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QASE-Based Case Study Learning for Enhancing Students' Critical Thinking Skills on Socio-Environmental Issues: The Case of Forest and Peatland Fires

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Abstract: This study aims to analyze the effect of QASE-based case study learning on students' critical thinking skills in addressing peatland fire problems. This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design to examine the effectiveness of QASE-based case study learning in improving students' critical thinking skills. The sample was selected using purposive sampling, involving students enrolled in environmental science and disaster mitigation courses, as well as first-year students. A total of 105 students from the University of Riau participated in this study. Data were collected using Higher-Order Thinking Skills (HOTS) test instruments and observation sheets. The data were analyzed statistically using N-Gain analysis and a t-test. The results showed an improvement in students' critical thinking scores, with the mean pretest score increasing from 69.74 to a mean posttest score of 87.28. The overall N-Gain score for students' critical thinking skills was 0.57, which was categorized as moderate. Among the critical thinking indicators, the ability to synthesize showed the most significant improvement in classes A and B. Furthermore, the t-test results showed a significance value of $p < 0.05$, indicating that QASE-based case study learning was effective in improving students' critical thinking skills in environmental learning. These findings suggest that the QASE model can be implemented as an alternative case-based learning strategy to enhance students' Higher-Order Thinking Skills (HOTS), particularly in addressing environmental issues such as peatland fires.

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Introduction

Case-based learning is a learning method designed to enhance high-level thinking in solving a case can help students to connect education and develop professional skills for practice (Hodijah, 2022; Thibaut & Schroeder, 2020). According to (Koehler et al., 2020), cases are factual news, complex issues written to stimulate class discussion and collaborative analysis. The learning method commonly used in case-based learning is CBL (Turk et al., 2019). CBL involves students and teachers only to help students analyze cases to identify problems, compare and evaluate optional solutions, and decide how to handle a case, applying constructivist learning theory (Yustina & Kapsin, 2017), digital literacy, ecoliteration, critical and creative thinking.

Critical thinking is a person's ability to find information and solve a problem from a problem by asking themselves to dig up information about the problem they are facing (Lestari et al., 2020). The indicators of critical thinking skills according to (Lestari et al.,

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2020; Suparmi et al., 2019) are as follows: 1) analytical skills, 2) synthesis skills, 3) problem recognition and problem-solving skills, 4) concluding skills, and 5) evaluation and assessing skills. Evaluation skills require mature thinking in determining the value of something with various criteria in finding solutions in the form of ideas or creating new ideas and products by creative thinking. Critical thinking skills can be improved through HOTS-based learning that invites students to think at a high level (Anggraini et al., 2023; Yustina, Mahadi, et al., 2022).

The results of the literature study obtained information that environmental damage is currently in a worrying condition (Suryaningsih, 2018) Because the habit of caring for the environment is very lacking (Masruroh, 2018). This is due to the lack of knowledge of local wisdom (Handayani, 2023), so that it is necessary to improve the life skills of local wisdom (Yustina, Zulfarina, et al., 2022) and motivation to protect the environment (Yustina et al., 2020). Environmental awareness is cultivated in society and the world of education. Students lack understanding of environment-oriented learning (Husin, 2019). Environmental mismanagement, especially wetlands, such as peat ecosystems, illustrates a lack of understanding and knowledge of the peculiarities, complexities, and vulnerabilities of peatland ecosystems as well as the natural relationships between peatlands, biodiversity, carbon, and water (Amania, 2020; Gunawan et al., 2020).

Integration of the environment in science learning makes learning more meaningful (Idris et al., 2022; Noviana et al., 2023). The advantages of case studies stimulate high-level thinking in environmental problem-oriented situations (Satwika et al., 2018). HOTS is the ability to connect and transform knowledge and experience that you already have in making decisions to solve problems (Dinni, 2018). For critical individuals (Asfiyah, 2021; Febrianti et al., 2021) who cares about the environment; every problem in the peatland environment such as the case of Forest and Peatland fires (KARHUTLAG) becomes an inspiration to create creative products that are useful for solving real-life problems (Sugiyanto et al., 2018).

According to (Noviana et al., 2023) Teachers must provide education about future disasters to students through various strategies, including through case studies. The learning uses case studies related to problems in peatland ecosystems. This requires the ability of students to think critically and creatively to answer problems in the learning process, case studies that require students' skills. To get solutions related to cases or problems in daily life about peatland ecosystems, learning is needed using Ask, Answer, Share and Evaluation (QASE) based case studies. QASE explores information in the digital era and related to environmental concepts regarding the current peatland ecosystem that requires students' critical thinking skills and creativity, the research framework in Figure 1.

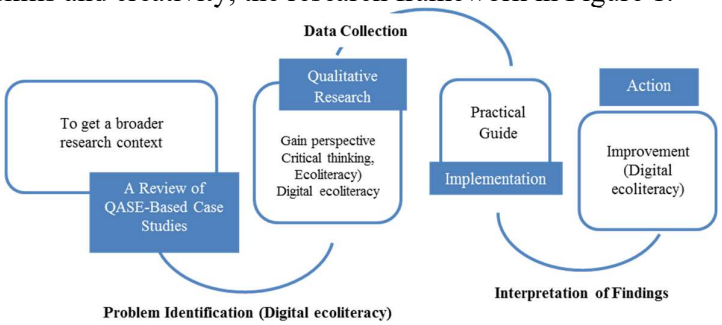

Figure-1. Framework for Thinking on Elaborating 21st Century Skills Using QASE-Based Case Studies (Author Source)

Previous studies have extensively examined problem-based learning and case methods separately, but limited studies investigate QASE-based case learning in peatland disaster

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contexts for enhancing university students' critical thinking. Therefore, this study aims to analyze the improvement of students' critical thinking skills through QASE-based case study learning on peatland fire issues. This has been empirically validated in many studies where methods such as structured questioning, collaborative discussion and reflective evaluation have been observed to significantly contribute towards the development of critical thinking by situating students within analysis, synthesis, argumentation and decision-making (Heard et al., 2020; Koehler et al., 2020; Tommasi et al., 2023). Additionally, digital learning environments paired with research of various disciplines provide faster access to information sources which in number and distance many times exceed the human ability ((Yustina, Mahadi, et al., 2022). Thus, incorporating QASE with case-based learning is anticipated to facilitate many students' development of critical thinking by establishing a recursive process involving inquiry, evidence generation, collaborative reflection and evaluation.

Research Method

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design to examine the effect of QASE-based case study learning on students' critical thinking skills. The design involved measuring students' initial critical thinking ability through a pretest, implementing the QASE learning intervention, and subsequently administering a posttest to identify changes in learning outcomes after treatment.

The research was conducted at the University of Riau from February to December 2025. The population consisted of first-semester undergraduate students enrolled in the Environmental Science and Disaster Mitigation (ILMB) course. A total of 105 students participated in the study and were selected using purposive sampling. The inclusion criteria included: (1) students enrolled in the ILMB course during the research period, (2) students from classes taught by the same lecturer team to ensure instructional consistency, and (3) students who completed the entire pretest–intervention–posttest sequence. The sample consisted of students from Fisheries (Class A; n=60) and Agrotechnology (Class B; n=45).

The data collection technique was carried out by test and observation. The test designed is a HOTS test. The pretest is given before learning, while the posttest is given after the learning. Observations are designed to observe students' HOTS abilities during the learning process. The critical thinking instrument is in the form of test questions as many as 20 items of multiple-choice questions, consisting of 5 indicators including 5 indicators of critical thinking, namely analyzing, synthesizing, recognizing and solving problems, concluding, and evaluating, (Hasibuan et al., 2025) and each indicator contains 4 question items. Data collection uses tests that are shared through google forms.

The question instrument was developed based on the preparation of a question grid that refers to indicators and sub-indicators of critical and creative thinking (HOTS). The decomposition of the grid of test and observation questions is found in Table 1.

Table 1. Breakdown of indicators and grids of HOTS questions

HOTS Capabilities	Aspects	Indicator	Peatland Ecosystem Question Grid
Critical Thinking	Analyze	Looking for similarities and differences	Analyze the difference between peatland and non-peat land (mineral land) based on characteristics
		Find the structure of a statement	Analyzing the existence of peatlands through scientific methods

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		Grouping	Analyze peatland groupings based on depth and decomposition of organic matter
		Identifying information	Analyzing peatland damage based on stimuli
	Synthesizing	Concept interconnectedness	Synthesizing peatland sustainability is reviewed from the linkages between economic, environmental, and policy aspects
		Discovery of new ideas	Synthesize innovative ideas as an environmentalist in meeting the economic needs of the community as well as the preservation of peatlands
		Relevance of the concept	Synthesize the concept of sustainable peatland management relevant to climate change mitigation efforts
		Build connectivity / Concept interconnectedness	Synthesize the relevant relationship between community participation and peatland restoration success
	Recognizing and Solving Problems	Identify the elements of the problem	Identify the root causes of peatland fires and the first steps to solve them
		Implementing the concept	Implementing peatland management solutions to avoid damage based on the concept of sustainable management
		Summarizing the problem	Formulate key problems that must be solved to prevent peatland degradation and reduce the risk of fires (forest and land fires)
		Provide problem-solving feedback	Responding to government policies in addressing peatland degradation
	Summing up	Trying to understand	Concluding the long-term consequences of peatland fires if not managed properly
		Deductive reasoning	Conclude by deduction the fire risk of an area if it is rewetting
		Inductive reasoning	Inductively deduce the phenomena presented on the stimulus
		Providing ideas	Providing ideas to reduce land clearing by burning, while maintaining the economic sustainability of local communities
	Evaluating and Assessing	Expressing opinions	Giving opinions about farmers who still use the burning method to clear peatlands
		Defending an opinion	Maintaining the view that local community empowerment is more

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			important than law enforcement in preventing peatland fires
		Assess with specific criteria	Assessing the long-term impact of peatland conversion for oil palm plantations on the environment and economy
		Work on evaluation questions	Evaluate the effectiveness of moratorium policies and peatland restoration programs in preventing forest fires and ecosystem restoration

The technique used to collect literacy data is through a questionnaire, using a likert scale from 1-4. The score obtained was then adjusted to the criteria in table 2. Adaptation (Scott, 2021) follows.

Table 2. Criteria for Achieving Critical Thinking Skills

Value	Remarks
86-100	Excellent
71-85	Good
56-70	Enough
41-55	Less

The data from the pretest-posttest results were then analyzed using N-gain analysis to measure the increase in students' critical thinking scores using the N-Gain formula and then categorized based on Table 3 below.

$$N - Gain\ Formula = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} x\ 100\%$$

Table 3. N-Gain Score Categorization

Range	Categories
0,70-1,00	Height
0,31-0,69	Medium
0-0,30	Low

Results and Discussion

1) Critical Thinking Analysis based on Observation

Critical thinking is a person's ability to find information and solve a problem from a problem by asking themselves to dig up information about the problem they are facing (Christina & Kristin, 2016). The results of observation through the study of case studies of peatland fire problems (karhutlag), showed that the critical thinking skills of students in class A were better than class B with an average score difference of 16.14. Comparison data on the average results of observations is presented in Table 3 below.

Table 3. Average Score of Critical Thinking Skills Observation Class A and B

Categories	Lack of Critical Thinking	Enough Critical Thinking	Good Critical Thinking	Excellent Critical Thinking	Average±SD
Class A	41-55	56-70	71-85	86-100	90.67±8.93
Frequency (N=60)	1	0	11	48	**Excellent Critical Thinking**
Class B	41-55	56-70	71-85	86-100	74.53±14.39
Frequency (N=45)	3	14	18	10	**Good Critical Thinking**

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Students' critical thinking skills include five indicators that are generally met very well. The profile of critical thinking skills of students A and B in each indicator and category is described in the following diagram.

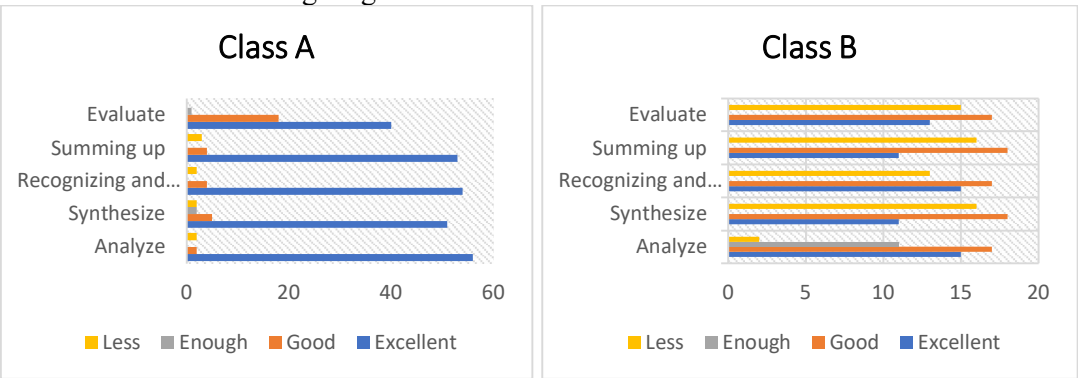

Figure 2. Comparison of Students' Critical Thinking Profiles based on observations

The results of the diagram show that in class A, students' critical thinking skills in each indicator are dominated by the very good category. Meanwhile, in class B, the distribution of categories is very good, good, and sufficient in each indicator varies. This shows that the implementation of case study learning in class B has not been optimal. Case studies if accompanied by effective discussions, critical questions and answers will improve students' critical thinking skills (Muh, 2017). The involvement of multiple viewpoints in class discussions improves critical thinking skills (Tommasi et al., 2023). In fact, in class B, there are still many presentation groups that discuss case studies who do not understand the material and just read the text. The questions given by classmates have also not been analyzed so that the results of critical thinking are still low (Ngidi & Dlamini, 2017).

2) Critical Thinking Analysis based on PreTest-Postest

The assessment of students' critical thinking in class A through pretests shows an increase in students' critical thinking skills. The presentation of the results data can be seen in Table 4 below.

Table 4. Pretest-posttest data and N-Gain grade A values

Indicator	Pretest A	Posttest A	N-Gain	Categories
Analyze	75.63	92.05	0.67	Medium
Synthesize	74.53	95.12	0.81	Height
Recognizing and Troubleshooting	71.37	87.01	0.55	Medium
Summing up	71.37	86.60	0.51	Medium
Evaluate	74.66	82.10	0,29	Low
Average	**73.51**	**88.47**	**0,56**	**Medium**

The data above shows that the indicator of critical thinking that has increased is the ability to synthesize. Through the case given, students are able to relate various biological concepts and scientific perspectives to respond to peatland forest fires (karhutlag). The ability to evaluate has also increased due to the stages of data interpretation and action in the QASE model. Where students at this stage relate various references in data analysis, then evaluate the case of forest and land fires.

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In contrast to class A, the data in class B shows that the indicators that have increased are categorized as high, namely the synthesizing indicator. The data on class B critical thinking skills is presented in Table 5 below.

Table 5. Pretest-posttest data and N-Gain grade B values

Indicator	Pretest A	Posttest A	N-Gain	Categories
Analyze	73.82	87.38	0.52	Medium
Menthesis	75.47	95.16	0.80	Height
Recognizing and Troubleshooting	59.93	85.70	0,64	Medium
Summing up	50.52	81.96	0,64	Medium
Evaluate	70.14	81.54	0,38	Medium
Average	**65.98**	**86.09**	**0,59**	**Medium**

Overall, the average critical thinking ability of students based on pre-test scores is classified as sufficient. Class A has a slightly higher value than class B. The most prominent indicator in both classes is the synthesizing indicator. The lowest indicator in class A and class B is evaluating. Students should position themselves in the problems contained in the case, so that the deepening of understanding has not yet been formed (Heard et al., 2020). The solutions provided to the problem should also be assessed from various points of view ranging from policy perspectives, political, economic, social, and environmental perspectives so as to open up broader insights (Liao & Yuan, 2024). The expected result is the emergence of various alternative solutions that are indeed sustainable, extensive, and in-depth so that their implementation is effective.

The results of the posttest showed an increase in students' critical thinking skills. This increase occurred because of the QASE-based case learning process which stimulated students to understand peatland material as a whole, starting from the definition, characteristics, distribution, and peatland ecosystem. The case presentation given made students improve their ability to analyze and synthesize, to solve problems (Dipuja & Wahyuni, 2025).

The question stage plays a role in building curiosity and the ability to identify problems through the preparation of questions relevant to peatland fire cases. Students formulate the question Why does peatland occur? What are the handling efforts that have been made so far? Various significant questions will arise that encourage students to collect literature studies from journals, discuss in groups. The results of the discussion included prevention, handling and mitigation of peatland fires in Riau Province. The results of this analysis were then concluded and evaluated for the effectiveness of its application. This learning step improves students' thinking skills to the HOTS level.

The Answer stage allows students to develop reasoning through the analysis of relevant scientific evidence and references. This stage is also important because it can increase the active participation and level of students' understanding of the topic of the material being discussed (Scott, 2026). This activity also strengthens the ability to synthesize and solve problems in critical thinking indicators. The Sharing Stage allows students to collaborate with each other in groups, thereby producing new and better ideas for solving forest and land fire problems (Wahyuni & Anhar, 2020). Arguments from various perspectives result in innovative thinking. The Evaluation stage strengthens the ability to reflect and reason on the solutions provided for a case (Nadia Nur Khamilah Al-hafidz et al., 2024).

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The findings of this study are in line with the research (Koehler et al., 2020) which shows that case-based learning improves problem-solving skills through a case-based discussion process. These results also reinforce the findings of Tommasi et al. (2023) that collaborative learning and digital literacy contribute to increased critical thinking. In addition, the study expands the results of (Yustina, Mahadi, et al., 2022) by showing that the integration of case-based learning and evaluative stages in QASE can have a positive impact on the learning context of disaster mitigation and peat ecology which has been limited to previous research.

C. Hypothesis Test

To determine the effectiveness of the application of the QASE model, testing was carried out using the paired sample t-test presented in Table 6 below.

Table 6. The Result of The Paired Sample T-Test

Classes	Mean Difference	t	Sig. (2-tailed)	Decision
A	14.96	8.667	<0.001	H_0 rejected
B	20.11	9.297	<0.001	H_0 rejected

Based on Table 6, the significance value in both classes was obtained of $p < 0.001$ (<0.05) so that the null hypothesis was rejected. This shows that there is a significant difference between students' critical thinking skills before and after the application of the QASE model. A high t-value indicates that the increase that occurred was not due to a coincidental factor, but was the result of the learning intervention given.

Conclusion

The results of the study show that the implementation of QASE-based case study learning is effective in improving students' critical thinking skills on forest and peatland fire materials. The average critical thinking ability score increased from 65.87 to 87.60 in class A and from 64.94 to 86.98 in class B with moderate improvement category (N-Gain = 0.57). The indicators of critical thinking that have experienced a significant increase are the ability to synthesize in classes A and B. The results of the T test showed a $p<0.05$ value which means that QASE-based case study learning is effective in improving critical thinking skills in environmental learning. These findings indicate that the QASE model can be used as an alternative to case-based learning strategies to improve students' HOTS abilities. Students are expected to be able to produce critical solutions in resolving forest and land fire cases.

Recommendation

For teachers, case study-based QASE learning can be applied in environmental learning to improve students' critical thinking skills. For learning model developers, innovative teaching materials are needed that support the QASE stage in a measurable manner. For subsequent researchers, it is recommended to use a quasi-experimental design with a control group.

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