the evaluation in the media showed that the average score of students was 91.1 out of a maximum score of 100. This shows that Problem-Based Learning-based learning media is able to support students' understanding of the Elemental Periodic System material and provide a more interactive learning experience. Problem-solving activities, discussions, and interactive exercises make students actively relate concepts to everyday life. Problem Based Learning improves students' engagement and critical thinking skills through contextual problem solving [22]. In addition, interactive digital media can increase students' understanding of concepts as well as learning interests [23]. Thus, the high response of students shows that the media is able to maintain attention and interest in learning during learning.

This media can be used as a support for learning in the classroom or as a means of independent learning because it is easily accessible, interesting, and helps students understand concepts more deeply through problem-solving activities. Problem-based learning packaged in digital media provides an active and contextual learning experience so as to foster students' interest in learning [24]. Thus, the use of Problem-Based Learning-based learning media not only increases interest in learning, but also helps students build conceptual understanding of abstract material. Media acts as a bridge between microscopic concepts and macroscopic representations in learning [25]. Therefore, the learning media developed can be used as a support for learning in the classroom and independent learning to increase students' interest in learning in elemental periodic system materials.

CONCLUSION

Based on the results of development research, Problem Based Learning-based learning media on the periodic system material of elements oriented to students' learning interests was developed using the Lee & Owens model which includes the stages of analysis, design, development, implementation, and evaluation. The results of the study showed that the learning media based on Problem Based Learning on the periodic system material obtained a percentage of validation of material experts of 92% and media experts of 93.2% with the category of "Very Feasible". The teacher's assessment showed a percentage of 98.67% with the category "Very Feasible", while the students' response in the one-on-one trial obtained a percentage of 95% and the small group trial obtained a percentage of 96.8% with the category "Very Good", so that Problem-Based Learning-based learning media is suitable for use as a chemistry learning medium and has the potential to foster students' interest in learning.

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