Jurnal Biolokus: Jurnal Penelitian Pendidikan Biologi dan Biologi
Vol. 8, Issue 1, June 2025
Pages : 17 – 31

p-ISSN: 2621-3702
e-ISSN: 2621-7538

The effect of guided inquiry with differentiated learning to enhance students' critical thinking skills

Widia Ningsih[1*], Dwi Yanti Cornelia Sipayung[1], Halim Simatupang[1]
[1]Department of Science Education, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Jl. Willem Iskandar Ps. V Medan Estate, North Sumatra, 20221, Indonesia
*corresponding author: widianingsih89@unimed.ac.id

ABSTRACT

This study was designed to determine the effect of guided inquiry model integrated with differentiated learning on students' critical thinking skills on respiratory system material in class VII junior high school. The background of this research is based on the low critical thinking skills of students in Indonesia, as well as the need for a learning approach that is able to respond to the diversity of learning styles, interests, and readiness of students in the classroom. The guided inquiry with differentiated learning model, employs a method of instruction that encourages students to solve problems through the application of analytical and critical thinking skills. The present study employs a quasi-experimental design, specifically pretest-postest control group design. The present study utilizes a critical thinking ability test instrument according to Ennis, comprising 10 essay questions. Hypothesis testing was carried out with a significance level of 0.05 with the help of SPSS version 26. The research results demonstrated a significant influence of the guided inquiry learning mode with differentiated learning on students' critical thinking abilities, as measured by the Mann-Whitney U test with Asymp scores. Sig (2-tailed) 0.000, indicating a significance value <0.05. In conclusion, guided inquiry with differentiated learning is effective to enhance students' critical thinking skills and can be an alternative adaptive and responsive science learning strategy in the Merdeka Curriculum.

Keywords: Critical thinking skill, differentiated learning, guided inquiry, learning model

INTRODUCTION

Education in the 21st century requires a paradigm shift in the teaching and learning process (Chetry, 2024; Khoiri et al., 2021). Students are no longer expected to merely master factual knowledge, but are also required to develop higher-order thinking skills, particularly critical thinking (Collins, 2014). It allows students to assess information, evaluate arguments, reach logical conclusions, and make rational decisions (Stanovich, 2016). These skills are not only essential in academic settings but are also highly relevant in real-life situations, where we frequently encounter complicated issues that demand careful and analytical solutions (Nickerson, 2010). The basis of this ability is knowledge renewal, which facilitates the acquisition of skills that allow for analysis and identification of cause and effect. Additionally, it enables the formation of ideas and the evaluation of information during the learning process (Fu, 2013).

However, the reality is that students' critical thinking skills in Indonesia are still relatively low (Arda et al., 2020; Siahaan et al., 2023). Based on various studies and educational evaluations, many students struggle to understand information deeply, make critical assessments, and apply knowledge in new contexts. This indicates that the teaching strategies used in schools have not fully succeeded in optimally developing students' critical thinking skills (Dam & Volman, 2004).

More specific research on critical thinking skills at the junior high school level shows similar results. Research by Widyapuraya et al. (2023) revealed that junior high school students scored low on several critical thinking indicators such as analyze (47,65%), conclude (53.12%), and explain (48.83%). This reflects the students'

difficulty in conducting in-depth analysis of learning materials and connecting the concepts they have learned to real-world situations.

In Indonesia, students' critical thinking skills remain relatively low, particularly at the junior high school level, as evidenced by the actuality on the ground (Billah et al., 2021; Kamsinah et al., 2020). Many students encounter challenges in comprehending information in its entirety, formulating logical conclusions, and applying scientific concepts to real-life contexts (King & Ritchie, 2012). Students typically memorize the names of organs and processes in science class, without understanding the relationship between structure and function, or the significance of the respiratory system in the context of human biology and health (Reiss & Tunnicliffe, 2001). This demonstrates that the educational approach still fails to adequately foster the development of students' critical thinking abilities.

One of the problems of students' low critical thinking skills is the use of teaching approaches that are still conventional and have not considered the needs and diversity of students in the classroom (Birgili, 2015). In a class, there are students with different levels of learning readiness, learning styles, and interests, but the learning process tends to be done uniformly (Ortega et al., 2018). As a result, many students are not optimally facilitated, both in terms of understanding concepts and developing their way of thinking.

Answering these challenges requires innovation in teaching strategies that can improve critical thinking skills while adapting to the individual needs of students (Abrami et al., 2015). One approach that can be used is guided inquiry learning, which is an approach that places students as active researchers who are engaged in the process of discovering knowledge through questioning, investigating, analyzing data, and drawing conclusions (Margunayasa et al., 2019; Rambe et al., 2020). Guided inquiry learning is particularly relevant at the junior high school level, as it provides sufficient structure and guidance for students to explore science concepts in greater depth (Kuhlthau et al., 2015).

Research by Falahudin et al. (2016) also confirmed that the guided inquiry learning model has a significant effect on students' critical thinking skills because this model encourages active student involvement in learning. This finding aligns with the research conducted by Faizin et al. (2024), which suggests that the implementation of the guided inquiry learning model leads to a substantial enhancement in students' critical thinking skills. The guided inquiry learning model emphasizes the formulation of predictions, the refinement of the ability to predict experimental outcomes, and the correlation of experimental results with the problems posed (Hasanah et al., 2020). Consequently, this model has a tangible impact on the improvement of students' critical thinking skills.

The efficacy of the inquiry learning model, on the other hand, cannot be separated from the diverse characteristics of the learners in the class (Andrini, 2016). Students have different levels of readiness, interests and learning styles. Therefore, the application of guided inquiry needs to be combined with differentiated learning, in order to accommodate the individual needs of students (Yuniarti & Subekti, 2024). According to Tomlinson and Moon, (2013), differentiated learning provides space for teachers to customize learning content, processes, and products based on student characteristics, so that all learners have fair opportunities to develop optimally.

In line with this, the Merdeka Curriculum Indonesia's recent education reform strongly promotes active, contextual, and student-centered learning (Hunaepi et al., 2024). This curriculum allows teachers flexibility in selecting and adjusting instructional strategies based on learners' needs (Fauzi, 2022). Within this framework, integrating differentiated instruction into the guided inquiry model is

highly relevant. Content differentiation enables the provision of learning materials at varying levels of complexity or in diverse formats. Process differentiation allows students to engage in different learning experiences, such as group discussions, hands-on experiments, or independent exploration, according to their learning preferences. Product differentiation gives students the option to demonstrate their understanding in various forms, including presentations, written reports, or creative projects (Tomlinson & Imbeau, 2010). These elements can be embedded into each phase of guided inquiry: stimulation, problem identification, data collection, analysis, and conclusion, so that learning becomes more inclusive, equitable, and effective in enhancing students' critical thinking skills.

While there have been many studies on guided inquiry learning and differentiated learning separately, there are still few studies that specifically examine the integration of both in the context of science learning at the junior high school level, especially on respiratory system material. By implementing a teaching approach that combines inquiry and differentiation, students are not only invited to explore the respiratory system material scientifically, but also given the space to learn according to their individual needs and potential. This approach is believed to create more meaningful learning, foster curiosity, and encourage students to think critically in understanding science concepts and their relevance to daily life .

The results of the preliminary observations conducted showed that around 60% of students had difficulty in understanding the concept of the respiratory system as a whole, especially in connecting organ functions with the respiratory process and its relation to health. Most students were only able to memorize the names of the respiratory organs without being able to explain the interrelationships between parts, analyze functional scenarios, or solve contextual problems that require logical and evaluative thinking. This condition shows that the respiratory system material, although biologically important, has not been fully utilized as a means to train students' critical thinking skills.

Respiratory system material has a high potential for developing critical thinking skills because it contains many elements that require analytical understanding, such as the relationship between structure and function, the diffusion process of oxygen and carbon dioxide, and the impact of living habits on the health of respiratory organs (Khasanah et al., 2017). Consequently, this material needs to be analyzed in depth, both in terms of content and learning approaches, to ensure that students not only master basic knowledge, but are also able to relate these concepts to everyday life and make the right decisions regarding their health (Dewi & Widodo, 2016). Based on the description above, this study aims to determine the effect of inquiry learning with a differentiated approach on improving students' critical thinking skills in understanding respiratory system material in class VII SMP. The findings of this study are expected to contribute to the development of learning strategies that are more effective, adaptive, and contextual, and become a practical reference for teachers in implementing the Merdeka Curriculum more optimally to support the achievement of students' critical thinking competencies in the 21st century.

METHOD

The research design is quasi-experimental, with a pretest-post-test control group design (Rogers & Révész, 2019). It was executed by presenting different treatments to two classes, as outlined in Table 1.

Table 1. Pretest-posttest control group design

Group	Pretest	Treatment	Post-test
Experimental Class	Y_1	X_1	Y_2
Control Class	Y_1	X_2	Y_2

Y_1 = Pretest score
Y_2 = Post-test score
X_1 = Guided inquiry with differentiated learning
X_2 = Direct instruction

The subjects of the study were students in class VIII at SMP Negeri 2 Pancur Batu, North Sumatera, Indonesia. The sample was determined using simple random sampling. This technique is a simple random sampling technique which is done by selecting sample members from the population randomly and without paying attention to existing strata (Etikan & Bala, 2017). To this end, class VIII-5 (n = 30) was designated as the experimental class, utilizing a guided inquiry learning model, while class VIII-6 (n = 30) was selected as the control class, receiving direct instruction. The steps and procedures for implementing guided inquiry with differentiated learning in experimental class are elaborated and explained in detail in Figure 1.

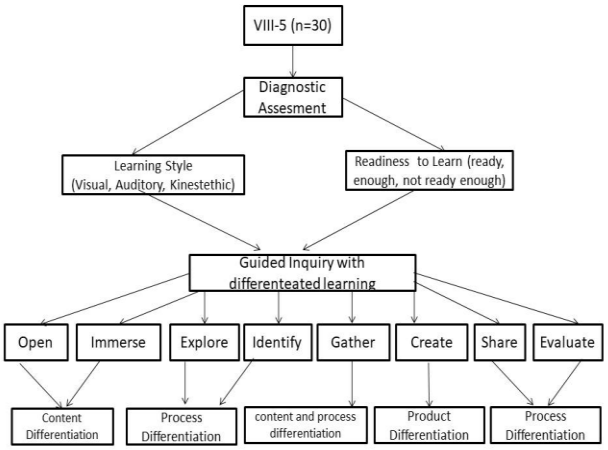

Figure 1. The steps for implementing guided inquiry with differentiated learning.

A diagnostic assessment was conducted to identify students' readiness levels and learning styles. The assessment employed two instruments: a basic science literacy test consisting of 10 multiple-choice and 3 short-answer questions to evaluate students' prior understanding of the respiratory system, and a learning style inventory to classify students as visual, auditory, or kinesthetic learners. The results were used to group students into three readiness categories— ready, enough, and not ready enough. These groupings informed the design and implementation of differentiated guided inquiry instruction, ensuring that learning activities were aligned with students' needs and preferences.

Data analysis techniques through prerequisite tests and hypothesis tests using the help of the IBM SPSS Statistics 26 program. Prerequisite tests use normality tests with the Shapiro-Wilk Test and homogeneity tests with Levene's test. While hypothesis testing uses nonparametric statistical methods using the Mann-Whitney U test.

The evaluation instrument employed is an essay question, administered to both sample classes at the commencement (pretest) and conclusion (post-test) of the learning process. This method was selected to ensure students' critical thinking skills prior to and following the implementation of the treatment. The essay questions administered in this study are designed to assess critical thinking indicators, as outlined by Ennis (1996), and have been developed by researchers with the assistance of expert validators. The critical thinking skills test grids employed in this study are presented in Table 2.

Table 2. Critical thinking instrument grid

Criteria	Indicator	Descriptions	Questions
Focus	Understand and focus on the question/problem	- Formulating the core of the question/problem - Disclosing facts needed to solve a problem - Using logical, relevant and accurate arguments	One of the functions of the nose is to warm and moisturize the air that enters through the nose. How does the nose warm and moisturize the air?
Reason	Provide reasons based on relevant facts/evidence relevant	- Presenting reasons that can support decision making - Making and determining the results of considerations /	Is active smoking as dangerous as inhaling cigarette smoke (passive smoking)? Give your reasons!

Criteria	Indicator	Descriptions	Questions
		arguments based on factual background - Providing reasons based on relevant facts / evidence	
Inference	Draws correct conclusions and selects appropriate reasons to support the conclusions.	- Draw conclusions with logical and reasonable reasoning - Organize the relationship between different parts of the problem systematically - Make and determine the results of considerations based on consequences	Read the text below! Smoking is a habit that has a serious impact on health. For active smokers, smoking cigarettes means directly introducing the toxic substances contained in cigarettes into their bodies. The impact of smoking is extensive and risks causing heart disease, stroke, cancer and other health problems. Cigarettes do not only affect active smokers, passive smokers or people who accidentally inhale cigarette smoke are also at are also at risk of health problems such as eye, nose and throat irritation, as well as increased risk of heart disease and cancer. as well as increasing the risk of developing heart disease and lung cancer in the long-term. Draw a conclusion based on the text above!
Situation	Uses information that is appropriate to the given problem	- Constructing provisional conjectures - Using complete information to solve problems - Connecting between information and arguments	Students of class VIII of SMP Negeri 2 Pancur Batu conducting a study tour near Mount Sibayak Berastagi. But when they started climbing, one of the students experienced shortness of breath because he could not stand the cold weather. Why and what should be done if this happens?
Clarity	Provide explanations about answers and conclusions made	- Gathering and checking relevant information - Providing explanations using clear and non-confusing sentences - Providing clarity on symbols or intentions that have been given so as not to raise other assumptions.	Explain the process of the respiratory mechanism from the nose to the lungs!
Overview	Rechecking overall answer	- Categorizing, understanding and clarifying information in the form of specific steps to find a solution. - Assessing claims and arguments - Reading, understanding and thoroughly checking back on what has been	To maintain a healthy respiratory system, Budi always exercises regularly. routine. However, after exercising Budi does not drink water so his body is lack of fluids. In your opinion, is Budi's action correct?

Criteria	Indicator	Descriptions	Questions
		found, learned, examined, considered and concluded from start to finish	

(Source: Ennis, 1996)

RESULTS AND DISCUSSION

Result

The initial ability value indicates that the mean critical thinking skills value in guided inquiry class with differentiated learning and direct instruction class is 28.80 ± 8.747 and 29.96 ± 6.037, respectively. This finding indicates that the observed differences between the two groups are not statistically significant, as evidenced by the Mann-Whitney test, which yielded a result greater than 0.05. The mean post-test value of critical thinking skills for students in the guided inquiry class was 77.03 ± 8.544, while it was 47.47 ± 10.204 for students in the direct instruction class. This finding indicates that the post-test results of the guided inquiry with differentiated learning class students are higher than those of the direct instruction class students. As illustrated in Figure 2.

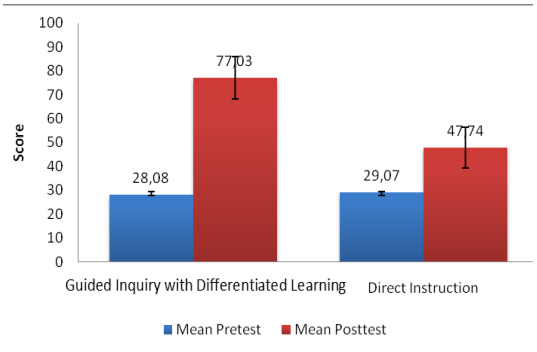

Figure 2. Mean score of students' critical thinking pretest-posttest.

Analysis of students' critical thinking skills per indicator was conducted to see how the guided inquiry with differentiated learning affected each aspect of critical thinking in the two sample classes. Based on the data analysis that has been done, it can be seen that each indicator of critical thinking ability in the two sample classes obtained different values.

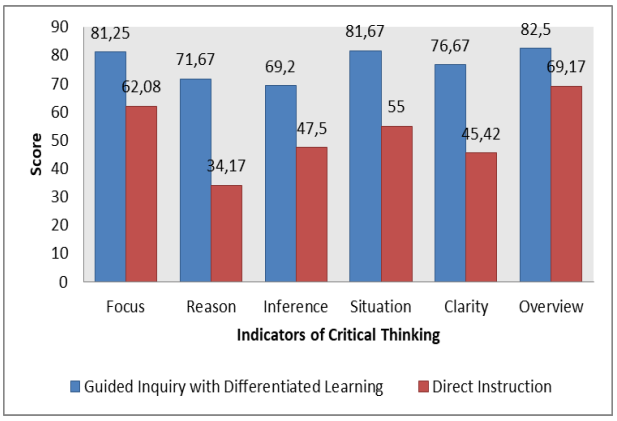

Figure 3. Analysis of critical thinking ability indicators.

The data obtained from the critical thinking skill test were analyzed using SPSS 26.0 for Windows. The analysis was preceded by a normality test using Shapiro-Wilk Test and a homogeneity test using Levene's test of equality of error variances. The summary of the normality and homogeneity can be seen in Table 3.

Table 3. Summary of normality and homogeneity tests

Group	N	Normality					Homogeneity		
		Pretest	Conclusion	Post-test	Conclusion	Sig	Pretest	Post-test	Sig
Guided Inquiry with Differentiated Learning	30	0.041	Not normal	0.252	Normal	0.05	0.013	0.577	0.05
Direct Instruction	30	0.232	Normal	0.000	Not normal				

The normality test demonstrated that the significance value of the pretest for the direct instruction class and the post-test for the guided inquiry class was both >0.05. This finding suggests that the data follows a normal distribution. However, a contrasting outcome was observed when the guided inquiry with differentiated learning class's pretest and direct instruction class's post-test were analyzed. The latter showed a significant value of <0.05. This finding suggests that the data does not confirm to a normal distribution. In light of the findings from the normality test, the hypothesis test that will be conducted is a non-parametric statistical test. Specifically, the Mann-Whitney test will be utilized as an alternative to the independent sample t-test, should the data not be normally distributed and homogeneous. The homogeneity test revealed a significant value of <0.05 for the two sample classes' pretest, indicating that the pretest data on students' critical thinking skills is not homogeneous. Conversely, the significance value of the post-test for both sample classes is >0.05, indicating that the post-test data is homogeneous. Afterwards, a hypothesis test was conducted to see the effect of guided inquiry on critical thinking skills using a non-parametric statistical test, namely the Mann Whitney Test with the help of the SPSS Statistic 26 for Windows computer program. Non-parametric statistical tests are used because the data obtained are not normally distributed and not homogeneous. The Mann Whitney Test results can be seen in Table 4.

Table 4. Mann-Whitney test results of critical thinking skills.

Group	N	Mean Rank	Post-test	Mann-Whitney U	Asymp. Sig. (2-tailed)
Guided Inquiry with differentiated learning	30	44.48	Y_2	30.500	0.000
Direct Instruction	30	16.52	Y_2		

The value of Asymp. Sig (2-tailed) 0.000 which means the significance value <0.05 then H_0 is rejected and H_a is accepted (attachment 22). Based on the results of hypothesis testing conducted, it can be concluded that there is an effect of guided inquiry with differentiated learning model on students' critical thinking skills on human respiratory system material in class VIII SMP Negeri 2 Pancur Batu.

The results demonstrated the impact of the guided inquiry with differentiated learning model on students' critical thinking skills. In this class, students are obligated to conduct investigations, search for information related to the investigation, formulate and identify problems, gather information that focuses on the goals to be achieved, create new things to share with others, and evaluate and conclude learning activities that have been carried out. The guided inquiry learning model aims to actively engage students and cultivate their critical thinking skills in identifying concepts related to the material being studied (Rambe et al., 2020). Meanwhile, differentiated learning aims to accommodate the different learning needs of students, both in terms of their learning readiness, interests and learning profiles, by adjusting learning content, processes and products (Herwina, 2021; Silmi et al., 2025) . Thus, each student gets an appropriate and meaningful learning experience according to their individual characteristics.

The integration of differentiated learning in this model further strengthens its effectiveness as it allows teachers to customize the learning process according to students' needs, learning styles and readiness (Jarnawi et al., 2025). Through this approach, students with diverse abilities can follow the inquiry process with appropriate support, whether in the form of content, process or product variations

(Wulandari, 2022). This provides each student with an equal opportunity to be actively involved in the investigation process, making it more optimal in developing critical thinking skills. The active engagement of students in learning activities has been demonstrated to enhance their critical thinking skills when conducting investigations to identify the expected material concepts (Burhanuddin, 2017)

There are six characteristics of the guided inquiry learning model 1) students are encouraged to engage in self-reflection, examining their own experiences to facilitate active learning; 2) students acquire new knowledge based on what they already know; 3) students cultivate and refine their capacity for systematic thinking through structured guidance and direction. 4) Student development occurs in a gradual manner; 5) Students' different ways of learning; 6) Students' learning experiences are enriched by a variety of activities, including discussion, collaboration, and the exchange of opinions, among others. The stages of the guided inquiry learning model are carried out sequentially. According to Kuhlthau et al. (2015) eight syntaxes for implementing guided inquiry have been proposed: Open, Immerse, Explore, Identify, Gather, Create, Share, and Evaluate. The implementation of guided inquiry using differentiated learning can be seen in the Table 5.

Table 5. The implementation of guided inquiry using differentiated learning

Syntax	Description	Differentiated Learning
Open	- The teacher poses inquiries that align with the curriculum to stimulate students' thinking and cultivate curiosity. - The teacher also utilizes a variety of sources to stimulate student engagement.	- Differentiation of conten that can be accessed by students regarding the impact of smoking on health and the human airway system. Not ready enough: Simple visual infographic (picture of healthy lungs vs smoker's lungs). Enough: Narrative reading text on the dangers of smoking to the respiratory system Ready students: Snippets of data from health journals related to the effects of nicotine and tar on respiratory organs - Difference in instruction detail in LKPD. Not ready enough: Listen to the teacher's explanation directly and slowly. Enough: Small group discussion to discuss the content of the reading passage. Ready students: Conduct a follow-up group discussion or scientific debate.
Immerse	- The teacher builds students' basic knowledge by providing explanations about the material being taught to explore interesting ideas to be understood further	- Differentiation of content that can be accessed by students regarding the impact of smoking on health and the human airway system. - Difference in instruction detail in LKPD
Explore	- Students collaborate in groups to conduct investigations and explore a breadth of information related to the material studied. They are tasked with completing the investigation activities in accordance with the directions provided in the LKPD. - The teacher facilitates the process by guiding students to search and observe a variety of sources to	- Process differentiation, conducting investigations according to students' learning styles, learning interests, and abilities. - Difference in instruction detail in LKPD

Syntax	Description	Differentiated Learning
	comprehend the information they have found. Subsequently, students transcribe the information they have found on the LKPD.	
Identify	- Students identify problems based on the investigation activities. topic being studied. - The teacher identifies students' thinking by guiding students to answer questions on the LKPD according to the results of the investigation that has been carried out.	- Process differentiation, identifying problems according to students' learning styles, interests, and abilities. - Differentiation of content that can be accessed by students on the topics discussed.
Gather	- Students gather information specifically and focus on the problem formulation that has been identified. Students are given the freedom to explore information from various learning sources related to the human respiratory system. - The teacher guides students to gather information and answer questions on LKPD by finding information from various learning sources.	- Students in groups answer the questions on the LKPD by finding information from various learning sources (content and process differentiation).
Create	- Students create something new to share with others and find ways to communicate it. - Students make a report of their investigation and summarize the results of their investigation by connecting it with the information obtained in the previous stage. - The teacher guides students to make a final report of the learning activities.	- Students in groups make a final learning report (product differentiation). 1. Visual: Respiratory system poster 2. Auditory: make a video recording about breathing material 3. Kinesthetic: breathing system model from scrap
Share	- Students present the results of their group discussions in front of the class. Other students are asked to respond in the form of appreciation, criticism and suggestions. - The teacher guides the presentation activity.	- This process differentiation is adjusted by sharing/presenting with the tasks assigned to each learning style.
Evaluate	- Students summarize and reflect on the entire learning process that has been carried out from the beginning to the end. - The teacher guides students to make conclusions	- Process differentiation

The findings indicate that the implementation of guided inquiry integrated with differentiated learning had a positive impact on students' critical thinking skills. The highest post-test mean scores were observed in the Overview (M = 82.5), Situation (M = 81.67), and Focus (M = 81.25) indicators. These results suggest that students were able to understand the learning context and identify central issues effectively, which aligns with the characteristics of the guided inquiry model that emphasizes active engagement, exploration, and the

synthesis of information. At this stage, differentiated content and process allowed students with varying learning styles and readiness levels to access the material in an equitable and adaptive manner.

Overview (evaluation) with indicators reflects the ability of students to be able to see the big picture of a problem or concept, connect various information that has been collected, compile a complete understanding of the learning process, and conclude what has been learned in an integrative form (Seranica et al., 2018). This ability at the evaluation stage using process differentiation requires students to be able to show that students not only understand parts of the material, but are also able to assemble and synthesize information to form a comprehensive understanding in accordance with the process that is in accordance with the understanding of the learners.

Situation, according Indawati et al. (2021) suggests that situation skills develop at the explore and gather stages when students explore and consider information to understand the situation and be able to complete the investigation. This is also relevant to the process differentiation given at the explore stage, students are led to understand the context of a problem or phenomenon that would be better if it is tailored to their learning style (Kolb & Kolb, 2005). Similarly, at the gather stage which allows them to search from a variety of different sources according to students to understand and identify various information to answer questions and complete the investigation.

The focus criteria in guided inquiry classes are cultivated through open and immerse stages, which require students to concentrate on the inquiry and explanations provided by the instructor. This pedagogical approach aligns with the findings of (Masitoh & Ariyanto, 2017) who contend that the open and immerse stages are pivotal in focusing students' attention and cultivating their fundamental understanding. Both stage is integrated with differentiated of content by presenting varied initial materials according to students' learning needs and readiness (Prast et al., 2015). With this approach, all students gain early access to the content of the respiratory system and encourage equitable engagement among students and facilitate cognitive readiness for the subsequent inquiry process.

However, lower mean scores were recorded for the Inference (M = 69.2), Reason (M = 71.67), and clarity (= 76.67) indicators, reflecting students' ongoing challenges in drawing logical conclusions and constructing arguments based on evidence. These results correspond with diagnostic assessments that identified a number of students in the "enough" and "not ready enough" categories, which likely contributed to their difficulties in higher-order thinking phases, particularly during the Create and Evaluate stages. Additionally, the dominance of kinesthetic learning styles among several students required more hands-on, experiential learning strategies, which may not have been fully accommodated in the current instructional design.

Inference relates to students' ability to make conclusions based on data or information that has been collected. Inference criteria are practiced in the classroom through the gather, create, and evaluate stages. In the create stage, students compile and organize information to answer the main question (Facione, 2015). While share and evaluate, students present their findings and reflect on the process to draw conclusions that are in accordance with the data and information collected (Pedaste et al., 2015). By using product differentiation, it encourages students to convey conclusions in a form that suits their learning style, which strengthens their understanding and expression of logical thinking (Subban, 2006). However, when viewed in learning readiness from process differentiation, students have different abilities in providing conclusions. For example, students with high readiness can infer results from complex data (e.g. lung volume vs

physical activity table), while students with medium readiness can draw conclusions from pictures of breathing flow diagrams. Meanwhile, low-readiness students answer guiding questions that lead them to conclusions

Reason, relates to the student's ability to provide logical reasons for an opinion, answer or decision (Alfaro-LeFevre, 2016). Students with high critical thinking skills are able to express the right reasons for the answers to the questions answered, while students with sufficient critical thinking skills are only able to provide correct answers but cannot provide reasons (Shalihin & Saptono, 2019). This criteria in guided inquiry classes are trained through the identify stage and the gather stage which requires students to provide answers to questions on the worksheets and the answers expressed are accompanied by relevant reasons. By customizing the inquiry process based on learning styles, however, teachers can help students build stronger and more meaningful reasoning. Visual students are helped by concrete evidence in the form of pictures, auditory students strengthen their logic through discussion, and kinesthetic students build understanding from direct physical experience (Sularso et al., 2015). All of these approaches aim to lead students to not only answer, but explain reasoning logically, which is the essence of high-level critical thinking .

Clarity relates to students' ability to explain problems, argue and provide solutions clearly and easily understood (Thorp, 2022) . Clarity criteria in guided inquiry classes are trained through the create stage and share stage which requires students to be able to explain and communicate the results of the learning they have done with clear language and can be understood by themselves and the audience (Yeritia et al., 2017). By implementing product differentiation at the create stage, it is easier to help students to convey ideas, answers, or opinions in a clear and structured manner by producing products according to their learning style.

Several factors may explain why some students scored below the minimum competency threshold of 70, particularly in the Inference and Reason indicators of critical thinking. Diagnostic assessment conducted at the beginning of the study revealed that a portion of students exhibited low learning readiness, characterized by limited conceptual understanding of the respiratory system and weak skills in interpreting scientific information. These deficiencies posed significant challenges for students when required to engage in higher-order thinking processes, such as making logical inferences and constructing evidence-based arguments.

In addition, the dominant kinesthetic learning styles identified among these students necessitated learning experiences that involved physical engagement, direct experimentation, and the use of concrete learning tools. However, constraints related to limited laboratory facilities and instructional time within the school context hindered the optimal implementation of such approaches. As a result, while content and process differentiation was employed, it was not fully sufficient to meet the learning preferences and cognitive needs of all students.

Moreover, the instructional design lacked adequate scaffolding during critical inquiry phases, particularly during elaboration and evaluation, where students are expected to justify conclusions with logical reasoning. Students with low scientific literacy were especially affected by this gap in support. The limited opportunity for personalized intervention and formative feedback further contributed to the variation in learning outcomes. These findings suggest that future implementations should consider incorporating tiered scaffolding strategies, enhancing scientific literacy through preparatory activities, and integrating interactive, problem-based learning tools that align with diverse

learning profiles. Such efforts may help ensure that all students have equitable opportunities to achieve mastery in critical thinking skills.

CONCLUSION

The results of the study indicate that guided inquiry model with differentiated learning has an impact on the enhancement of students' critical thinking skills regarding respiratory system material in class VII junior high school. This paradigm promotes student engagement in a systematic scientific inquiry process encompassing steps such as issue formulation, information gathering, data analysis, and conclusion derivation. Differentiated learning affords educators the freedom to adapt instructional material, methodologies, and outcomes according to students' learning preferences, interests, and preparedness levels.Meanwhile, differentiated learning provides flexibility for teachers to customize learning content, processes and products based on students' learning styles, interests and readiness levels. A responsive and participatory learning environment is established by the collaboration of these two approaches, which not only enables students to delve deeper into concepts but also offers them the opportunity to demonstrate their comprehension in a manner that is most appropriate for their individual requirements. Through this integration, students are not only able to develop critical thinking indicators but also feel more valued in their different ways of learning. Therefore, the application of a differentiated guided inquiry model can be one of the effective solutions in science learning to build 21st century critical thinking skills. This study is limited by its implementation in a school with specific student characteristics and learning environment, which may restrict the generalizability of the findings to broader educational contexts. Therefore, future research is recommended to involve multiple schools with diverse backgrounds in order to obtain more representative results. Further studies may also explore additional variables that influence the effectiveness of differentiated learning within the guided inquiry model, such as student interest and the supportiveness of the learning environment.

REFERENCES

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of educational research, 85*(2), 275-314. https://doi.org/10.3102/0034654314551063

Alfaro-LeFevre, R. (2016). Critical thinking indicators. *Stuart: Teaching Smart.*

Andrini, V. S. (2016). The Effectiveness of Inquiry Learning Method to Enhance Students' Learning Outcome: A Theoritical and Empirical Review. *Journal of Education and Practice, 7*(3), 38-42.

Arda, A., Supriyatman, S., & Afadil, A. (2024). A Review of Students' Critical Thinking Skills in Science Learning in Indonesia. J*urnal Pendidikan MIPA, 25*(4), 1787-1798. http://dx.doi.org/10.23960/jpmipa/v25i4.pp1787-1798

Billah, A., & Masykuri, M. (2021). Analysis of critical thinking in junior high school students through science learning in Indonesia: A systematic review. *In Journal of Physics: Conference Series*, *1796*(1), p. 012013. IOP Publishing. https://doi.org/10.1088/1742-6596/1796/1/012013

Birgili, B. (2015). Creative and Critical Thinking Skills in Problem-based Learning Environments. *Journal of Gifted Education and Creativity*, *2*(2), 71–80. https://doi.org/10.18200/jgedc.2015214253

Burhanuddin (2017). Pengaruh Pembelajaran Inkuiri Terhadap Aktivitas Dan Hasil Belajar Peserta Didik. *Inspiratif Pendidikan*, *6*(2), 305-315. https://doi.org/10.24252/ip.v6i2.5762

Chetry, K. K. (2024). Transforming education: Paradigm shifts in 21st century learning. *International Journal of Multidisciplinary Research, 2*(5), 469-479.

Collins, R. (2014). Skills for the 21st Century: teaching higher-order thinking. *Curriculum & Leadership Journal, 12*(14), 1-8.

Dam, G, T., & Volman, M. (2004). Critical thinking as a citizenship competence: teaching strategies. *Learning and instruction, 14*(4), 359-379. https://doi.org/10.1016/j.learninstruc.2004.01.005

Dewi, S. P., & Widodo, A. (2016). Analisis Konsepsi Siswa dalam Materi Sistem Respirasi. *In Seminar Nasional Pendidikan IPA Tahun 2021. 1*(1), 361-368. http://www.conference.unsri.ac.id/index.php/semnasipa/article/view/703

Ennis, R. H. (1996). Critical thinking dispositions: Their nature and assessability. *Informal logic, 18*(2).

Etikan, I., & Bala, K. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal, 5*(6), 00149.

Facione, P.A. (2015). Permission to Reprint for Non-Commercial Uses Critical Thinking: What It Is and Why It Counts. *Insight assessment*, *5*(1), 1–30.

Faizin, A., Susantini, E., & Raharjo, R. (2024). Application of A Guided Inquiry Learning Model to Improve Students' Scientific Literacy Skills. *IJORER: International Journal of Recent Educational Research, 5*(2), 490-503. https://doi.org/10.46245/ijorer.v5i2.573

Falahudin, I., Wigati, I., & Astuti, A. P. (2016). Pengaruh model pembelajaran inkuiri terbimbing terhadap kemampuan berpikir kritis siswa pada pembelajaran materi pengelolaan lingkungan di SMP Negeri 2 Tanjung Lago, Kabupaten Banyuasin. *Bioilmi: Jurnal Pendidikan, 2*(2), 92–101. https://doi.org/10.19109/bioilmi.v2i2.1133

Fauzi, A. (2022). Implementasi Kurikulum Merdeka Di Sekolah Penggerak. *Pahlawan: Jurnal Pendidikan-Sosial-Budaya*, *18*(2), 18–22. https://doi.org/10.57216/pah.v18i2.480

Fu, J. (2013). Complexity of ICT in education: A critical literature review and its implications. *International Journal of education and Development using ICT, 9*(1), 112-125.

Hasanah, S., Purwoko, A.A., & Hakim, A. (2020). The Effect of Guided Inquiry Learning Model on Chemistry Learning Outcomes. *Journal of Science and Science Education*, *1*(1), 15–20. https://doi.org/10.29303/jossed.v1i1.446

Herwina, W. (2021). Optimalisasi Kebutuhan Murid Dan Hasil Belajar Dengan Pembelajaran Berdiferensiasi. *Perspektif Ilmu Pendidikan*, *35*(2), 175–182. https://doi.org/10.21009/pip.352.10

Hunaepi, H., & Suharta, I. (2024). Transforming education in Indonesia: The impact and challenges of the Merdeka belajar curriculum. *Path of Science, 10*(6), 5026-5039. https://doi.org/10.22178/pos.105-31

Indawati, H., Sarwanto, S., & Sukarmin, S. (2021). Studi Literatur Pembelajaran Inkuiri Terbimbing terhadap Kemampuan Berpikir Kritis IPA SMP. *Inkuiri: Jurnal Pendidikan IPA, 10*(2), 99-107. https://doi.org/10.20961/inkuiri.v10i2.57269

Jarnawi, M., Haeruddin, H., Werdhiana, I. K., Syamsuriwal, S., & Mu'aziyah, S. E. S. (2025). Integrating thinking styles into differentiated instruction: enhancing learning outcomes in science education. *Integrated Science Education Journal, 6*(1), 47-53. https://doi.org/10.37251/isej.v6i1.1328

Kamsinah, D. L., Abdullah, A., & Suryajaya, S. (2020). Analysis of critical thinking skills in junior high school students. *Journal of Advances in Education and Philosophy, 4*(6), 234-237. https://doi.org/10.36348/jaep.2020.v04i06.002

Khasanah, A. N., Widoretno, S., & Sajidan, S. (2017). Effectiveness of critical thinking indicator-based module in empowering student's learning outcome in respiratory system study material. *Jurnal Pendidikan IPA Indonesia, 6*(1). https://doi.org/10.15294/jpii.v6i1.8490

Khoiri, A., Komariah, N., Utami, R. T., Paramarta, V., & Sunarsi, D. (2021). 4Cs analysis of 21st century skills-based school areas. *In Journal of Physics: Conference Series 1764*(1), IOP Publishing. https://doi.org/10.1088/1742-6596/1764/1/012142

King, D., & Ritchie, S. M. (2012). Learning science through real-world contexts. *Second international handbook of science education*, 69-79.

Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of management learning & education, 4*(2), 193-212. https://doi.org/10.5465/amle.2005.17268566

Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2015). Guided inquiry: Learning in the 21st century. *Bloomsbury Publishing USA.*

Margunayasa, I. G., Dantes, N., Marhaeni, A. A. I. N., & Suastra, I. W. (2019). The Effect of Guided Inquiry Learning and Cognitive Style on Science Learning Achievement. *International Journal of Instruction, 12*(1), 737-750. https://doi.org/10.29333/iji.2019.12147a

Masitoh, I.D., & Ariyanto, J. (2017). Pengaruh Model Pembelajaran Inkuiri Terbimbing terhadap Kemampuan Berpikir Kritis Siswa Kelas X MIA pada Materi Pencemaran Lingkungan di Surakarta. *Bioedukasi*, *10*(1), 71–79.

Nickerson, R.S. (2010). How to Discourage Creative Thinking in the Classroom. *Nurturing Creativity in the Classroom*, 1–5. https://doi.org/10.1017/CBO9780511781629.002

Ortega, D. P., Cabrera, J. M., & Benalcázar, J. V. (2018). Differentiating instruction in the language learning classroom: Theoretical considerations and practical applications. J*ournal of Language Teaching and Research, 9*(6), 1220-1228. https://doi.org/10.17507/jltr.0906.11

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., Manoloi, C.C., Zacharia, Z.C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: *Definitions and the inquiry cycle. Educational research review, 14*, 47-61. https://doi.org/10.1016/j.edurev.2015.02.003

Prast, E. J., Van de Weijer-Bergsma, E., Kroesbergen, E. H., & Van Luit, J. E. (2015). Readiness-based differentiation in primary school mathematics: Expert recommendations and teacher self-assessment. *Frontline Learning Research, 3*(2), 90-116. https://doi.org/10.14786/flr.v3i2.163

Rambe, Y. A., Silalahi, A., & Sudrajat, A. (2020). The effect of guided inquiry learning model and critical thinking skills on learning outcomes. *In The 5th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2020)*, 151-155. Atlantis Press. https://doi.org/10.2991/assehr.k.201124.033

Reiss, M. J., & Tunnicliffe, S. D. (2001). Students' understandings of human organs and organ systems. *Research in Science Education, 31*(3), 383-399. https://doi.org/10.1023/A:1013116228261

Rogers, J., & Revesz, A. (2019). Experimental and quasi-experimental designs. *In The*

Routledge handbook of research methods in applied linguistics , 133-143. Routledge. https://doi.org/10.4324/9780367824471-12

Seranica, C., Purwoko, A. A., & Hakim, A. (2018). Influence of guided inquiry learning model to critical thinking skills. *IOSR Journal of Research & Method in Education, 8*(1), 28-31. https://doi.org/10.9790/7388-0801022831

Shalihin, N. A. F., & Saptono, S. (2019). Implementation of guided inquiry learning to improve the critical thinking skills of junior high school students. *Journal of Innovative Science Education, 8*(3), 306-314.

Siahaan, E. Y. S., Muhammad, I., Dasari, D., & Maharani, S. (2023). Research on critical thinking of pre-service mathematics education teachers in Indonesia (2015-2023): A bibliometric review. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika, 9*(1), 34-50. https://doi.org/10.29407/jmen.v9i1.19734

Silmi, T. A., Lubis, A., & Maulidi, A. (2025). Model Differentiated Learning in 21st Century Education: A Systematic Review of Strategies, Results, And Challenges. Al *Ulya: Jurnal Pendidikan Islam, 10*(1), 60-80.

Stanovich, K.E. (2016). The Comprehensive Assessment of Rational Thinking. *Educational Psychologist*, *51*(1), 23–34. https://doi.org/10.1080/00461520.2015.1125787

Subban, P. (2006). Differentiated instruction: A research basis. *International Education Journal*, *7*(7), 935–947.

Sularso, A., Karyanto, P., & Sugiharto, B. (2015). Pengaruh Penggunaan Model Pembelajaran Inkuiri Terbimbing Terhadap Kemampuan Berpikir Kritis Siswa Ditinjau Dari Gaya Belajar Siswa Kelas X Sma N Karangpandan Tahun Pelajaran 2012/2013. *Bio-Pedagogi: Jurnal Pembelajaran Biologi, 4*(2), 1-4.

Thorp, H.H. (2022). Communicating with clarity. *Science*, 377(6613), 1363. https://doi.org/10.1126/science.ade8683

Tomlinson, C. A., & Imbeau, M. B. (2010). Leading and managing a differentiated classroom. Ascd

Tomlinson, C. A., & Moon, T. R. (2013). Assessment and student success in a differentiated classroom. Ascd.

Widyapuraya, N. W., Suryana, A. L., Suyanta, S., & Wilujeng, I. (2023). Profil keterampilan berpikir kritis siswa SMP Negeri 1 Juwangi pada pembelajaran IPA. *Jurnal Penelitian Pendidikan IPA, 9*(3), 1368-1374. https://doi.org/10.29303/jppipa.v9i3.1723

Wulandari, A.S. (2022). Literature Review: Pendekatan Berdiferensiasi Solusi Pembelajaran dalam Keberagaman. *Jurnal Pendidikan Mipa*, *12*(3), 682–689. https://doi.org/10.37630/jpm.v12i3.620

Yeritia, S., Wahyudi, W., & Rahayu, S. (2017). Pengaruh Model Pembelajaran Inkuiri Terbimbing Terhadap Penguasaan Konsep Dan Kemampuan Berpikir Kritis Fisika Peserta Didik Kelas X SMAN 1 Kuripan Tahun Ajaran 2017/2018', *Jurnal Pendidikan Fisika dan Teknologi*, *3*(2), 181–187. https://doi.org/10.29303/jpft.v3i2.398

Yuniarti, R., & Subekti, H. (2024). Transforming Learning Experiences: Student Perspectives on Differentiated Learning in Guided Inquiry. *JOELI: Journal of Educational and Learning Innovation, 1*(1), 20-31.