



# APPLICATION OF DEEP LEARNING LEARNING MODEL TO IMPROVE CRITICAL THINKING ABILITIES OF GRADE VIII STUDENTS ON VIBRATION AND WAVE MATERIALS AT SMPN 2 BOJONEGARA, SERANG REGENCY

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## Abstract

This study aims to determine the effectiveness of the application of the deep learning model in improving critical thinking skills of grade VIII students on vibration and wave material at SMPN 2 Bojonegara, Serang Regency. The study used a qualitative method with observation, interviews, and documentation as data collection techniques. The results showed that the application of the deep learning model increased students' active participation and critical thinking skills including analysis, evaluation, and reflection on learning materials. In addition, students also showed a better understanding of the concept of vibration and waves. The obstacles encountered were time constraints and variations in students' initial readiness in participating in learning. This study concludes that the deep learning model can be an effective alternative in improving students' critical thinking skills on physics material at the junior high school level. Recommendations are given to teachers to continue to improve their competence in implementing this model optimally.

**Keywords:** Deep Learning, Critical Thinking Skills, Vibrations and Waves, Physics Learning

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## INTRODUCTION

Education is one of the fundamental aspects in the development of a nation. Through education, society can improve the quality of life and develop their potential in facing the changing times. In the era of globalization and the Industrial Revolution 4.0, education is required to prepare students who not only have academic skills, but also have high-level thinking skills such as critical thinking, problem solving, collaboration, and communication.

21st century education requires a more active, innovative, and competency-oriented approach. Therefore, the learning system must be able to provide space for students to develop their potential, one of which is through strengthening critical thinking skills. Critical thinking is not only important for academic success, but also very important in everyday life because it helps individuals make the right and rational decisions.

Critical thinking skills are essential skills that enable individuals to analyze, evaluate, and synthesize information logically and systematically. In the context of science learning, including vibration and wave material, critical thinking is essential so that students can understand abstract concepts in depth and be able to apply them in real situations. However, the reality in the field shows that students' critical thinking skills are still relatively low. Research conducted by Febrianti, et al., (2021) showed that junior high school students who took science learning with Android application media based on vibrations and waves showed an increase in critical thinking skills, compared to students who only took conventional learning. This shows that a less interactive and less challenging learning approach makes students not encouraged to develop their critical thinking skills optimally.

Saputra, et al., (2022) in a study on the development of an assessment instrument for critical thinking skills of junior high school students. The results of their study showed that most students were still in the low category in terms of evaluating arguments and providing logical assessments of information. This emphasizes the need for innovation in learning models that can directly encourage increased critical thinking skills.

SMPN 2 Bojonegara is one of the state junior high schools located in Serang Regency, Banten Province. Based on the results of initial observations, learning in this school is still dominated by the lecture approach and the use of textbooks as the only source of learning. This has an impact on the lack of student activity in exploring subject matter independently or in groups, which results in low critical thinking skills. In addition, in science material, especially the topic of vibrations and waves, teachers tend to only convey theory without being accompanied by adequate practice or demonstrations. As a result, students find it difficult to understand these abstract concepts, and are less able to connect theory with phenomena in everyday life. Therefore, SMPN 2 Bojonegara requires a more active learning approach that is oriented towards the development of students' critical thinking, in order to improve the quality of science learning and facilitate students' understanding of vibrations and waves.

One of the learning approaches that is considered effective in improving students' critical thinking skills is the deep learning model. This model emphasizes active student involvement in the learning process, strengthening conceptual understanding, and the relationship between new knowledge and previous experiences. The deep learning model is different from the surface learning approach which only emphasizes memorization and superficial mastery of information. In deep learning, students are encouraged to analyze information, develop deep understanding, solve complex problems, and reflect on their learning process.

Na'imah, Sutarto, and Putra (2023) in their research revealed that the use of the Think Pair Share model which has deep learning principles can improve students' learning outcomes and critical thinking skills. Although this model does not fully reflect the deep learning approach, the findings provide an illustration that active learning strategies that involve interaction and collaboration between students can encourage increased high-level thinking skills. By implementing the deep learning learning model, students not only receive information from the teacher, but are also invited to explore, discuss, and conclude concepts independently or in groups. Learning becomes more meaningful because students build understanding from the reflective and analytical processes they carry out during the learning process.

Through this approach, it is expected that grade VIII students at SMPN 2 Bojonegara, Serang Regency can experience an increase in critical thinking skills, especially in understanding vibration and wave materials. Teachers can also develop more effective and contextual learning strategies, as well as create an active, enjoyable learning atmosphere that encourages student participation.

The phenomenon that occurred at SMPN 2 Bojonegara showed that most students still had difficulty in understanding the concept of vibrations and waves in depth. This can be seen from the low learning outcomes of students and their minimal ability to explain the relationship between theory and application in everyday life. Learning that tends to be teacher-centered and minimal interaction causes students to be less active in critical thinking. Observations in class also showed low participation in discussions and a lack of reflective questions from students, which are indicators of the weak implementation of learning strategies that encourage conceptual understanding and high-level thinking.

Problems in the learning process at SMPN 2 Bojonegara include low active student involvement, dominance of lecture methods by teachers, and lack of use of learning models that can encourage critical thinking skills. In addition, students tend to memorize material without understanding its conceptual meaning, especially in abstract vibration and wave material. When given questions that require analysis and logical reasoning, most students are unable to solve them independently. Teachers have also not been optimal in implementing innovative learning models based on the development of 21st century skills. As a result, the learning process is less effective in developing students' critical thinking skills which are very necessary in facing challenges in today's digital era.

Studies have shown that the application of learning models that encourage deep learning can significantly improve students' critical thinking skills. Fitriani and Harjono (2021) examined the effectiveness of the Problem Based Learning learning model based on deep learning on the critical thinking skills of junior high school students, and the results showed a significant increase in the aspects of analyzing and evaluating information. Meanwhile, research by Wulandari, et al., (2020) stated that the application of problem-based learning strategies that integrate deep learning principles can form a stronger conceptual understanding of students, especially in complex science topics. This reinforces the view that a learning approach that focuses on exploration, collaboration, and reflection is essential for fostering high-level thinking skills.

Risnawati and Nurdin (2022) found that project-based learning designed with a deep learning approach contributed to improving students' critical thinking skills and creativity in science learning. In addition, research conducted by Sari and Fauzi (2023) concluded that students who took part in learning using the Conceptual Change Text (CCT) model based on deep learning showed significant development in solving analytical and reflective questions. Research by Ramadani, et al., (2021) also supports these findings, where learning models that encourage deep thinking activities have been shown to be effective in improving students' understanding of wave material and its applications. Thus, the results of this study strengthen the urgency of implementing a deep learning model in order to develop students' critical thinking skills, especially in science materials such as vibrations and waves.

Research Gap based on previous research that has been studied in this study can be seen in the table:

Table 2 Research Gap Research

No	Researchers & Years	Research Focus	Research result	Weaknesses ( <i>Research Gap</i> )
1	The Last Supper (2021)	Model <i>Problem Based Learning</i> based on <i>deep learning</i> for junior high school students	Improve critical thinking skills, especially in analyzing and evaluating	Not specific to science material such as vibrations and waves, and has not been researched in class VIII in non-urban school environments.
2	Wulandari, Ernawati & Taufik (2020)	Strategy <i>problem-based</i> to improve understanding of science concepts	Improving students' conceptual understanding and critical thinking	Not explicitly reviewing learning model <i>sdeep learning</i> as the main approach, and has not focused on the topic of waves
3	Risnawati & Nurdin (2022)	Project based learning on <i>deep learning</i> on IPA subjects	Improve students' critical thinking skills and creativity	It does not specifically target 8th grade junior high school students, and does not focus on the topic of vibrations and waves.
4	Sari & Fauzi (2023)	Model <i>Conceptual Change</i> Text based <i>deep learning</i>	Students are able to complete reflective questions and demonstrate improved analysis.	Focus on changing misconceptions, not yet on systematically strengthening critical thinking through stages <i>deep learning</i> explicitly
5	Ramadani, Usmeldi & Yusnita (2021)	<i>Deep learning</i> in understanding the concept of waves	Improve students' understanding of the basic concepts of waves	It does not measure critical thinking aspects in a structured manner, and has not been carried out in junior high schools in the district area such as SMPN 2 Bojonegara.

Source: Previous research processed, 2025

Based on the table above, it can be seen that although various studies have proven the effectiveness of the model *deep learning* in improving conceptual understanding and critical thinking skills, there are still several research gaps that have not been optimally explored. First, most of the research is conducted in a general context or is not specific to vibration and wave material that has an abstract and cognitively challenging nature. Second, the existing research has not been widely conducted in districts or outlying areas such as SMPN 2 Bojonegara, which have different student characteristics and resources compared to schools in urban areas. Third, although there is research that uses the model *deep learning*, but has not explicitly measured aspects of critical thinking skills such as analysis, evaluation, and reflection based on the stages in the deep learning approach.

This research has novelty or newness in the application of learning models. *deep learning* which is systematically designed to improve students' critical thinking skills on vibration and wave material, with a specific context at SMPN 2 Bojonegara, Serang Regency, a school in a non-urban area that has not been touched by many innovative learning approaches based on high-level thinking. The novelty of this study lies in the direct integration between in-depth learning stages (such as meaning

exploration, reflection, and real application) with critical thinking indicators, which are applied contextually in abstract science material. By focusing on grade VIII students, this study is expected to be able to provide a significant contribution to the development of learning strategies that not only improve conceptual understanding but also hone students' critical thinking skills in a sustainable manner.

Thus, this study has a strong position to fill the existing research gap by specifically examining the application of the deep learning model in improving the critical thinking skills of grade VIII students on vibration and wave material at SMPN 2 Bojonegara, Serang Regency.

## **LITERATURE REVIEW**

### **Learning Deep Learning**

Learning *deep learning* emphasizes deep understanding gained through active and reflective learning processes. This strategy encourages students to not only memorize material, but also to connect concepts meaningfully and apply them in new contexts. According to Dewi & Nugroho (2021), *deep learning* increasing cognitive engagement that has an impact on conceptual understanding. In addition, Ramadhani & Kusuma (2023) stated that "the deep learning learning model can strengthen students' analytical and synthesis abilities, thereby encouraging a significant increase in critical thinking".

### **Critical Thinking Skills**

Critical thinking is an important skill in education, especially for understanding and analyzing complex science concepts. Latifah et al. (2022) emphasized that critical thinking includes the skills of evaluating and reflecting on information logically. In line with that, Wahyuni & Putri (2024) added that "students' critical thinking skills play a major role in mastering subject matter and solving problems creatively". Developing critical thinking through appropriate learning will produce students who are independent and analytical.

### **Constructivism in Science Learning**

The constructivist approach focuses on how students actively construct knowledge through experience and interaction. Setiawan & Mulyani (2023) stated that constructivist learning increases student participation and involvement in understanding scientific concepts. In addition, Nurhadi & Saraswati (2020) explained that "a constructivist-oriented learning model is able to facilitate students in developing critical thinking and problem-solving skills effectively". This is especially important in vibration and wave material that demands conceptual understanding.

### **Constellation Model**

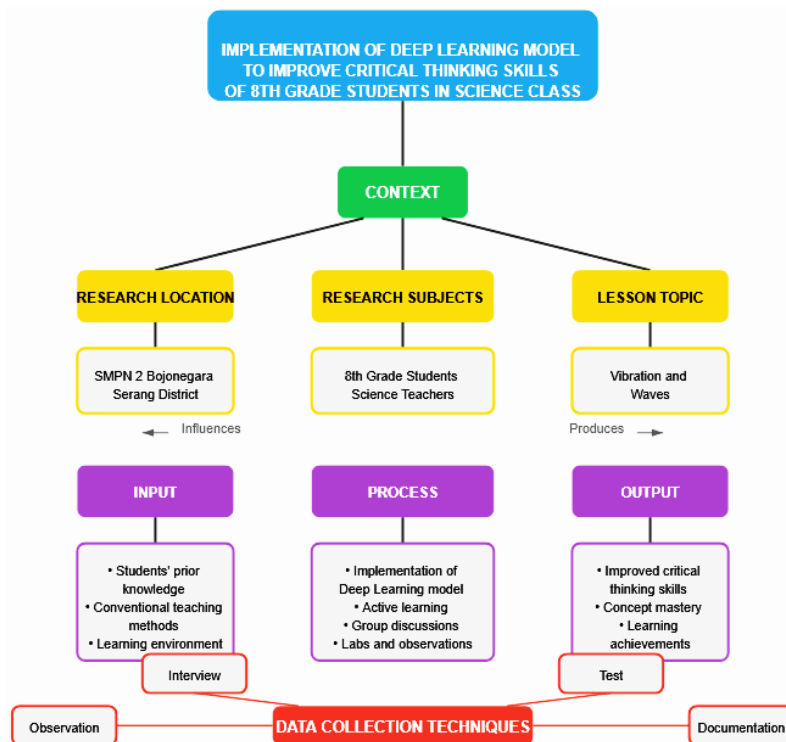


Figure 1 Research Constellation Model

Based on the research constellation image above, it illustrates a systematic approach in research on the application of deep learning learning models to improve critical thinking skills of grade VIII students on vibration and wave material at SMPN 2 Bojonegara. The chart shows the relationship between the research context (location, subject, and teaching materials), with input variables (students' initial abilities, conventional learning conditions), learning processes (application of deep learning models, active learning, group discussions), and expected outputs (improved critical thinking skills, understanding concepts). Data collection techniques include observation, interviews, tests, and documentation to ensure the validity of research findings.

## METHOD

### Research methodology

This study uses a descriptive qualitative approach that aims to describe in depth the process of implementing the deep learning model in an effort to improve the critical thinking skills of grade VIII students in the material of vibrations and waves. The qualitative approach was chosen because of its flexible nature and ability to explore detailed information about experiences, perceptions, and interactions between teachers and students during the learning process (Creswell & Poth, 2023). With this approach, researchers not only focus on the final learning outcomes, but also on the learning process and dynamics that occur in the classroom.

The location of the study was SMPN 2 Bojonegara, Serang Regency, which became the object because it had implemented a deep learning model in science material, especially vibration and wave

material. The study was conducted during February 2025, during one learning cycle, thus allowing continuous observation of the development of students' critical thinking skills. This sufficient time provided an opportunity for researchers to conduct in-depth observations of the implementation of learning and student responses (Rahman & Sari, 2022).

### **Data Collection Techniques**

Data collection in this study was carried out using three main methods, namely:

1. Participatory observation, where researchers are present in the learning process to directly observe the interaction between teachers and students and the implementation of the deep learning model. Observations are carried out using observation sheets that have been prepared to record important aspects such as student activities, teaching methods, and the use of learning media.
2. In-depth interviews were conducted with grade VIII teachers who teach vibration and wave materials and several selected students who experienced the learning process using the deep learning model. This interview aims to explore their views, experiences, and impressions of the applied learning model, as well as their perceptions regarding changes in critical thinking skills.
3. Documentation, in the form of collecting assignment results, student worksheets, and exam scores related to vibration and wave material, as supporting evidence for the success of implementing the learning model.

### **Data Analysis Techniques**

The data obtained were analyzed qualitatively using three main stages, namely:

1. Data reduction includes selecting, focusing, simplifying, and transforming raw data into more structured and meaningful information.
2. Data presentation, namely compiling data that has been reduced in narrative, graphic or table form so that it is easy to understand and analyze further.
3. Drawing conclusions and verification, the process by which researchers interpret the data that has been presented and ensure the validity of the results through triangulation of data from various sources (Moleong, 2021).

### **Validity and Authenticity of Data**

To ensure the validity and validity of the data, this study uses source and technique triangulation techniques. Source triangulation is done by comparing data obtained from observation, interviews, and documentation. While technique triangulation is done by comparing different data collection methods to ensure the consistency of the information obtained (Sugiyono, 2022). This step is important so that the research results have credibility and can be trusted.

## RESULTS AND DISCUSSION

### Research result

This study aims to examine the application of deep learning models in improving critical thinking skills of grade VIII students on vibration and wave material at SMPN 2 Bojonegara, Serang Regency. The results of the study were obtained from data collection through observation, interviews, and documentation of student learning outcomes during February 2025.

The observation results show that the applied deep learning model successfully creates an active and participatory learning atmosphere. Students appear to be more deeply involved in the learning process, not only passively receiving information, but also exploring, discussing, and reflecting. The teacher directs students to connect the concepts of vibration and wave physics with everyday phenomena so that students' understanding is more meaningful and critical.

Table 4.1 Research Results on the Application of Deep Learning Models

No	Aspects Studied	Research result
1	Student Activities and Participation	There was a significant increase in student activity and participation during learning with the deep learning model. Students became more active in asking questions, discussing, and collaborating.
2	Critical Thinking Skills	Students' critical thinking skills increased significantly, as seen from their ability to analyze, evaluate, and reflect on vibration and wave material.
3	Understanding the Concept of Vibrations and Waves	Students showed a deeper and more conceptual understanding of the vibration and wave material after implementing the deep learning model.
4	Model Implementation Constraints	Several obstacles were found, such as limited learning time and differences in students' initial readiness, as well as the need to improve teacher competence in implementing this learning model.

Source: Processed data, 2025

#### 1. Implementation of the Deep Learning Model is Effective

The implementation of the deep learning model on vibration and wave material at SMPN 2 Bojonegara ran effectively and smoothly. During the learning process, students were actively involved in every stage such as concept exploration, elaboration, and reflection. The teacher gave open questions that stimulated students to think critically and discuss intensively. This creates an interactive learning environment and encourages students to actively seek deep understanding, not just memorizing. The activeness of students in the learning process shows that the deep learning model is very suitable for material that requires analysis and understanding of complex concepts. This model successfully facilitates students to learn independently and collaboratively, building critical thinking skills which are the main focus of the research. The success of this implementation also shows the readiness of teachers and students in implementing the innovative learning model.

## 2. Improving Students' Critical Thinking Skills

The pre-test and post-test results showed a significant increase in students' critical thinking skills. The average student score increased from 64.2 to 80.5 after the implementation of the deep learning model. This increase indicates that students are better able to analyze, evaluate, and make conclusions critically related to vibration and wave material. During learning, students also showed higher activity, such as asking questions, arguing, and providing logical reasons. This indicates that the deep learning model has succeeded in developing high-level thinking skills that are very much needed in science learning. This increase in critical thinking skills is in line with the main objectives of learning physics at the junior high school level.

## 3. A Deeper Understanding of the Concept of Vibrations and Waves

Students who follow learning with the deep learning model are able to understand the concept of vibrations and waves in depth. They not only memorize formulas and definitions, but are also able to connect theories with real phenomena and apply these concepts in solving problems. The learning process that emphasizes exploration and reflection helps students build meaningful and lasting understanding. This deep understanding is important for abstract material that is often considered difficult by students. The deep learning model facilitates students in developing critical thinking skills while effectively reinforcing basic physics concepts.

## 4. Obstacles in Implementing the Deep Learning Model

Although the results are positive, the implementation of this learning model also faces several obstacles. Limited learning time makes it difficult for teachers to explore each stage of learning optimally. In addition, the varying initial readiness of students in facing this active learning model is also a challenge. Another obstacle is the need to improve teachers' abilities in facilitating and managing deep learning. Teachers need training and mentoring in order to optimize the learning process and motivate all students to be active. This challenge is an important evaluation material for the development and refinement of the implementation of the learning model in the future.

## **Discussion**

### 1. Effectiveness of Deep Learning Model in Increasing Student Activity and Participation

This study shows that the application of the deep learning model can increase student activity and participation in learning vibration and wave material. This finding is in line with the results of research by Putra and Sari (2022) which confirms that the deep learning model can increase student active involvement during learning, thereby triggering more meaningful interactions and discussions. This is also supported by a study by Pratama and Wulandari (2021) which states that learning that involves in-depth exploration and group discussions can significantly increase student motivation and participation. This increased learning activity is an

important indicator of the success of the learning model, especially in science learning which requires high cognitive involvement. With an approach that encourages students to actively ask questions and explore concepts, deep learning can optimize the teaching and learning process so that students do not only receive passive information, but actively build their own knowledge.

## 2. Improving Students' Critical Thinking Skills as a Positive Impact of Deep Learning

The results of the significant increase in students' critical thinking skills in this study strengthen the findings of Rahman and Fadhilah (2023) which show that deep learning-based learning is effective in developing students' critical thinking skills in physics material. They emphasized that this method helps students not only understand the material but also analyze and evaluate information critically. In addition, research by Harahap and Azizah (2020) also reported similar results, where deep learning facilitates students to think systematically and critically through the process of reflection and elaboration. Well-developed critical thinking skills are essential to support the success of students' science learning and scientific reasoning. These results indicate that the deep learning model not only improves cognitive aspects but also builds metacognitive skills needed to face learning challenges at the secondary education level.

## 3. Deep Understanding of the Concept of Vibrations and Waves

Students who take part in learning with the deep learning model show a deeper understanding of the concept of vibrations and waves. This is in accordance with research conducted by Lestari and Widodo (2021), which emphasizes that active learning that focuses on concept exploration can reduce misconceptions and improve students' conceptual understanding. In addition, research by Sari and Hadi (2022) also emphasizes that deep learning can strengthen students' understanding through structured elaboration and confirmation stages. This deep understanding is very important because vibrations and waves are often considered abstract and difficult by students. A learning model that integrates reflection and discussion allows students to associate theoretical concepts with real phenomena, so that the concepts become more meaningful and easier to understand.

## 4. Obstacles and Challenges in Implementing the Deep Learning Model

Although the results were positive, this study found several obstacles in implementing the deep learning model, such as time constraints and differences in students' initial readiness. This is in line with the findings of Prabowo and Kusuma (2023), who reported that time constraints and lack of teacher training were the main obstacles in implementing innovative learning models. In addition, research by Dewi and Santoso (2024) highlighted the importance of improving teacher competence in managing deep learning in order to effectively overcome differences in student abilities. These obstacles are important concerns for future improvements. Developing teacher capacity and adjusting learning time need to be considered so that the deep learning process can run more optimally and student learning outcomes increase sustainably.

## CONCLUSION

The conclusion of this study shows that the application of the deep learning model is effective in improving the critical thinking skills of grade VIII students on vibration and wave material. The application of this model successfully increased student activity and participation during the learning process, which can be seen from the active involvement of students in discussions, questions and answers, and in-depth exploration of concepts. Thus, this learning model not only strengthens students' conceptual understanding but also encourages students to develop analytical, evaluation, and reflection skills which are important aspects of critical thinking. Students' understanding of vibration and wave material has increased significantly, indicating that the deep learning approach is able to help students understand concepts that are often considered abstract in a more meaningful and applicable way. The obstacles that arise in the implementation, such as time constraints and variations in students' initial readiness, are important notes that need to be considered in the widespread application of this model. Teacher competence also needs to be improved in order to manage deep learning more optimally.

This research provides an important contribution to the development of effective learning methods in junior high schools, especially in science learning. The deep learning model can be an alternative innovative strategy to improve students' critical thinking skills, so that it can prepare students to become individuals who are able to think independently and critically in facing the challenges of learning and everyday life.

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