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Critical Thinking Ability, Cognitive Learning Outcomes, and Student Learning Activities in Excretion System Learning Using PBL-Based E-LKPD

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Abstract

The aims of this study are : (1) determine the improvement of students' critical thinking skills in excretory system learning using PBL-based E-LKPD, (2) determine the increase in students' cognitive learning outcomes in excretory system learning using PBL-based E-LKPD, and (3) know the learning activities of students in learning the excretory system using PBL-based E-LKPD. This research is a Quasi Experiment research using a Non-Equivalent Control Group Design. The population in this study were all students of class XI IPA SMA N 2 Sragen. The sampling method is a purposive sampling; the research sample is students of class XI IPA 3, XI IPA 4, and XI IPA 5. The variables in this study consist of the independent variable, namely PBL-based E-LKPD, and the dependent variable is critical thinking ability and learning outcomes for cognitive learners. Data collection methods in this study were tests, observations, and questionnaires. The data in this study are the test scores for critical thinking skills, test scores for cognitive learning outcomes, the implementation of student activities, the implementation of learning, and student responses to learning. The data analysis technique used is descriptive statistical analysis (%) and hypothesis testing using the Independent Sample T-Test and Mann-Whitney U tests. The results of hypothesis testing the N-gain score on both variables show Sig. (2-tailed) <0.05, meaning that there is a difference in the improvement of critical thinking skills and students' cognitive learning outcomes between the experimental and control classes. Implementing student learning activities in the experimental class gave higher results than in the control class. The implementation of learning in each meeting reached a percentage of 85% with very good criteria. The response of students in the category of strongly agree and agree reached a percentage of 89.1%. The conclusions of this study are (1) increasing students' critical thinking skills in excretory system learning using PBL-based E-LKPD reaching the high category, (2) increasing students' cognitive learning outcomes in excretory system learning using PBL-based E-LKPD reaching high categories, and (3) The activities of students in learning the excretory system using PBL-based E-LKPD reached the very active category.

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INTRODUCTION

Critical thinking ability is one of the abilities that must be developed in science learning, especially biology, in 21st-century education. Critical thinking ability is an ability that every student must have in following developments and facing future educational challenges, this ability is used in decision making or solving problems that are usually related to everyday life (Basri & Sumarmin, 2020). The ability to think critically trains students to make decisions from various points of view carefully, thoroughly, and logically. Through the ability to think critically, a person can ask questions, sort out relevant information, and make appropriate conclusions (Amin et al., 2017). Low cognitive learning outcomes can be seen from the results of the 2018 PISA research showing the average science score obtained by Indonesian students is 396, with an OECD average score of 489, this score makes Indonesia ranked 71 out of 79 PISA participating countries (OECD, 2019). Cognitive learning outcomes are essential in education because they are used to determine the level of students' understanding of the material being studied. In addition, from the learning outcomes, teachers can assess the success of a learning activity. Cognitive learning outcomes are learning outcomes related to students' intellectual abilities, which consist of the dimensions of cognitive and knowledge development processes (Solihat et al., 2018).

The results of the interview with a Biology teacher in one of the public high schools in Sragen revealed that several obstacles were encountered during the learning process. First, students' low critical thinking ability and cognitive learning outcomes can be seen in students who have difficulty answering problem-based essay questions on excretory system material. The second is the lack of learning media that supports the primary learning media. The main learning media used are biology textbooks. In addition to the primary learning media, LKPD is also a supporting learning medium, but its use only lasts a few times. The worksheet used has an unattractive appearance because it only contains writing, this makes students lose interest in learning. The use of LKPD as a supporting learning media is needed so that students remain directly involved in learning. The LKPD used by the teacher is usually the LKPD obtained from the printing press, not the LKPD designed by the teacher. According to (Sari et al., 2016), LKPD should be compiled and developed by the teacher to suit the learning objectives. The lack of students' interest in learning impacts students' low understanding of the material being studied, this also affects the low ability to analyze problem-based questions and student learning outcomes on the excretory system material.

From the problems above, it can be seen that the selection of learning models and media by teachers affects the sustainability of learning activities so that they are carried out optimally (Fatahullah, 2016) and (Suciono et al., 2021). One of the teacher's tasks is to provide learning media that support student activity, such as LKPD. LKPD is one of the learning media that is made following the basic competencies that must be achieved and carried out by students, which are arranged in the form of task sheets, instructions for implementing assignments, and learning evaluations (Pawestri & Zulfiati, 2020). The rapid development of technology in education also requires teachers to make various innovations in making learning media so that the use of learning media is presented in electronic form. E-LKPD is a student activity sheet done digitally and carried out systematically, including pictures, text, audio, video, and various kinds of interactivity (quizzes, questions, evaluations, and so on) (Ardiani & Musadad, 2017). The advantage of LKPD, which is packaged in electronic form, is that the teacher can arrange material for assessment according to the needs of students in the classroom more interestingly and interactively, not even limited by space and time. In addition, E-LKPD can be an attractive tool when students' interest in learning decreases (Syafitri & Tressyalina, 2020).

In accordance with the 2013 Curriculum and the Independent Curriculum, the learning carried out must be in accordance with the scientific approach and the use of technology in using digital learning media to facilitate the learning process. One of the learning models with a scientific approach is the Problem Based Learning model. Problem Based Learning is a learning model that encourages students to acquire problem-solving skills through critical thinking, gain knowledge about interrelated concepts, and use everyday life problems as a stimulus for students (Maryati, 2018). Utilization of technology in using digital learning media for example changing the use of LKPD into E-LKPD. E-LKPD is a student activity sheet that is

done digitally and carried out systematically which includes pictures, text, audio, video and various kinds of interactivity (quizzes, questions, evaluations, and so on) (Ardiani & Musadad, 2017). E-LKPD combined with the Problem Based Learning model is a learning media in which it contains activities that refer to Problem Based Learning syntax which consists of 5 stages, namely 1) student orientation to problems; 2) organize students; 3) guide individual or group investigations; 4) develop and present results; and 5) analyze and evaluate the process and results of problem solving (Trianto in Agoestanto, 2016).

According to Novitasari & Puspitawati (2020) and Munika et al. (2022), PBL-based, E-LKPD is effective for training students' critical thinking skills. Research conducted by Gede Swiyadnya et al. (2021) explains that the combination of Problem Based Learning and LKPD models effectively improves student learning outcomes because the learning activities come from everyday problems that students often encounter. According to Andriyani et al. (2020), using Problem Based Learning learning models assisted by LKPD live worksheets can increase student activity; this is shown by the enthusiasm of students in working on LKPD independently, curiosity is higher, and students' confidence when expressing opinions.

Based on this background, it is necessary to conduct research with the title "critical thinking skills and cognitive learning outcomes of students in excretory system learning using PBL-based E-LKPD."

RESEARCH METHOD

The type of research used is Quasi Experimental Design using a Non-Equivalent Control Group design. The variables in this study include the independent variable, namely learning using PBL-based E-LKPD, and the dependent variable, namely the ability to think critically and students' cognitive learning outcomes. This study's population was all class XI science students in one of the public high schools in Sragen. The sample is selected using a purposive sampling technique. Data collection methods in this study were tests, observations, and questionnaires. The data used in this research consists of the results of the pretest and post-test of critical thinking skills and cognitive learning outcomes of students, learning activities, implementation of learning and student responses. The data analysis technique used is descriptive statistical analysis (%) and hypothesis testing using the Independent Sample T-Test and Mann-Whitney U tests.

RESULTS AND DISCUSSION

In this section, the results and discussion are presented on (1) critical thinking skills, (2) cognitive learning outcomes, (3) student learning activities, (4) learning implementation, and (5) student responses to the use of PBL-based E-LKPD.

Critical Thinking Ability

Data on students' critical thinking skills were obtained from test results in the form of pretest and post-test questions in the form of essays given at the beginning and end of learning given to the experimental class and control class.

Tabel 1 Recapitulation of Pretest and Posttest Values of Critical Thinking Ability in the Experimental Class and Control Class

Variasi	Pretest		Posttest	
	Experiment	Control	Experiment	Control
The highest score	45,00	42,50	92,50	85,00
The lowest score	20,00	22,50	65,00	60,00
Average score	34,3056	34,4444	80,4514	75,4861
Total (%)	0%	0%	87,5%	72,3%
Number of students	72	36	72	36

Tabel 2 Test Results Independent Sample T-Test Critical Thinking Ability in Experiment Class and Control Class

Result	Sig. (2-tailed)	Conclusion
Pretest experiment and control class	,904	No difference
Posttest experiment dan control class	,000	Difference

Table 1 shows that the pretest value of critical thinking skills in the experimental and control class has an average value that is almost the same; it can be seen in Table 2 that the pretest value of the experimental and control class obtained a Sig value. (2-tailed) 0.904 > 0.05 means that there is no significant difference in the pretest value of critical thinking skills between the experimental class and the control class; this shows that the critical thinking skills of students in the experimental class and control class tend to be the same at the beginning. While the post-test scores in the experimental class and the control class have different average values (Table 1), the post-test scores for the experimental class have a higher average value than the control class; it can be seen in Table 2 that the post-test scores for the experimental and control classes obtained Sig. (2-tailed) 0.000 > 0.05 means that there is a significant difference in the post-test value of critical thinking skills between the experimental class and the control class; it means that the critical thinking skills of students in the experimental class and control class are different at the end. The difference in the value of post-test critical thinking skills shows that using PBL-based E-LKPD affects students' critical thinking skills.

Tabel 3 Results of N-Gain Analysis of Critical Thinking Ability in Experiment Class and Control Class

Class	N-Gain	Category
Experiment	0,7056	High
Control	0,6278	Medium

Tabel 4 Test Results Independent Sample T-Test Score N-Gain Critical Thinking Ability in Experiment Class and Control Class

Result	Sig. (2-tailed)	Conclusion
N-gain experiment dan control class	,000	Difference

Table 3 shows that the N-gain of critical thinking skills for the experimental class is 0.7056 (high category) and for the control class is 0.6278 (medium category). Table 4 shows that the N-gain score of critical thinking skills in the experimental and control classes obtained a Sig value. (2-tailed) of 0.000 <0.05, meaning there is a significant difference in the N-gain score (increase) of critical thinking skills between the experimental and control classes.

Table 5 Implementation of Learning Using PBL-Based E-LKPD

Class	Meeting			
	1	2	3	4
XI IPA 3	89,47%	92,98%	100%	100%
XI IPA 4	91,23%	94,74%	100%	100%
Category	Very good	Very Good	Very Good	Very Good

The average post-test score and N-gain score of critical thinking skills in the experimental class are higher than in the control class; this is influenced by differences in the learning media used. The experimental class uses PBL-based E-LKPD media, while the control class uses Powerpoint media. In the experimental class, students learn by applying the syntax of the Problem Based Learning model contained in the PBL-based E-LKPD, consisting of stages (1) orientation of students to problems; (2) organizing students; (3) guiding individual and group investigations; (4) develop and present the work; and (5) analyzing and evaluating the process and results of problem-solving. The use of PBL-based E-LKPD facilitates students to carry out various learning activities. Giving problems at the beginning of learning will stimulate students to carry out various advanced activities until a problem solution is found. This follow-up

activity includes thinking activities, seeking relevant information, analyzing, discussing, presenting the results, and making conclusions at the end of the lesson. The number of activities carried out by students will make them more active and positively impact their critical thinking skills. In addition, learning that focuses on problem-solving will stimulate students to develop their critical thinking skills. Based on the results of observations of the implementation of learning in Table 5 shows the results that learning using PBL-based E-LKPD is very well done so that teachers can apply it to improve students' critical thinking skills. While in the control class, learning activities are dominated by the teacher; the teacher conveys the material through Powerpoint media, and the students pay attention to the teacher's explanation.

Table 6 PBL-Based E-LKPD Components That Support Students' Critical Thinking Ability

No	Critical Thinking Ability Indicator	Media Component
1.	Give a simple explanation	Through questions presented in the PBL-based E-LKPD
2.	Build basic skills	Through the material links provided in PBL-based E-LKPD, students are trained in the ability to sort and select relevant information
3.	Making conclusions	Through the concluding column at the end of the learning activities presented in PBL-based E-LKPD
4.	Provide further explanation	Through questions presented in the PBL-based E-LKPD
5.	Set strategy and tactics	Through group discussions in finding solutions to the problems presented in PBL-based E-LKPD

The results of this study following research Herdiansyah (2018) showed that the results of the critical thinking ability of the experimental class that is treated using LKPD based on the Problem Based Learning model were higher than the control class; this was because during learning students were accustomed to problems related to everyday life so that students are familiar with the existence of problems and can find out the benefits of the material being studied. Another research conducted by Riswanti (2020) states that Problem Based Learning is effective because learning activities present problems that students must solve; this will encourage students to develop their critical thinking skills to analyze problem solving and solutions. Research conducted by Astuti et al. (2018) explains that using Problem Based Learning-based worksheets makes students more independent in learning so that their critical thinking skills can be honed. According to Fitria & Suparman (2019) and Munika et al. (2022), PBL-based E-LKPD is effective for training students' critical thinking skills.

Cognitive Learning Outcomes

Data on students' cognitive learning outcomes are obtained from test results in the form of pretest and post-test questions in the form of multiple choices at the beginning and end of learning given to the experimental and control classes

Table 7 Recapitulation of Pretest and Posttest Values of Cognitive Learning Outcomes in the Experimental Class and Control Class

Variasi	Pretest		Posttest	
	Experiment	Control	Experiment	Control
The highest score	56,00	56,00	96,00	88,00
The lowest score	16,00	20,00	68,00	64,00
Average score	36,7778	37,8889	83,6111	77,2222
Total (%)	0%	0%	94,5%	75%
The number of students	72	36	72	36

Table 8 Test Results Independent Sample T-Test Cognitive Learning Outcomes in Experiment Class and Control Class

Result	Sig. (2-tailed)	Conclusion
Pretest experiment dan control class	,576	No difference
Posttest experiment dan control class	,000	Difference

Table 7 shows that the pretest scores of cognitive learning outcomes in the experimental class and control class have almost the same average value; it can be seen in Table 8 that the pretest value of the experimental and control classes obtained the Sig value. (2-tailed) 0.576 > 0.05, meaning that there is no significant difference in the pretest score of cognitive learning outcomes between the experimental class and the control class; this indicates that the cognitive learning outcomes of students in the experimental class and the control class at the beginning tend to be the same. While the post-test scores in the experimental class and the control class have different average values (Table 7), the post-test value of the experimental class has a higher average value than the control class; it can be seen in Table 8 that the post-test scores of the experimental and control classes get Sig. (2-tailed) 0.000 > 0.05 means that there is a significant difference in the post-test score of cognitive learning outcomes between the experimental class and the control class; it means that the cognitive learning outcomes of students in the experimental class and the control class at the end are different. The difference in post-test scores for cognitive learning outcomes shows that using PBL-based E-LKPD affects students' cognitive learning outcomes.

Table 9 Results of N-Gain Analysis of Cognitive Learning Outcomes in the Experiment Class and Control Class

Class	N-Gain	Category
Experiment	0,7395	High
Control	0,6263	Medium

Table 10 Test Results Independent Sample T-Test Score N-Gain Cognitive Learning Outcomes in the Experimental Class and Control Class

Result	Sig. (2-tailed)	Conclusion
N-gain experiment class dan control class	,000	Difference

Table 9 shows that the N-gain of cognitive learning outcomes for the experimental class is 0.7395 (high category) and for the control class is 0.6263 (medium category). Table 10 shows that the N-gain score of cognitive learning outcomes in the experimental and control classes has a Sig value. (2-tailed) of 0.000 <0.05, meaning that there is a significant difference in the cognitive learning outcomes' N-gain score (increase) between the experimental and control classes.

The average post-test score and N-gain score of cognitive learning outcomes in the experimental class were higher than in the control class; this is because, in the student-centered learning experimental class, the teacher facilitates students by providing PBL-based E-LKPD in each lesson. In the control class, the learning is teacher-centered, where the teacher explains the material through Powerpoint shows. PBL-based E-LKPD as a learning medium can help teachers and students in the learning process. From the teacher's perspective, the existence of PBL-based E-LKPD makes it easier for teachers to direct students so that learning can be active and student-centered. Meanwhile, in terms of students, it provides opportunities for students to carry out various activities that can support the improvement of students' cognitive learning outcomes. The PBL-based E-LKPD used in this study is the E-LKPD which contains the syntax of the Problem Based Learning learning model and was developed through the Liveworksheet.com website, which is presented with a more attractive appearance and is easily accessible to students. The attractive appearance of the LKPD is one factor determining the motivation of students to learn. High learning motivation will make students more interested in learning so that the process of understanding a material will be more straightforward; this will affect the improvement of students' cognitive learning outcomes. The existence of videos presented in the E-LKPD also increases students' interest in learning; high interest in learning will make it easier for students to understand the material being studied. This follows the research results of

Hasyim et al. (2021) and Pamungkas & Koeswanti (2021) that using video in learning makes students more interested and easier to understand learning materials, and a good understanding of the material will affect the improvement of student learning outcomes.

The results of this study are in line with Gede Swiyadnya et al. (2021) who explain that the combination of Problem Based Learning and LKPD models is effective in improving student learning outcomes because the learning activities come from everyday problems that students often encounter. The use of PBL-based LKPD can increase understanding and make students more active in improving student learning outcomes (Sujarwo, 2021). According to Lailiah et al. (2021), learning assisted by E-LKPD influences students' cognitive learning outcomes because E-LKPD has an attractive appearance that increases students' motivation to learn so learning outcomes will also increase. E-LKPD helps students understand the concept of the material being studied so that it has an impact on improving student learning outcomes (Fitria & Suparman, 2019). Using the Problem Based Learning model requires students to carry out various activities such as responding, remembering, solving problems, analyzing, and making decisions in groups. Based on the results of observations in Table 5, the implementation of the learning process using PBL-based E-LKPD is very well done so that teachers can apply PBL-based E-LKPD to improve students' cognitive learning outcomes. Using the Problem Based Learning syntax improves students' cognitive learning outcomes compared to those taught with conventional learning (Kristinawati et al., 2018).

Student Learning Activities

Data on student learning activities were obtained from filling in the observation sheets made by observers during the learning process.

Table 11 Recapitulation of Observation Results of Student Learning Activities

Indikator Aktivitas Belajar	Student Learning Activities		
	XI IPA 3	XI IPA 4	XI IPA 5
Oral activities	3	3	1
Listening activities	3	3	1
Writing activities	3	3	1
Mental activities	3	3	0
Total	12	12	3
Percentage	100%	100%	25%
Category	Very active	Very active	Less active

The learning activities observed by the observers include oral, listening, writing, and mental activities, each of which consists of 3 sub-indicators. Based on the results of observations of learning activities presented in Table 11, it shows that in the experimental class, all sub-indicators of learning activities were carried out by students with a percentage of 100% with a very active category. While in the control class, the learning activities carried out by students are minimal, students only do 3 sub-activities from 12 sub-activities with a percentage of 25% in the less active category.

In the experimental class, the use of PBL-based E-LKPD facilitates students to carry out various learning activities, including oral, listening, writing, and mental activities. The activities presented in the PBL-based E-LKPD refer to the syntax of the PBL model, which starts from presenting a problem to making conclusions from problem-solving that has been found. Various learning activities by students help students find solutions to the problems presented and make students more active in working on problems and get used to reasoning to find solutions to problems; this will make students better understand the concept of a material being studied and make learning more meaningful. According to Andriyani et al. (2020) and Khikmiyah (2021), the use of the PBL learning model assisted by the LKPD live worksheet increased students' learning activeness.

A series of learning activities carried out by students helps in the process of developing critical thinking skills, and vice versa, if students tend not to carry out these activities, students will experience difficulties in developing their critical thinking skills. It is in line with Ilham & Hardiyanti (2020) opinion, which states that students who are less active in participating in learning will impact their critical thinking

skills. The number of activities carried out by students will stimulate students to think and remember much information that has been obtained so that understanding of the material being studied will also increase and ultimately improve students' cognitive learning outcomes. According to Dayeni et al. (2017) stated that the Problem Based Learning model could increase student activity in learning and make students receive more information when student participation in learning increases, their thinking activity will also increase and will also have an impact on increasing cognitive learning outcomes.

Student Responses to the Use of PBL-Based E-LKPD

Student response data was obtained from filling out the student response questionnaire after participating in learning activities using PBL-based E-LKPD.

Table 12 Recapitulation of Student Response Questionnaire Results on the Use of PBL-Based E-LKPD

No	Statement	Positive Response		Negative Response	
		Respondent	(%)	Respondent	(%)
1.	Learning is more fun	66	91,7	6	8,3
2.	Learning is easier to understand	62	86,1	10	13,9
3.	Learning attracts interest in learning	62	86,1	10	13,9
4.	PBL-based E-LKPD helps solve problems	63	87,5	9	12,5
5.	Learning combines various activities	66	91,7	6	8,3
6.	Learning can affect social relations in the classroom	67	93,1	5	6,9
7.	PBL-based E-LKPD can be applied to other materials	61	84,7	11	15,3
8.	PBL-based E-LKPD helps in self-study	66	91,7	6	8,3
	Average	**89,1%**		**10,9%**	

Student response data is used to determine student responses regarding using PBL-based E-LKPD. The questionnaire contains 8 statements with 4 answer options: strongly agree, agree, disagree, and disagree. Student responses were grouped into 2 categories: positive responses (strongly agree and agree) and negative (less agree and disagree). Table 12 shows that the percentage of students who gave a positive response was 89.1%, and the percentage of students who gave a negative response was 10.9%.

Students feel that learning using PBL-based E-LKPD makes the learning atmosphere more fun, the material learned easier to understand, makes students more enthusiastic in learning, makes learning more interesting, and helps students learn independently. It is in line with the results of research conducted by Fuadah (2021) that the use of PBL-based E-LKPD media makes learning more lively, not dull, the material is easier to learn, make lessons more fun, and makes students more active, independent, more enthusiastic and interested in participating in learning so that it affects the improvement of students' critical thinking skills. Another study Puspita & Dewi (2021) showed that using PBL-based E-LKPD obtained student responses in the very good category because it helps students learn independently.

In addition, students also responded that the use of PBL-based E-LKPD helps students solve problems, makes students respect the ideas and ideas of others, and PBL-based E-LKPD should also be applied to other materials. It is in line with research Bakhri & Supriadi (2017) which states that through PBL syntax, students are accustomed to solving problems related to everyday life by conducting group discussions. The existence of group discussions will make students learn to appreciate the ideas and ideas of others.

CONCLUSION

Based on the results of research and discussion, it can be concluded that (1) increasing students' critical thinking skills in excretory system learning using PBL-based E-LKPD reaches a high category, (2) increasing students' cognitive learning outcomes in excretory system learning using E-LKPD-based PBL reached the high category, and (3) the activities of students in learning the excretory system using PBL-based E-LKPD reached the very active category.

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