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Problem- Based Learning Informatics E-LKPD: Improving Computational Thinking Skills

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Abstract: This research and development aims to produce PBL-based Informatics E-LKPD learning media to improve students' computational thinking skills. This type of research is development research using the 4D development model, namely: (1) define, (2) design, (3) develop, and (4) disseminate. The results of the study show: (1) Material expert validation tests show that the developed medium is very feasible, with an average score of 84%. (2) Instructional Design Expert validation test with very appropriate criteria and an average score of 87% (3) Media Expert validation test in the very proper category with an average score of 83%. (4) Individual trials with very good criteria and an average score of 90% (5) The criterion small group trial was very good, with an average score of 87%. and (6) Field trials with very good criteria and an average score of 89%. The practicality test by the teacher is very good, with an average score of 88%, while the results of the practicality test on students, with an average score of 90%, are in the very good category. The results of the experiment using PBL-based Informatics E-LKPD in the experimental class averaged 86 learning outcomes, while students who were taught without using PBL-based Informatics E-LKPD had an average score of 70. Hypothesis testing using the Independent t-test obtained a sig. (2-tailed) of 0.000, where the result is <0.05, shows a significant difference between classes taught using PBL-based Informatics E-LKPD and classes without using PBL-based Informatics E-LKPD. Therefore, the use of PBL-based informatics and E-LKPD in effective learning to improve students' computational thinking skills.

Keywords: Informatics E-LKPD; Problem-Based Learning; Computational Thinking

1. INTRODUCTION

Faced with Society 5.0, several skills are needed to be mastered, one of which is the ability to think at a higher level to be able to solve problems. One that can support higher-order thinking skills is literacy. Literacy has a crucial role in the process of improving higher-order thinking skills such as analyzing, evaluating, and creating [1]. However, in a study conducted by Science Performance (PISA) 2018, which is a Worldwide Ranking of the average score of math, science, and reading that measures the scientific literacy of 15-year-old children, it was found that Indonesia got a very low score and was far behind other countries. in other Asian countries. Indonesia was ranked 74th out of 79 countries for reading ability, and 73rd and 71st out of 79 countries for assessments of math ability and science ability, respectively. From here, we realize the importance of literacy. Thus, it is very important to continue to make innovations to improve literacy skills. One way to encourage literacy skills is to master Computational Thinking skills [2].

Computational thinking is a way of thinking or a method of thinking similar to the way used by computer scientists to solve problems using concepts from computer science such as algorithms, programming, data processing, and systematic problem solving. According to Wing [3], Computational Thinking is a high-level thinking skill that enables one to solve complex problems effectively by using principles and methods related to computer science. In this concept, the use of technology, data, and algorithms is seen as part of a complex problem's solution.

One of the things that can help increase student motivation is the use of various media in classroom learning [4]. With a variety of media used, it is hoped that it can facilitate differentiated learning so that it is in accordance with the characteristics of students and that it can increase students' interest and motivation in learning. However, in the field, it is found that there are not many innovative learning media for Informatics, especially with the integration of computational thinking, so that learning is still limited to the use of textbooks.

A study conducted in 2022 entitled "Assessing Computational Thinking: A Systematic Review of Empirical Studies" conducted by Tang [5] found that most assessments of computational thinking focused on students' programming or computing skills, so another study was needed that focused on thinking skills. computational solutions to solve everyday problems outside of computer science or programming. Therefore, it is necessary to develop a learning tool that integrates computational thinking on other topics, as was done by Batul [6], who integrated CT in mathematics with the title "Development of SSCS Model Learning Devices with the RME Approach and Its Effect on Computational Thinking Ability". This study found that the learning design developed was able to improve students' computational thinking skills in a valid, effective, and practical manner.

To prepare a medium that can help learning be optimal, the selection of the learning model to be used is carried out. Santayasa [7] conducted a study of innovative learning alternatives that are suitable for use in the 21st century. The results of the study indicated several learning models that could be used, including the PBL model, project based learning, inquiry learning, and collaborative problem-solving tasks. In line with this research, Loyens [8] also expressed a similar opinion.

1.1 The Nature of Learning and Informatics Learning Outcomes

Dimyati and Mudjoyono [9] Explain that learning involves the occurrence of mental changes in students. Explain that learning is a complex activity. The results of learning take the form of capabilities. After learning, people have skills, knowledge, attitudes, and values.

Learning is an activity, both physical and psychological, that produces new changes in behavior in individuals who learn in the form of relatively constant abilities that are not caused by maturity or something temporary [10].

Suyono and Hariyanto [11] stated in their book that according to constructivism theory, knowledge cannot simply be transferred from the teacher's mind to the student's mind. That is, students must actively build their own knowledge structure through independent exercises.

In connectivism theory, the starting point for learning occurs when knowledge is activated through the process of connecting learners and providing information to a learning community [12]. Connectivism theory states that knowledge is distributed over networks, and therefore learning consists of the ability to construct and traverse these networks [13].

Learning is an indispensable skill that can be strengthened by intellectual activity and mental training. Intellectual activities involve creativity, exploration, innovation, formulating questions, answering questions, solving problems, and thinking critically. Mental training involves developing curiosity, interest, patience, perseverance, practice, competitive spirit, self-motivation, determination, and self-confidence [14].

Sudjana [15] said that the skills students acquire follow the learning experiences they have had. Learning outcomes are the consequences that are obtained after a person performs teaching and learning actions [16].

According to Gani and Zulhaji [17], learning outcomes are changes in behavior, which can be identified by comparing behavior before a person experiences a learning situation with the behavior shown after the learning process occurs. These changes take the form of increased capabilities or abilities in some types of performance or changes in the attitudes, interests, and values of someone who has learned.

According to Nugraha [18], learning outcomes are abilities that children acquire after going through a process of learning activities by themselves. Student learning outcomes are divided into 3 domains, namely the cognitive, affective, and psychomotor domains. According to Bloom in Fauzi [19], there are 3 domains of learning outcomes, namely: (1) The cognitive domain, which is related to intellectual learning outcomes consisting of knowledge, memory, understanding, analysis, application, and evaluation; These six goals are hierarchical in nature, meaning that the ability to evaluate has not been achieved if the previous abilities have not been fulfilled or mastered; (2) The affective domain, with regard to attitudes that consist of acceptance, response, evaluation, organization, and the formation of lifestyles; and (3) the psychomotor domain, with regard to the results of learning skills and the ability to act.

1.2 The Nature of Computational Thinking

Wing [20] defines computational thinking as "solving problems, designing systems, and understanding human behavior by drawing on the basic concepts of computer science." Computational thinking is a way of thinking to solve problems by formulating them in the form of computational problems and compiling solutions to these problems in the form of algorithms [21]. Mushtofa [22] explained that the main activity in computational thinking is problem solving, to find efficient, effective, and optimal solutions that can be run by humans or machines.

There are four foundations of computational thinking known in Informatics, namely Abstraction, Algorithms, Decomposition, and Patterns, which are very basic and are broadly explained as follows [23]: (1) Abstraction, which is extracting important parts of a problem and ignoring the unimportant so that it is easier to focus on solutions; (2) Algorithms, namely writing automated solutions through algorithmic thinking (sequential steps) to achieve a goal (solution). If these sequential steps are given to the computer in a language understood by the computer, you will be able to "instruct" the computer to do the steps. (3) Decomposition and formulation: the problem is such that it can be solved quickly, efficiently, and optimally by using a computer as a tool. Problems that are difficult, let alone big ones, will become easy if they are solved systematically in parts; and (4) Recognizing problem patterns, generalizing, and transferring the problem solving process to other similar problems.

1.3 The Nature of Learning Media

Gerlach and Ely [24] argue that broadly, media are human, material, or events that build conditions that make students acquire knowledge, skills, and attitudes. AECT (Association for Educational Communication and Technology) defines media as all forms and channels used in the process of conveying information. Miarso [25] argues that media is anything that can stimulate students' thoughts, feelings, attention, and willingness so that it can encourage the learning process in students.

Educational media is anything that can be used to channel messages from the sender to the recipient so that it can stimulate the thoughts, feelings, concerns, interests, and attention of students in such a way that the learning process occurs [26]. Learning Media is anything that can be used to mediate messages to recipients so that they can stimulate the ideas, sympathies, feelings, and interests of students to be involved in learning activities [27].

In this study, the type of media to be used is interactive multimedia in the form of Student Worksheets (LKPD). LKPD is a student guide that is used to carry out investigative or problem-solving activities. One way of implementing it in class is to package the subject matter in the form of LKPD, which has the characteristic of first presenting a phenomenon that is concrete, simple, and related to the concept to be studied [28].

Trianto [29] argues that Student Activity Sheets (LAS) and worksheets (LKPD) can be in the form of guidelines for cognitive development exercises as well as guidelines for the development of all aspects of learning in the form of experimental or demonstration guides.

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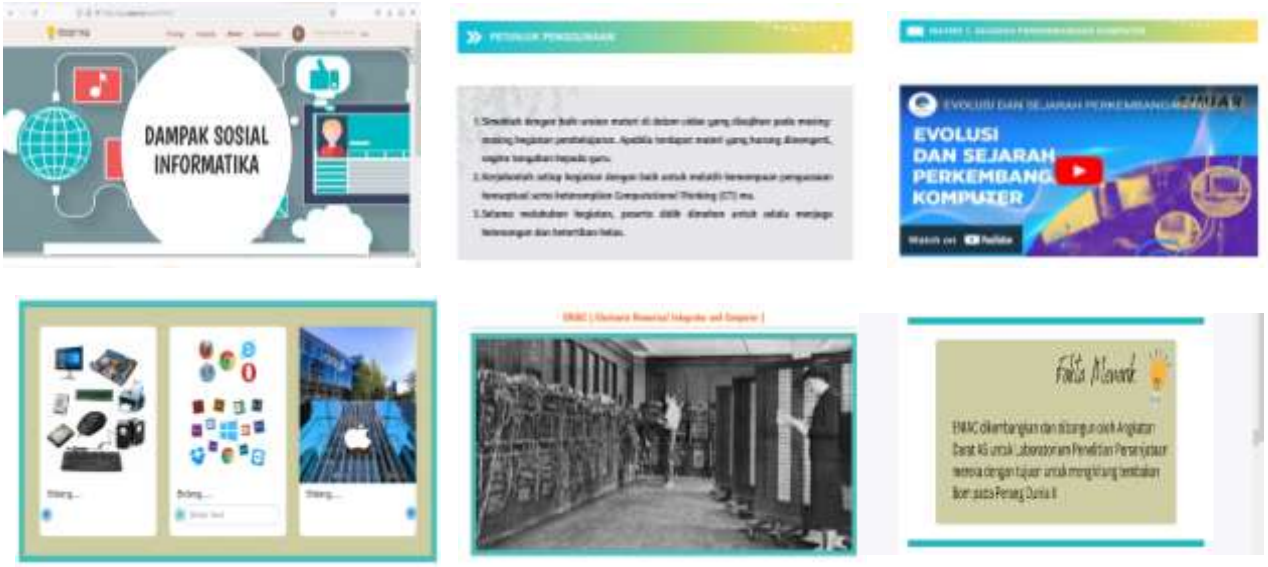

Figure 1. Display of PBL-based Informatics E-LKPD

1.4 Models of Problem-Based Learning

Barret and Moore [30] in their book state that "problem-based learning is the learning that results from the process of working towards the understanding of a resolution of the problem. The problem is encountered first in the learning process." Problem-based learning is learning that results from the process of working towards solving problems. Problems encountered in the learning process.

Problem-based learning is designed by presenting problems and then gaining important knowledge from the problems raised [31]. The characteristics of problem-based learning are that it is more challenging to "learn how to learn", working in groups to find solutions to real-world problems. This given problem is used to tie curiosity to the intended learning. Problems are given to students before they learn concepts or material related to problems that must be solved together.

Arends [32] states that the essence of PBL is to present authentic and meaningful problematic situations to students, which can serve as springboards for investigations. PBL is designed to help students develop thinking and problem-solving skills, learn adult roles, and become independent learners. This model provides an alternative for teachers to present more foamy learning to students. The following are the steps of the PBL learning model:

Tabel 1. PBL Model Syntax

Phase	Teacher Activity
Phase 1	Orienting students to problems, explaining learning objectives and logistics needed, and motivating students to be actively involved in problem-solving activities
Phase 2	Organizing Learners to learn Forming Learners limits and organizes learning tasks related to the problem at hand.
Phase 3	Guide individual or group investigations. Encouraging students to collect appropriate information, carry out experiments, and seek explanations for solutions
Phase 4	Develop and present the work. Help students plan and prepare appropriate works, such as reports, and help students share assignments with friends.
Phase 5	Analyze and evaluate the problem solving process. Helping students reflect on education and the processes used during problem solving

1.5 The Nature of Problem-Based Learning-based E-LKPD

E-LKPD is an electronic form of LKPD that contains practice sheets for students that can be accessed digitally and done continuously and systematically within a certain period of time [33][34]. E-LKPD is designed to guide students in understanding subject matter independently. E-LKPD can be developed using various learning methods, one of which is problem-based learning.

According to Prastowo [35], there are five forms of LKPD, including (1) LKPD that helps students find a concept; (2) LKPD that helps students apply and integrate various concepts that have been found; (3) LKPD as a study guide; (4) LKPD as reinforcement; and (5) LKPD as practical instructions. In this study, the form of PBL-based Informatics E-LKPD that will be developed is a combination of LKPD as a study guide, LKPD as reinforcement, and LKPD that helps students apply and integrate various concepts that have been found. In his book, LKPD consists of six main elements, which include: titles, study instructions, basic competencies or subject matter, supporting information, tasks or work steps, and assessment. In this research, LKPD will be developed based on the PBL model, which is integrated with computational thinking techniques. The following is the E-LKPD design that will be developed:

Table 2. Problem-Based Learning E-LKPD

No.	Media E-LKPD	PBL phase
1	Cover and Title	
2	Instructions for study and use	Phase 1: Orientation of students to problems, explaining the

No.	Media E-LKPD	PBL phase
3	Question lighter	necessary logistics, motivating students
4	Main material in video form	Phase 2: Organizing students to learn
5	Multiple choice questions, matching, fill in the blank	
6	Illustrations pictures and interesting facts	
7	Problem Solving Problems (Included with instructions for solving problems using computational thinking techniques)	Phase 3: Guiding individual or group investigations. In this phase computational thinking techniques will be integrated to help solve problems Phase 4: Develop and present the work. Help students prepare appropriate results and put them in the results report including helping students share assignments with their friends
8	Reflection	Phase 5: analyzing and evaluating the problem-solving process, students are asked to provide feedback about the learning that has been passed

The research problem is formulated as follows: (1) Is the developed PBL-based Informatics E-LKPD learning media suitable for use in improving computational thinking skills? (2) Is the developed PBL-based Informatics E-LKPD learning media practically used in improving computational thinking skills? (3) Can the developed PBL-based Informatics E-LKPD learning media effectively improve computational thinking skills?

2. METHOD

The research method used is the research and development method (R&D). Gall and Borg [36] in a book entitled "Educational Research" say that R&D in education is an industry-based development model, where research findings are used to design learning products, which are then tested systematically in the field, evaluated, and perfected until a learning product is produced that meets effective, efficient, and quality standards. The development model that will be carried out in this study is the 4D model (define, design, develop, and disseminate) [37].

This research was conducted at SMAN 1 Silaut, which is in Pesisir Selatan Regency, West Sumatra, during the even semester of the 2022–2023 school year. This stage involves testing the product in the field. Evaluation of the feasibility and effectiveness of the product being developed was carried out in class X of SMAN 1 Silaut. The feasibility trial evaluation was carried out in several stages. The first stage is an individual trial, in which there are three student respondents who will be involved. The second stage involved small group trials involving nine students. And the last stage in the feasibility evaluation is a field trial involving 30 students. The product developed will be validated by three experts, including material experts, media experts, and learning design experts, on the feasibility of PBL-based E-LKPD products.

Computational thinking assessments will be assessed by an assessment team consisting of two teachers who will review students' posttest answers. The following is the assessment rubric:

Table 3. Computational thinking assessment rubric

Aspect	Indicator
Decomposition	Students are able to break down problems into smaller problems that are easier to solve
Algoritma	Students are able to make a set of sequences of problem solving steps
	Students are able to solve similar problems using the same steps or principles
Pattern recognition	Students are able to transfer their knowledge and skills to solve problems
	Students are able to identify patterns, similarities, and relationships between the knowledge they have and the problems they face
	Students are able to make conclusions
Abstraction	Students are able to evaluate or distinguish which information is important and which is not important
	Students are able to delete information that is not needed
	Students are able to add or subtract details to clarify problems

Brennan and Resnick [38] dan Csizmadia et al [39]

Feasibility Test Data Analysis Techniques. The data collected from the results of expert validation, then analyzed with the following steps:

a. Make a tabulation of the answer scores of each instrument item in each aspect..
b. ind the average score of answers on each aspect with the formula:

$$x = \frac{\sum X}{n}$$

Information:
x: Average score
$\sum X$: The sum of the scores of the statement items
n: Number of data (number of statement items)

To assess the feasibility of the media as a whole, this is done by involving all item scores on the three assessment aspects and calculating the average value with the formula:

$$X_t = \frac{\sum X_i}{N}$$

Information:
X_t: Average score
$\sum X_i$: Total score of the three assessment aspects
N: Total data for the three assessment aspects
To determine feasibility, the results obtained from this calculation are interpreted as in the table below:

Table 4. Percentage of Product Quality Assessment

Percentage %	Validity Level	Information
80 – 100	Very valid	Not Revised
60 – 79	Valid	Not Revised
40 – 59	Invalid	Partial Revision
20 – 39	Invalid	Revision
00 – 19	Very invalid	Revision

(Source: Arikunto[40])

Effectiveness of Test Data Analysis Techniques Data collection techniques were used using the posttest in the control class, and experiments were carried out to determine the effectiveness of teaching modules and PBL-based E-LKPD with test results on the material social impact of informatics on students. Furthermore, the data generated from the test will be tested for its effectiveness. Before carrying out the effectiveness test with the t-test, there are several stages of statistical tests that must be carried out, including the normality test and homogeneity test. The normality test functions to determine whether the distribution of respondent data is normally distributed or not. A homogeneity test is a test of whether or not the variances of two or more distributions are the same.

Hypothesis test. The research hypothesis needs to be tested for validity; in this study, the statistical technique used to test the hypothesis is the t-test (an independent test). The requirements that must be met in the t-test data analysis are the presence of posttest results in the sample group. The hypothesis of the effectiveness test to be tested is as follows:
Ho: $\mu_1 = \mu_2$
Ha: $\mu_1 > \mu_2$

Information::
μ_1: average student learning outcomes using PBL-based E-LKPD to improve computational thinking skills
μ_2: average student learning outcomes without using PBL-based E-LKPD to improve computational thinking skills

Ho: The developed PBL-based E-LKPD is not used effectively to improve students' computational thinking skills.
Ha: The developed PBL-based E-LKPD is effectively used to improve students' computational thinking skills

For hypothesis testing, the two-party test formula is used:

$$t_{hitung} = \frac{\overline{x}_1 - \overline{x}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where S is the root of the combined variance calculated by the formula:

$$S^2 = \frac{(n_1-1){S_1}^2 + (n_2-1){S_2}^2}{n_1 + n_2 - 2} \text{ dimana } S = \sqrt{s^2}$$

Keterangan:
$\overline{x}_1$: the average score of the experimental class
$\overline{x}_2$: average score of the control class
n_1 : number of experimental class samples
n_2 number of control class samples
${S_1}^2$: variance in the experimental class
${S_2}^2$: variance in the control class
S : combined variance
t : calculation price with db = n1 + n2 – 2

The correlation criterion obtained is said to be significant (the hypothesis is accepted) if the price tcount > ttable for a significance level of 5%.

3. RESULTS AND DISCUSSION

3.1 RESULTS

The results of the assessment by media experts, material experts, individual trials, small group trials and limited field trials for all aspects of the assessment are determined by the average score. The results of the assessment were then analyzed and determined whether or not it was appropriate to develop PBL-based Informatics E-LKPD learning media. The average percentage of the results of the assessment of media experts, material experts, individual trials, small group trials and field trials is shown in table 5 below:

Table 5. Feasibility of PBL-based Informatics E-LKPD learning media

No	Categorization	Percentage of average score %	Criteria
1.	Material Expert Validation	84,00	very feasible
2.	Media Expert Validation	83,00	very feasible
3.	Learning Design Validation	87,00	very feasible
4.	Individual Trial	90,00	very feasible
5.	Small Group Trial	87,00	very feasible
6.	Field Test	89,00	very feasible
The average		86,67	very feasible

Based on the results of the expert assessment and trials in the table above, it was found that the PBL-based Informatics E-LKPD got an average score of 86.67% which is in the "Very good" category, so it can be concluded that the PBL-based Informatics E-LKPD developed is Worthy.

Product Practicality Test on Teachers. The following is descriptive data on the practicality test of PBL-based Informatics E-LKPD learning media by students.

Table 6. The average percentage of PBL-based Informatics E-LKPD media practicality test results for teachers

No	Assessment Indicator	Average Percentage	Criteria
1	Accessibility Aspect	90%	Very good
2	Aspects of Usefulness	88%	Very good
3	Presentation Aspects	87%	Very good
Average		88%	Very good

Product Practicality Test on Students. The following is descriptive data on the practicality test of PBL-based Informatics E-LKPD learning media by students.

Table 7. The average percentage of PBL-based Informatics E-LKPD media practicality test results for students

No	Assessment Indicator	Average Percentage	Criteria
1	Accessibility Aspect	90%	Very good
2	Aspects of Usefulness	90%	Very good
3	Presentation Aspects	90%	Very good
Average		90%	Very good

Product Effectiveness Test Research Data Description. Students' computational thinking skills. The following is descriptive data on students' computational thinking assessment scores in the control and experimental classes:

Table 8. Average score of computational thinking skills in the Control and Experiment Classes

Aspect	Control Class	Experiment Class
Decomposition	3.57	4.43
Pattern Recognition	3.59	4.44
Abstraction	3.47	4.33
Algorithm	3.43	4.10

The results of the study in the experimental class obtained the lowest student score of 64 and the highest score of 100. Meanwhile, the mean value was 86 with a mode of 100 and a standard deviation of 9.606. The following is descriptive data for classes taught using PBL-based Informatics E-LKPD, or what is called the Experiment class.

Table 8. Frequency Distribution of Posttest Learning Outcomes of students who are taught using PBL-based Informatics E-LKPD

Class	Class Intervals	Absolute Frequency	Relative Frequency
1	64 – 69	2	7%
2	70 – 75	3	10%
3	76 – 81	4	13%
4	82 – 88	9	30%
5	89 – 94	6	20%
6	95 – 100	6	20%
Total		30	100%

The results of the study in the control class obtained the lowest student score of 50 and the highest score of 86. Meanwhile, the mean value was 70 with a mode of 60 and a standard deviation of 9.018. The following is descriptive data for classes that are taught using textbooks, which are called Control classes. The results of the data on student learning outcomes in the control class will later be compared with the data on student learning outcomes from the experimental class.

Table 9. Frequency Distribution of Posttest Learning Outcomes of students who are taught not using PBL-based Informatics E-LKPD

Class	Class Intervals	Absolute Frequency	Relative Frequency
1	50 – 55	2	7%
2	56 – 61	3	10%
3	62 – 67	6	20%
4	68 – 73	8	27%
5	74 – 79	6	20%
6	80 – 86	5	17%
Total		30	100%

Before conducting the t-test to assess effectiveness, there are several requirements that must be carried out first, namely the normality test and homogeneity test. The normality test is used to evaluate the distribution of the data used in the analysis. This table provides information about significance, which is a measure of the level of confidence in determining whether the data is normally distributed or not. The following are the results of the research data normality test:

Table 10. Normality Test

Tests of Normality							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	GROUP	Statistic	Df	Sig.	Statistic	df	Sig.
Learning outcomes	Control Class	0.091	30	0.200*	0.979	30	0.785
	Experiment Class	0.118	30	0.200*	0.953	30	0.203
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

To find out whether the data is normally distributed or not, it is done by comparing the resulting significance values. If the significance value is < 0.05, it is concluded that the data is not normally distributed, whereas if the significance value is >0.05, it is concluded that the data is normally distributed.

Based on the results of the normality test performed, a significance of 0.200 was obtained. Based on the criteria used, if the significance is greater than 0.5, then the data can be considered normally distributed. Therefore, it can be concluded that the data used in this study tends to be normally distributed.

The homogeneity test is used to evaluate whether the variance (variation) between several groups or treatments is the same or homogeneous. Homogeneity tests provide important information in evaluating the homogeneity of the variance between the groups being compared.

The basis for decision-making on the homogeneity test is that if the significance value is > 0.05, then the data distribution is homogeneous. However, if the significance value is <0.05, then the data distribution is not homogeneous. The following are the results of the research data homogeneity test:

Table 11. Homogeneity Test

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Learning outcomes	Based on Mean	0.028	1	58	0.868
	Based on Median	0.040	1	58	0.842
	Based on Median and with adjusted df	0.040	1	57.706	0.842
	Based on trimmed mean	0.031	1	58	0.860

From the table of homogeneity test results above, a significance of 0.868 is obtained. So, based on the criteria used, if the significance is greater than 0.5, then the data can be considered homogeneous. Therefore, it can be concluded that the data used in this study tends to be homogeneous.

Hypothesis submission. In this study, hypothesis testing was carried out using the Independent t-test, where previously the normality test and homogeneity test had been carried out as prerequisite tests. The t test is a difference test between two unpaired groups, with the aim of knowing whether or not there is an average difference between the two groups. The

independent sample t test is included in parametric statistics, which means that the data normality assumption must be met, or in other words, the data must be normally distributed. The hypothesis in this study is as follows:

Ha: There are significant differences in learning outcomes between classes that study using PBL-based Informatics E-LKPD and classes that are not taught using PBL-based Informatics E-LKPD.

Ho: There is no significant difference between classes taught using PBL-based Informatics E-LKPD and classes taught without PBL-based Informatics E-LKPD.

There are testing criteria for the independent sample t-test, namely, if the sig. (2-tailed) is 0.05, it can be concluded that there is a significant difference. Meanwhile, if the sig. (2-tailed) is > 0.05, it can be concluded that there is no significant difference. The following are the results of the independent t-test on research data:

Table 12. Hypothesis Testing with t-test

Independent Samples Test								
		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Hasil Belajar	Equal variances assumed	-6.637	58	0.000	-15.96667	2.40568	-20.78217	-11.15117
	Equal variances not assumed	-6.637	57.770	0.000	-15.96667	2.40568	-20.78257	-11.15076

From the calculation results in the table above, it was found that the sig. (2-tailed) is 0.000, where the value is < 0.05, so it can be concluded that there is a significant difference between the experimental class, or the class that is taught using the PBL-based Informatics E-LKPD, and the control class, or the class that is not taught using the E-LKPD PBL-based Informatics.

3.2 DISCUSSION

In this study, an analysis was carried out on the feasibility of PBL-based Informatics E-LKPD learning media. The results of the due diligence by experts showed that this learning medium was declared very good by material experts, with an average percentage of 84%. Instructional design experts also consider this learning medium to be very good, with an average percentage of 87%. Meanwhile, media experts gave a very good assessment, with an average percentage of 83%.

The findings of this study are also in line with other studies that show the feasibility of E-LKPD learning media. Research by Efendi [41] and Zahroh [42] found that the learning media developed were very feasible based on several aspects such as presentation, content, and language.

Theories related to the practicality of learning media support this finding. According to Arikunto [43], practicality is related to the ease of use of evaluation tools, both in preparation, use, interpretation/conclusion of results, and storage. Milala [44] also stated that practicality refers to the ease of using learning media by teachers and students, which makes the learning process meaningful, interesting, fun, and useful, and increases creativity in the learning process.

The findings of this study are also in line with other studies that show the practicality of E-LKPD learning media. Batul's research [45] found that the learning media developed facilitated and helped the implementation of learning. Efendi [46] shows that the use of Student Worksheets (LKPD) makes it easier for students to study independently and carry out written assignments. Zahroh's research [47] shows that e-LKPD based on scientific literacy has a very practical implementation in the learning process.

Based on the results of the research data processing conducted, there are significant differences in Informatics learning outcomes and computational thinking abilities between students who study using PBL-based Informatics E-LKPD and students who are taught using textbooks. Students who study using PBL-based Informatics E-LKPD get an average grade higher than the class that studies using textbooks. This is in line with Nuriansyah's opinion [48] that interactive and innovative learning media can increase students' learning motivation, and this increase in motivation will help improve learning outcomes.

This finding is in accordance with the existing theory that learning media are effectively used to increase the achievement of learning objectives [49]. In addition, interesting multimedia learning media can help increase student interest and motivation, and interesting media can make it easier for students to understand and remember the material presented [50].

This is in line with the results of Malik's research [51], which shows that the use of learning media in the form of interactive multimedia can improve students' computational thinking skills. Efendi [52] and Zahroh [53] showed similar results, showing that the use of E-LKPD in learning can support the learning process, help students understand material more easily, and train students to think critically.

Thus, the results of the study show that the use of PBL-based Informatics E-LKPD in the experimental class significantly improves students' computational thinking skills compared to the control class. This shows that the use of PBL-based E-LKPD Inforamtika learning media in learning is effective in facilitating the development of students' computational thinking and provides significant benefits in the context of informatics learning.

4. CONCLUSION

Based on the formulation, objectives, results, and discussion of PBL-based Informatics E-LKPD media development, it can be concluded as follows:

1. The developed PBL-based Informatics E-LKPD learning media is very suitable for use in improving computational thinking skills
2. The developed PBL-based Informatics E-LKPD learning media is practically used in improving computational thinking skills

3. The developed PBL-based Informatics E-LKPD learning media is effectively used in improving computational thinking skills

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