Building Critical Thinking Skills of 21st Century Students through Problem Based Learning Model

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A B S T R A K

Penelitian ini di latar belakangi untuk mengatasi keterbatasan kemampuan berpikir kritis siswa kelas V mengenai materi IPA sistem pernafasan manusia. Penelitian ini bertujuan untuk menganalisis pengaruh model PBL terhadap pengembangan keterampilan berpikir kritis siswa abad 21. Penelitian ini menggunakan desain Quasi Eksperimental yang dikenal dengan Non-Equivalent Control Group Design, dengan populasi penelitian sebanyak 106 siswa. Sampelnya terdiri dari 36 siswa kelas VA (kelompok kontrol) dan 33 siswa kelas VB (kelompok eksperimen). Pengumpulan data dilakukan dengan menggunakan metode tes yang terdiri dari lima soal pilihan ganda dan 15 soal deskriptif. Analisis data meliputi penilaian normalitas, homogenitas, dan uji hipotesis. Perhitungan T-Test hasil post-test menunjukkan adanya temuan yang signifikan dengan nilai Sig. nilai 0,000 < 0,05. Signifikansi tersebut menunjukkan bahwa model Problem Based Learning memberikan dampak positif dalam menumbuhkan kemampuan berpikir kritis pada siswa abad 21. Penerapan model PBL dalam pendidikan sains khususnya dalam konteks sistem pernafasan manusia termasuk dalam kategori efektif.

A B S T R A C T

The research was conducted to address the limited critical thinking abilities of fifth-grade students regarding the human respiratory system. This study aims to analyze the influence of the PBL model on the development of critical thinking skills in 21st-century students. This study employed a Quasi Experimental design known as the Non-Equivalent Control Group Design, with a research population of 106 students. The sample consisted of 36 students in class VA (control group) and 33 students in class VB (experimental group). Data collection was performed using a test method comprising five multiple-choice questions and 15 descriptive questions. Data analysis involved assessing normality, homogeneity, and hypothesis tests. The T-Test calculation of the post-test results revealed a significant finding with a Sig. value of 0.000 < 0.05. This significance indicates that the Problem Based Learning model has a positive impact on fostering critical thinking skills in 21st-century students. Implementing the PBL model in science education, particularly in the context of the human respiratory system, falls within the effective category.

1. INTRODUCTION

The rapid advancements in science and technology have brought about significant changes and challenges in the 21st century, creating a highly competitive environment. In order to thrive in this fast-paced development, students need to possess competent abilities. Among these abilities, critical thinking is considered a crucial skill that students must acquire in the 21st century (Rahmatika et al., 2021; Shaw et al., 2020). Critical thinking is a cognitive process that involves analyzing and evaluating information, arguments, and evidence in a logical and systematic manner. It enables individuals to question assumptions, recognize biases, and consider alternative perspectives. In today's complex and interconnected world, critical thinking skills are essential for making informed decisions, solving problems, and effectively navigating through a vast amount of information (Kavenuke et al., 2020; Kembara et al., 2019; Shaw et al., 2020). Developing critical thinking skills enables students to logically and rationally analyze and evaluate problems, empowering them to devise innovative solutions. By learning to think critically, students are encouraged to explore multiple viewpoints, examine evidence, and draw well-reasoned conclusions

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(Kavenuke et al., 2020; Kembara et al., 2019; Shaw et al., 2020). These skills are particularly valuable in addressing complex and ambiguous situations, allowing students to approach challenges with creativity, adaptability, and resilience. Moreover, students with a critical thinking mindset instinctively question and analyze the data and information they receive, recognizing that not all information can be blindly trusted (Cheong & Cheung, 2008; Ismail et al., 2018).

Critical thinking fosters reasoning and reflectivity in students' thought processes, allowing them to assess the reliability of information and data, thus empowering them to actively and effectively build their own knowledge (Kumar & Refaei, 2017; Suhirman et al., 2020). By nurturing critical thinking skills, students are better equipped to navigate the complexities of the modern world and meet the demands of an ever-changing society. In the field of education, there is a growing emphasis on incorporating critical thinking into the curriculum. Educators are employing various instructional strategies and approaches, such as problem-based learning, inquiry-based learning, and collaborative learning, to foster critical thinking skills among students (Kavenuke et al., 2020; Kembara et al., 2019; Shaw et al., 2020). These pedagogical methods encourage active engagement, independent thinking, and the application of knowledge in real-world contexts, providing students with opportunities to develop and practice their critical thinking abilities. In conclusion, critical thinking skills are essential for students to thrive in the rapidly evolving landscape of the 21st century. The ability to analyze information, think independently, and make well-reasoned decisions is crucial in various academic and professional domains. By cultivating critical thinking skills, students can become lifelong learners, adaptable problem solvers, and informed citizens who contribute meaningfully to society.

Critical thinking is widely recognized as a valuable skill that enables individuals to make rational decisions and effectively solve problems by selecting trustworthy information. It involves the application of intelligence to analyze, evaluate, and assess problems, fostering a habit of logical thinking (Firdaus et al., 2019; Yumiati & Kusumah, 2019). Developing critical thinking abilities helps students cultivate the right mindset for generating effective solutions to the challenges they encounter. In the 21st century, critical thinking has become an essential competency for students to thrive in a highly competitive world across various domains. Consequently, education systems strive to provide opportunities for students to develop their critical thinking skills, as it is a fundamental goal of education to foster a critical mindset among students. Research indicates that a significant majority (99%) of educational institutions support the cultivation of critical thinking (Apriliana et al., 2019; Huber & Kuncel, 2016). However, the reality of critical thinking skill acquisition among students in Indonesia paints a different picture. The results of the Programme for International Student Assessment (PISA) data from 2018 reveal that Indonesia ranked 71 out of 77 OECD (Organization for Economic Cooperation and Development) countries (Andriyani et al., 2021). These low scores from the international study indicate that students in Indonesia possess minimal mastery of critical thinking skills, as evidenced by the science literacy score of only 396.

The field of science learning in elementary schools frequently grapples with the challenge of low levels of critical thinking skills among students. Research conducted in 2019 emphasizes that students still possess minimal mastery of critical thinking skills (Purnaningsih et al., 2019). Similarly, a study conducted in 2021 at SD Kasinus Sengkan reveals that students' ability to think critically remains in the low category (Mareti & Hadiyanti, 2021). These issues arise due to the relatively difficult nature of the material presented on the human respiratory system, leading students to adopt a passive stance during learning activities. Consequently, students feel hesitant to ask questions even when provided with opportunities to develop their thinking skills (Mariskhantari et al., 2022). Furthermore, students struggle to provide explanations for their answers when asked to demonstrate their critical thinking abilities. This assumption is reinforced by the opinion conveyed by a research in 2022, suggesting that students still rely on learning books as their sole reference, limiting their thinking to the content within those books (Risnawati et al., 2022). As a result, students lack a comprehensive understanding of the reasoning behind their answers to questions or problems presented by their teachers.

These challenges also manifest in Class V at SDN Dukuh Menanggal I/424 Surabaya, where students continue to exhibit low levels of critical thinking skills. This is evident through their inability to express their opinions, even when given opportunities during learning activities, and their examination results related to the human respiratory system material falling below the minimum passing grade (KKM). These issues necessitate appropriate intervention, such as the application of strategic and innovative learning models that foster the development of critical thinking skills within the school's curriculum. One such model believed to enhance students' ability to think critically is the Problem-Based Learning (PBL) model. PBL is considered an innovative approach that can improve students' critical thinking when confronted with problems (Mardi et al., 2021; Sulistyaningrum et al., 2019). The selection of the PBL model to enhance students' critical thinking ability is supported by various studies. For instance, a research conducted discovered that implementing PBL had a positive impact on students' critical thinking ability (Happy &

Widjajanti, 2016). Similarly, research conducted demonstrated that the application of PBL led to a significant improvement in students' critical thinking skills (Noprianda et al., 2019).

The Problem Based Learning (PBL) model is an active learning approach that engages students in practicing various domains of Bloom's taxonomy, including analysis, evaluation, and synthesis of knowledge. By applying this model, students are stimulated to think critically, reflectively, and creatively when seeking solutions to given problems. The use of the PBL model has shown positive effects in enhancing students' critical thinking abilities. A study done in 2020 suggest that when implemented effectively, the stages of the PBL model can foster students' critical thinking skills (Rahmat et al., 2020). This is achieved by presenting real-life problems that encourage students to analyze issues, generate solutions, and consider the best possible decision (Azer et al., 2013; Khusaini et al., 2018). Consequently, the PBL model serves as an intriguing solution to help students develop their critical thinking skills and actively participate in the learning process. Considering these factors, the PBL model is a strategic approach suitable for educational settings. Therefore, this research aims to analyze the influence of the PBL model on the development of critical thinking skills in 21st-century students. Additionally, the study will explore how the PBL model enhances students' thinking skills and examine the specific indicators of critical thinking that demonstrate improvement through the application of PBL in learning activities.

2. METHOD

This research employs a Quasi Experimental design with a Non Equivalent Control Group Design, where the assignment of the control and experimental classes is not randomized. The study will administer a pre-test at the beginning and a post-test at the end for both groups. The experimental class will be subjected to the Problem Based Learning (PBL) learning model, while the control class will not receive any treatment. Table 1 presents the research design that will be utilized in this study.

Table 1. Research Plan

Class	Pre-Test	Intervention	Post-Test
X1	O1	-	O3
X2	O2	R1	O4

The study population consisted of 106 fifth-grade students from SDN Dukuh Menanggal I/424 Surabaya. The research sample included 36 students from class VA (control group) and 33 students from class VB (experimental group). Purposive sampling was employed to select the research participants. This technique involved selecting samples based on specific criteria aligned with the research objectives.

The data collection method involved administering both a pre-test and a post-test consisting of multiple-choice questions and descriptive questions. The pre-test and post-test each consisted of 5 multiple-choice questions and 15 descriptive questions. These questions were formulated based on the content related to the human respiratory system and were developed using 11 critical thinking skill indicators from Ennis. The specific format of the critical thinking test questions used in this study can be found in Table 2.

Table 2. Indicator for the Critical Thinking Ability Test Questions

No.	Aspect	Indicator	Test Item
1	Elementary Clarification	Focusing the question	1
		Analyzing argumentation	2, 3
		Asking and answering clarifying and challenging question	4
2	Basic Support	Considering credibility (criteria of a source)	2*, 5
		Observing and considering the results of the observation	3*, 6
3	Inference	Making induction and considering the result	1*, 7
		Making deduction and considering the result	8
		Making and considering the value of the decision	4*
4	Advanced Clarification	Defining terms	9, 10
		Identifying assumptions	5*, 11
5	Strategies and Tactic	Deciding on an action	12, 13, 14, 15
	Total Number of Questions		**20**

The data analysis will be conducted using IBM SPSS Statistics 23, employing the following techniques: (1) Assessment of data normality using the Kolmogorov-Smirnov test; (2) Evaluation of data homogeneity using the Levene's test; and (3) Hypothesis testing using Independent Samples T-Test.

3. RESULT AND DISCUSSION

Result

The study results are crucial for researchers to address the previously formulated research questions and draw conclusions based on the analyzed data and findings. The statistical analysis of the critical thinking ability test results for fifth-grade students at SDN Dukuh Menanggal I/424 Surabaya, both before and after implementing the Problem Based Learning model, will be presented in Table 3.

Table 3. Results of Statistical Analysis of Critical Thinking Ability

Data		*Pre-Test*		*Post-Test*	
Group		**Control**	**Experiment**	**Control**	**Experiment**
N		36	33	36	33
Mean		46.5	39.58	65.5	85
Std. Dev		10.459	9.928	6.860	10.595
Min.		28	23	53	62
Max.		69	56	85	98
Normality Test (Kolmogorov-Smirnov)	**Sig.**	**0.200**	**0.200**	**0.200**	**0.082**
	Description	**Normal**	**Normal**	**Normal**	**Normal**
Homogeneity (Levene Statistic)	**Sig.**	**0.751**		**0.002**	
	Description	**Homogen**		**Not Homogen**	
Difference Test (Independent sample T-Test)	**Sig.**	**0.006**		**0.000**	
	Description	**Significant**		**Significant**	

Based on the calculation results presented in Table 3, the post-test values in both the control and experimental classes were analyzed using parametric statistics, specifically the T-Test. The obtained Sig value was 0.000, which is less than the significance level of 0.05, indicating statistically significant results. This significance suggests a difference in students' critical thinking ability between the control and experimental classes, leading to the rejection of Ho and acceptance of H1. Hence, it can be concluded that the Problem Based Learning (PBL) model effectively enhances 21st-century students' critical thinking skills, particularly in the context of human respiratory system material

Subsequently, an analysis was conducted on the test data of students' critical thinking skills to determine the extent of improvement in each indicator related to the human respiratory system material. The percentage increase in scores for each critical thinking skills indicator is presented in Table 4.

Table 4. Increase in Critical Thinking Ability Indicators

Aspect	Indicator	Percentage		Increase
		Pre-Test	**Post-Test**	
Elementary Clarification	Focusing the question	38%	84%	46%
	Analyzing argumentation	39%	87%	48%
	Asking and answering clarifying and challenging question	32%	92%	60%
Basic Support	Considering credibility (criteria of a source)	40%	93%	53%
	Observing and considering the results of the observation	44%	92%	48%
Inference	Making induction and considering the result	22%	85%	63%
	Making deduction and considering the result	45%	92%	47%
	Making and considering the value of the decision	88%	91%	3%
Advanced Clarification	Defining terms	23%	84%	61%
	Identifying assumptions	28%	80%	52%
Strategies and Tactic	Deciding on an action	21%	78%	57%

Referring to the previously presented Table 4, an analysis of the 11 indicators of critical thinking skills reveals that students have demonstrated mastery in all indicators. The results indicate an increase in student answer scores across the indicators. Among the indicators, the highest percentage increase is observed in the indicator of making inductions and considering the results of induction, with a percentage of 63%. Conversely, the indicator with the lowest percentage increase is making and considering the value of decisions, which shows a percentage increase of 3%.

Discussion

Based on the research results obtained through the T-Test statistical test, it is evident that the Problem-Based Learning (PBL) model effectively enhances 21st-century students' critical thinking skills in the context of the human respiratory system. By implementing PBL in the experimental class, students are guided to engage in discussions concerning respiratory system challenges in the Covid-19 era, thereby fostering critical thinking to address these issues. Collaborative group work enables students to analyze and generate creative solutions, facilitating the development of decision-making skills and enhancing their critical thinking abilities. In the PBL model, students are provided ample opportunities to think critically by posing open-ended questions, synthesizing data, and engaging in evaluation processes (Almulla, 2018; Rahmat et al., 2020). The success of this research can be attributed to the creation of a supportive learning environment tailored to the students' needs, which effectively facilitates the development of critical thinking skills (Dwi et al., 2020; Gregory & Lodge, 2015). These findings align with previous research indicating that the Problem-Based Learning model effectively enhances students' critical thinking skills (Kamil et al., 2019; Munandar et al., 2018). Additionally, a study conducted in 2021 supports these findings, demonstrating that the application of the Problem-Based Learning model in the experimental class significantly enhances students' critical thinking skills compared to the control class, which utilizes conventional teaching methods (Rahmatika et al., 2021). The integration of the Problem-Based Learning model into the instruction of the human respiratory system material proves to be an efficient approach. This assertion is further reinforced by the analysis of each critical thinking indicator, as discussed in the preceding subsection, which reveals a substantial increase in students' scores from the pre-test to the post-test, indicating the efficacy of Problem-Based Learning in fostering critical thinking abilities.

This finding aligns with previous research conducted in 2014, which demonstrated the positive influence of the Problem Based Learning model on students' critical thinking skills (Happy & Widjajanti, 2016). Similar results were also found in the study done in 2017, indicating that PBL-based learning fosters students' critical thinking abilities (Phungsuk et al., 2017). Additionally, a study conducted in 2018 yielded comparable results, highlighting the positive impact of the Problem Based Learning model on students' critical thinking skills (Munandar et al., 2018). The implementation of the 5 syntaxes of the Problem Based Learning model places demands on students to independently seek answers, utilize their thinking skills to develop an understanding of the given concepts, and ultimately engage in maximum critical thinking. This perspective aligns with the views of a study cinducted in 2021, which emphasize that the Problem Based Learning model encourages active collaboration among students to acquire knowledge independently and continuously exchange ideas within their groups, fostering creative problem-solving abilities (Darwati & Purana, 2021). This notion is further supported by by a study in 2022, which assert that Problem Based Learning requires students to effectively communicate, collaborate, and utilize technology to construct new knowledge independently (Hayama & Desai, 2022).

In the first indicator, which focuses on questions, there was a significant increase of 46%. This achievement can be attributed to the implementation of the Problem-Based Learning (PBL) model in the learning activities. PBL provides students with authentic experiences that support their ability to focus and analyze given phenomena. By engaging in Problem-Based Learning, students are stimulated to think critically and connect their existing knowledge with real-world problems. The problem itself, acting as a content and knowledge regulator in PBL, encourages students to reason and formulate focused questions. This process of questioning not only helps students explore the topic in-depth but also enhances their ability to identify key issues and develop effective problem-solving strategies. By continuously practicing and refining their questioning skills, students become adept at framing relevant inquiries that drive their critical thinking process (Hung, 2006; Pawar et al., 2020).

The second indicator, analyzing arguments, also demonstrated a notable increase of 48%. This success can be attributed to the problem-solving discourse embedded within the PBL approach. By engaging in PBL, students are encouraged to analyze problems from different perspectives and evaluate the strengths and weaknesses of various arguments. Through this analytical process, students develop their ability to critically assess information, identify logical fallacies, and construct well-supported arguments. PBL provides ample opportunities for students to engage in debates, discussions, and group collaborations, allowing them to refine their analytical skills and cultivate a deeper understanding of complex issues.

Additionally, the emphasis on analyzing arguments within the PBL model nurtures students' ability to think critically about the validity and reliability of the information they encounter, promoting a more nuanced and thoughtful approach to problem-solving (Harisantoso et al., 2020; Yulianti, E., & Gunawan, 2019).

The third indicator, asking and answering questions, displayed a remarkable increase of 60%. This achievement can be attributed to the application of the Problem-Based Learning model in the learning process. Through PBL, students actively engage in problem-solving activities, allowing them to develop their problem-solving abilities. In PBL, students apply a constructionist approach, which involves finding the right knowledge and solutions through asking and answering questions. The continuous cycle of formulating questions, seeking answers, and reflecting on the obtained information fosters a sense of curiosity, inquiry, and critical thinking. Learning with the Problem-Based Learning model encourages students to become more active participants in their education, as they take ownership of their learning by driving the questioning process. By asking and answering challenging questions, students develop a deeper understanding of the subject matter and refine their critical thinking skills. PBL also promotes collaboration and communication among students, as they engage in meaningful dialogue to explore different perspectives and arrive at well-informed solutions. This student-centered approach not only enhances their critical thinking but also nurtures their ability to effectively express and defend their ideas (Bijsmans & Schakel, 2018; Phungsuk et al., 2017).

The fourth indicator, which focuses on considering credibility, shows a significant increase of 53%. This achievement is attributed to the implementation of the Problem-Based Learning (PBL) model in the student learning process. In PBL, students are required to enhance their critical thinking skills by critically evaluating various sources. Critical thinking involves carefully considering the credibility of sources to ensure the relevance and reliability of information used in problem-solving. The PBL model provides students with opportunities to work with ill-structured problems and encourages them to utilize a range of knowledge sources, whether acquired prior to the learning experience or during it. This approach prompts students to continually assess the credibility of the sources they utilize, thereby promoting a more discerning and analytical mindset (Igwe et al., 2021; Saepuloh et al., 2021).

The fifth indicator, focusing on observing and considering the results of observations, demonstrates a notable increase of 48%. This achievement can be attributed to the substantial emphasis placed on independent observation and investigation within the Problem-Based Learning model. Through PBL, students are actively involved in the process of making their own observations and conducting investigations to acquire comprehensive knowledge. By engaging in firsthand exploration, students are empowered to develop their critical thinking skills based on the observations they gather. They are encouraged to carefully consider the significance and implications of their observations, using them as building blocks for problem-solving. The Problem-Based Learning model provides students with the necessary scaffolding and support to foster their ability to think critically based on the information obtained through their observations (Eismawati et al., 2019; McNamara et al., 2020).

The sixth indicator, which pertains to making induction and considering the results of induction, exhibits the highest percentage increase among the other ten indicators, with an impressive 63%. This outstanding achievement can be attributed to the successful implementation of the stages involved in developing and presenting work within the Problem-Based Learning model. The activities undertaken during this stage significantly influence students in drawing generalizations from the observations they have made. The Problem-Based Learning model places a strong emphasis on constructing knowledge based on real-world situations, and the culmination of this construction process lies in students' ability to make inductions and carefully consider the results of their inferences. Through regular practice of asking open-ended questions, students develop their skills in making inductions and drawing conclusions from the information they receive. This process of induction and evaluation fosters their critical thinking abilities and contributes to their overall growth as thoughtful and analytical learners (Almulla, 2018; Ye & Xu, 2023).

The seventh indicator, which focuses on making deductions and considering the results of deductions, exhibits a remarkable increase of 47%. This achievement can be attributed to the profound impact of critical thinking on students, as it empowers them to engage in deductive reasoning based on the information they acquire. To reinforce this ability, Problem Based Learning (PBL) plays a crucial role in guiding students to remain aligned with their learning objectives. PBL achieves this through various stages, such as the development and presentation of work (Hung, 2006; Munawaroh, 2020). By employing PBL, students are granted opportunities to investigate and draw deductions from the data and facts they encounter, thereby fostering the growth of their critical thinking skills.

Moving on to the eighth indicator, which focuses on making and evaluating the value of decisions, it demonstrates the lowest percentage increase of only 3%. The relatively low achievement in this area can be attributed to students' already strong grasp of the material pertaining to the function of human respiratory organs prior to their exposure to the Problem Based Learning model. This assertion is

supported by the high pre-test results, which garnered a remarkable percentage of 91%. Consequently, the minimal increase from pre-test to post-test in this indicator is unsurprising. Nevertheless, the implementation of the Problem Based Learning model equips students with the ability to make informed decisions when confronted with various challenges. This approach stimulates students to employ both previously acquired knowledge and newly acquired information to determine the value of their decisions in problem-solving scenarios. The Problem Based Learning model serves as a catalyst for students to discover the most effective methods for achieving their goals, thus offering them a platform to develop their critical thinking abilities (Lin, 2018; Vekli & Cimer, 2012). Moreover, the capability to make and evaluate decisions is vital for students, as it equips them with the skills necessary to contribute meaningfully to society. Consequently, Problem Based Learning emerges as a significant conduit for students to enhance their critical thinking skills, enabling them to become well-rounded individuals capable of making informed decisions and positively impacting their communities. This model empowers students to think critically, evaluate options, and make decisions that align with their values and goals (Carlgren, 2013; Sumarno, 2019).

The ninth indicator, which focuses on defining terms, exhibits a remarkable increase of 61% following the indicator of making inductions. This achievement can be attributed to the integration of Problem Based Learning (PBL) in the learning process, particularly during the stage of developing and presenting work. During this stage, students are given the opportunity to provide comprehensive explanations and elucidate their observations. By applying the Problem Based Learning model, students engage in learning through real-world problems or cases, which enables them to define terms and concepts relevant to the case or phenomenon under study. This opportunity arises as students consolidate their prior knowledge and employ it to reinforce their understanding, thereby enabling them to offer detailed explanations pertaining to specific terms (Amin et al., 2020; Faradillah & Humaira, 2021).

Moving on to the tenth indicator, which involves identifying assumptions, a significant increase of 52% is observed. This achievement can be attributed to the effectiveness of the analysis and evaluation stages within the Problem Based Learning model. As highlighted by a study in 2006, Problem Based Learning serves as a gateway for students to harness their reasoning abilities and grasp concepts associated with the process of identifying assumptions within a given context (Hung, 2006; Papadakis et al., 2020). The success of this model plays a pivotal role in assisting students in identifying various assumptions that arise in relation to data and facts while solving existing problems.

Shifting focus to the eleventh indicator, which centers around deciding on an action, a substantial increase of 57% is evident. This accomplishment can be attributed to the efficacy of the stages employed in the Problem Based Learning model, particularly during the evaluation of problem-solving. The evaluation process facilitates critical thinking among students and encourages them to consider multiple action options. Individuals with well-developed critical thinking skills tend to generate a range of potential solutions rather than relying solely on a single option. This aligns with the findings proposed by a study in 2020. It suggests that the Problem Based Learning model provides students with the space and resources necessary to decide on the most appropriate action when addressing a problem (Lailaturrahmah et al., 2020). By utilizing diverse sources of knowledge, data, and facts acquired in the field, students can make informed decisions and enhance their problem-solving abilities.

The Problem Based Learning (PBL) model has a profound positive impact on students' critical thinking abilities, particularly in the 21st century where global competitiveness is essential. Each step of the PBL syntax plays a crucial role in shaping students' analytical and evaluative capacities. By following the prescribed activities, students are consistently trained to analyze and scrutinize information before accepting it. Critical thinkers question and critique assumptions, striving to establish the validity and reliability of acquired knowledge. PBL creates an environment that nurtures these skills by engaging students in real-world problems. This approach prompts students to reflect on their own assumptions, explore diverse perspectives, and engage in rigorous inquiry. By challenging preconceived notions, students enhance their critical thinking abilities. These skills are invaluable in the 21st century, equipping students with the necessary tools to thrive in a complex and competitive global landscape. Problem Based Learning not only facilitates subject-specific knowledge acquisition but also cultivates the critical thinking prowess necessary for lifelong learning and success in today's world.

4. CONCLUSION

The findings of the study demonstrate a significant increase in the application of the Problem-Based Learning (PBL) model for teaching the human respiratory system, leading to the development of critical thinking skills in 21st-century students. Based on the results, it can be concluded that implementing the PBL model in science education, particularly in the context of the human respiratory system, falls within the

effective category. This conclusion is supported by the notable improvement in post-test scores following the implementation of the PBL model as a teaching approach. Furthermore, students' critical thinking abilities exhibited a remarkable progression from lower to higher levels. Through the utilization of the Problem-Based Learning model, students are empowered to enhance their problem-solving skills. The PBL approach focuses on five key areas that significantly contribute to improving students' critical thinking abilities. These areas include introducing the concept of Problem-Based Learning and cultivating an engaging learning environment, presenting problem scenarios and tasks that encourage active student participation, fostering critical and independent analysis of gathered information, facilitating the development of innovative solutions to the presented problems, and encouraging students to abstract the knowledge acquired from their experiences. Considering these five essential areas, it is evident that the Problem-Based Learning model is an effective choice for enhancing students' critical thinking skills in educational settings. Furthermore, the PBL approach fosters an environment where students are encouraged to openly explore and discover innovative solutions to the challenges they encounter

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