IMPROVES CRITICAL THINKING SKILLS AND SELF-EFFICACY OF LEARNERS USING THE PJBL-STEAM MODEL IN WETLAND CONTEXTS

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Abstract. *Critical thinking skills are essential thinking skills mastered in the 21st century to ensure the progress of a nation. They can help a person to solve problems by interpreting, analyzing, evaluating, and inferring. Self-efficacy refers to an individual's confidence in their capacity to address challenges. Critical thinking skill is associated with self-efficacy. The PjBL-STEAM paradigm is an alternative aimed at enhancing pupils' capacity for critical thought and self-efficacy. This study uses a fruit solution that may grow in wetlands as a wetland setting to teach electrolyte and nonelectrolyte solution principles. By examining pretest and posttest results, this study explores how the PjBL-STEAM learning paradigm might improve students' critical thinking and self-efficacy in wetland settings. This research paradigm uses a one-group pretest-posttest framework with a quasi-experimental design. This research was performed at SMAN 3 Barabai, focusing on the class X MIA population, using a purposeful sample of 25 students from class X MIA 3. Data acquisition via assessments and surveys. Data analysis was conducted by comparing pretest and posttest data. The findings indicated that the PjBL-STEAM learning model within the wetland environment enhanced students' critical thinking abilities and self-efficacy, yielding an N-gain value of 0.58 for critical thinking (moderate category) and 0.75 for self-efficacy (high category). Utilizing PjBL-STEAM in wetland environments is reported to enhance students' critical thinking abilities and self-efficacy.*

Kata Keywords: *Critical Thinking, Self-Efficacy, PjBL, STEAM*

INTRODUCTION

In the 21st century, at least four competencies must be mastered: thinking creatively, high comprehension, communication, and critical thinking skills (Eichmann *et al.*, 2019). The capacity for critical thinking is among the essential capitals that is very important for each person and is a fundamental part of the maturity of the human being that must be trained along with one's intellectual growth. (Nautical & Yuliani, 2021) According to Muti'ah (2020), Critical thinking is a process that use cognitive abilities effectively to assist an individual in making, assessing, and determining choices on beliefs or actions. Critical thinking may be affected by an individual's conviction in their problem-solving capabilities. That belief is called *self-efficacy*. *Self-efficacy is the belief in one's own ability.* High *self-efficacy* can increase a person's confidence in achieving success.

Based on several existing facts, the critical thinking skills of pupils in Indonesia remain comparatively deficient. This is substantiated by several research that have been undertaken. One of them is derived on Luzywati's observations (2017) at SMA Negeri 1 Sindang Indramayu, which stated students' low critical thinking ability due to learning that leads to *Teacher-centered*, which makes students only receive information from teachers**.** Moreover, Leonard and Amanah (2017) assert that students are often insufficiently motivated to cultivate their cognitive abilities during the majority of the learning process. Education is primarily focused on the retention and accumulation of knowledge, resulting in pupils being intellectually proficient but deficient in practical application. Consequently, pupils' critical thinking abilities stagnate and become difficult to cultivate.

Education offers pupils the chance to assimilate knowledge effectively and refine their capacity for critical thought, as shown by

project-based learning. According to the 2013 curriculum, project-based learning is referred to as Project Based Learning (PjBL). Project labor encompasses intricate duties derived from formidable difficulties, designing, solving problems, and making decisions. (Rani, 2021). According to Kricsfalusy, George, and Reed (2018), one of the learning models that might enhance students' critical thinking skills in learning that incorporates real-world challenges is the PjBL model. Applying the PjBL model requires students to complete a project that exists in everyday life. In concluding the results of the project that has been carried out, the student's critical thinking can be seen.

An approach that fits the PjBL model is the STEAM approach (Saints, 2022). DeJarnette (2018) states that the STEAM approach implements these five fields. Project-based learning benefits greatly from STEAM, which also helps students' critical thinking, which is influenced by their sense of self-efficacy or confidence. PjBL, or STEAM-based project-based learning, improves students' self-efficacy and critical thinking skills.

The PjBL-STEAM model's use improves pupils' capacity for critical thought, as shown by study done by Priantari, Prafitasari, Kusumawardhani, and Susanti (2020), which indicates that STEAM-PjBL application may elevate students' critical thinking capabilities. In addition, the research results by Ahmad, Astriani, and Alfahnum (2020) stated that learning using PjBL-STEAM significantly impacts students' criticism of a problem.

Fitriyani, Rahmawati, and Yusmaniar (2019) mentioned that electrolyte and nonelectrolyte solution materials are chemical materials that include factual, conceptual, and procedural knowledge. This material studies the classification of solutions based on their electrical conductivity through several symptoms that appear. In its application, electrolyte and nonelectrolyte solution materials are very suitable for development through the PjBL-STEAM approach in wetland environments to enhance self-efficacy and critical thinking abilities. Because the classification of solutions such as sugar, saline, and vinegar solutions is too commonly studied in this material. Therefore, the intended wetland context is a solution sourced from fruits that grow well in wetlands, including lime, star fruit, banana, Ampalam (a type of mango), and Binjai. This is so that the latest innovation appears in learning this material.

Based on the background presented, this article will examine the enhancement of students' critical thinking skills and self-efficacy via Project-Based Learning in a STEAM context, focusing on electrolyte and non-electrolyte solution materials.

METHOD

This study used a one-group pretest-posttest methodology and is quasi-experimental. Pretests were part of the study's design and were given prior to the PjBL-STEAM learning paradigm being implemented in a wetland environment, followed by posttests done after the treatment.

The following is the layout of a single group pretest-posttest design:

Table 1. ***One group pretest-postest design***

Pretest	Treatment	*Postest*
T_1	X	T_2

Information:

T1: *Pretest* is performed before treatment is given

X: Treatment is given to students

T2: The final test (*postest*) is performed after treatment

This study's population is class X MIA SMAN 3 Barabai students for the 2021/2022 school year. The sample was 25 students from class X MIA 3 SMAN 3 Barabai. Samples are obtained using purposive sampling, a sampling method that takes certain factors into account. The intended consideration is that the class sampled represents the population.

This study has free, bound, and control variables. The free variable is the PjBL-STEAM model, the bound variable is critical thinking ability and *self-efficacy***,** and the control variable is the material used in the study, namely electrolyte solution and nonelectrolyte material.

Data collection techniques use critical thinking ability test instruments and *self-efficacy* questionnaires. The test instruments used previously have undergone a validation process by five expert validators/practitioners as a form of the feasibility of using the instrument for research.

Critical thinking test instruments and *self-efficacy* questionnaires are given to students

before learning to use PjBL-STEAM in the wetland context (pretest) and after learning to use PjBL-STEAM in the wetland context *(posttest).* The test results will reference whether using In wetland environments, the PjBL-STEAM methodology may enhance students' critical thinking and self-efficacy in electrolyte and nonelectrolyte solution materials.

The test result data obtained from the data collection results are then analyzed through the following procedures: (1) Provide the student's answer score by the answer key and scoring guidelines used, (2) Create a table of student test result scores from *the pretest* and *posttest* results. (3) Group learners in critical thinking assessment criteria. The grouping of learners is based on the opinions of Setyowati, Subali, and Mosik (2011).

Table 2. Critical Thinking Ability Criteria

Value Range	Criteria
81,25-100	Very critical
62,50-81,25	Critical
43,75-62,50	Less critical
25,00-43,75	Very less critical

(4) Grouping learners in *self-efficacy* criteria is based on the opinion of Riduwan (2012).

Table 3. Self Efficcay Criteria

Percentage (%)	Category
81 - 100	Very high
61 - 80	High
41 - 60	Medium
21 - 40	Low
0 - 20	Very low

(5) The improvement of critical thinking ability and *self-efficacy* of learners is calculated by the *N-Gain* equation of Hake's opinion (1998) as follows:

$$\% \langle g \rangle = (\% \langle S_f - S_i \rangle)/(100 - \% \langle S_i \rangle)$$

Information:

$\langle g \rangle$ = Gain index (*N-Gain*)

$\langle S_i \rangle$ = pretest score

$\langle S_f \rangle$ = Score gain after treatment (*posttest*)

Table 4. N-Gain Criteria

No	Nilai Gain	Klasifikasi
1	$\langle g \rangle \geq 0,7$	High
2	$0,7 > \langle g \rangle \geq 0,3$	Medium
3	$\langle g \rangle < 0,3$	Low

RESULTS AND DISCUSSION

Learning effectiveness measures how well students use the PjBL-STEAM approach to improve their critical thinking abilities and self-efficacy. It is evident how efficient the learning method was by comparing the *pretest and posttest values, which are* then measured by *N-gain* (Arham & Dwiningsih, 2016).

1. Critical Thinking Ability

The mental process of problem-solving, assumption analysis, reasoning, evaluation, research, and decision-making is known as critical thinking. According to Facione, self-regulation, interpretation, analysis, evaluation, inference, and explanation are the fundamental components of critical thinking skills. The critical thinking indicators used in this study are interpretation, analysis, evaluation, and inference (Saputra, 2020).

Learning using PjBL-STEAM was conducted on 25 class X MIA 3 SMAN 3 Barabai students. Before learning using PjBL-STEAM, To ascertain their starting skills, pupils were given pretest questions. After learning PjBL-STEAM at the last meeting, students were given post-test questions to determine how the PjBL-STEAM model influences Critical thinking abilities and self-efficacy of pupils. Data on critical thinking ability test results from pretest and posttest values can be seen in Table 5.

Table 5. Critical thinking ability test result

Value interval	Category	*Pretest*		*Postest*	
		F	%	*F*	%
81,25 – 100	Very critical	-	-	13	52
62,50 - 81,25	Critical	10	40	11	44
43,75 – 62,50	Less critical	10	40	1	4
25,00 – 43,75	Very less critical	5	20	-	-
Number of samples		25		25	

Table 5 shows that the results in the pretest questions were five students with significantly less critical categories, ten with less critical categories, and ten with critical categories. Meanwhile, after

learning PjBL-STEAM, it can be seen that in the results of the posttest, there are 13 students with very critical categories, 11 students with critical categories, and only one less critical student, and there are no students with significantly less critical categories. The average overall score of students on the *pretest* and *posttest is presented in the following Figure* 1.

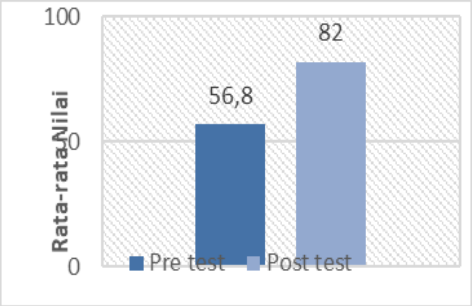

Figure 1. Critical thinking ability

Figure 1 shows an increase in the average overall value of the *pretest* and *posttest*. Table 6 below shows the average critical thinking ability scores and the highest and lowest scores in the class.

Table 6. Critical thinking ability

Value	*Pretest*	*Postest*
Highest	80	100
Lowest	35	60
Average	56,8	82

To evaluate the improvement of critical thinking skills after the application of the created learning aids in the educational process, the critical thinking ability test results from the pre-test and post-test are then converted into N-gain data. Table 7 displays the N-gain statistics.

Table 7. N-gain Critical Thinking ability

Interval N-gain	Category	Frequency
(g) ≥ 0,7	High	8
0,7 >(g) ≥0,3	Medium	14
(g) < 0,3	Low	3

Based on calculations, the *value of N-gain* is 0.58. The value is included in the moderate category so that the use of developed learning tools gives good results in improving critical thinking skills.

2. Self Efficacy

N-gain is then used to evaluate the improvement in students' self-efficacy from the pre-test to the post-test based on the data gathered from their self-efficacy before and after the test after the implementation of the PjBL-STEAM learning paradigm. This research employs the following markers of self-efficacy: (1) verbal persuasion, (2) vicarious experiences, (3) mastery experiences, and (4) emotional and physiological states. Table 8 below displays the results of self-efficacy surveys based on pretest and posttest scores.

Table 8. Pretest and posttest results of the self-efficacy questionnaire

Percentage	Category	Frequency of learners	
		Pretest	***Postest***
81-100	Very high	3	25
61-80	High	22	-
41-60	Medium	-	-
21-40	Low	-	-
0-20	Very low	-	-
Sum		**25**	**25**

Table 8 shows that three learners have self-efficacy with very high categories in the pretest and 22 learners have self-efficacy with high categories in the posttest. Meanwhile, in the *posttest*, all students had self-efficacy, which was a very high category. This also shows that previous students' essential self-confidence or self-efficacy is sufficient. The *self-efficacy* data with the highest and lowest values in the class can be seen in Table 9.

Table 9. Average pretest and posttest self-efficacy scores of learners

Value	*Pretest*	*Posttest*
Lowest	64	88
Highest	81	100
Average	**74,44**	**93,56**

Table 9 shows an increase in completeness, which can be seen from the highest and lowest scores of self-efficacy questionnaires, namely the lowest scores

of students in pretest 64 and postest 88. The highest score on the pretest was 81, and the post-test reached 100. The average value obtained as a whole in the pretest and post-test is presented in Figure 2 below.

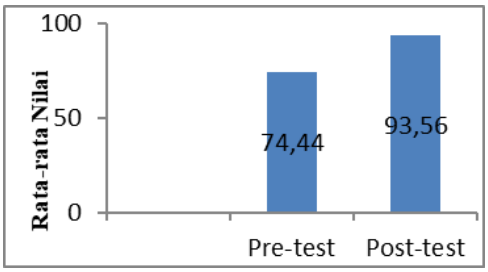

Figure 2. *Pretest* and *posttest self-efficacy* results

Figure 2 shows that the average overall self-efficacy value in the pretest only reached 74.44%, while it reached 93.56% in the posttest. This shows increased students' self-confidence after learning using the PjBL-STEAM model.

The information gleaned from students' self-efficacy scores on the pretest and posttest is then analyzed using N-gain, which aims to determine the increase in self-efficacy from pretest to postest after learning using PjBL-STEAM. N-gain data in outline can be seen in Table 10 below:

Table 10. N-gain self-efficacy result of learners

N-gain	Category	Frequency of learners
(g) < 0,3	Low	-
0,3 < (g) < 0,7	Medium	10
(g) > 0,7	High	15

The study of the average results between the pretest and the posttest indicates a significant enhancement in students' self-efficacy, shown by an N-gain value of 0.75, categorized as high. The implementation of the PjBL-STEAM paradigm enhances students' self-confidence, hence demonstrating its effectiveness.

CONCLUSION

From the study findings and discourse, the following conclusions may be drawn:

1. Learning using PjBL-STEAM in the context of wetlands has an N-gain value of 0.58 and may successfully enhance pupils' critical thinking abilities and a moderate category.
2. Learning using PjBL-STEAM in a wetland context can increase students' self-efficacy in terms of effectiveness with an *N-gain* value of 0.75 with a high category.

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