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# Analysis of Pedagogical Integration in natural Science Distance Learning System

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**Abstract:** This research aims to analyze the implementation of integrating content, media, and teaching methods as learning outcomes in natural science learning. The context of carrying out this research is a distance learning system. This descriptive research focuses on pedagogical competence, graduate opinion, supporting factors, and obstacles faced in integrating content, media, and teaching methods. The research participants were 94 teachers from various islands who taught in grades 4, 5, and 6. The stages for obtaining data began with distributing responses, teaching observations, natural science content tests, and interviews with several teachers as representatives. This research shows that teachers have achieved high success in several aspects of natural science learning based on data analysis, including initial motivation, the relationship of material to daily life, and material explanations, reaching more than 85%. The results of the interviews show that variations in approaches and obstacles related to the completeness of natural science technology instrument facilities need more attention to improving facilities and teacher understanding. Data analysis shows good achievement with potential for improvement, particularly in demonstrations, teaching methods, and integration of natural science content. Observations of teacher activities provide positive picture, while teachers' opinions regarding the student-centered approach show creativity in overcoming facility constraints. Thus, increasing accessibility to technology and digital learning resources can help overcome obstacles in integrating content, media, and teaching methods in natural science learning. The results of this research provide important insights for developing strategies and policies to increase the effectiveness of natural science learning in distance learning systems.

**Keywords**: pedagogy, integration in teaching, natural science, distance learning

**Abstrak:** *Penelitian ini bertujuan untuk menganalisis implementasi integrasi konten, media, dan metode pembelajaran sebagai hasil pembelajaran dalam pembelajaran ilmu pengetahuan alam. Penelitian ini dilaksanakan dalam konteks sistem pembelajaran jarak jauh. Penelitian deskriptif ini berfokus pada kompetensi pedagogik, persepsi lulusan, faktor pendukung, serta kendala yang dihadapi dalam mengintegrasikan konten, media, dan metode pembelajaran. Partisipan penelitian terdiri dari 94 guru dari berbagai pulau yang mengajar di kelas 4, 5, dan 6. Tahapan pengumpulan data dilakukan melalui penyebaran kuesioner, observasi pembelajaran, tes konten ilmu pengetahuan alam, serta wawancara dengan beberapa guru sebagai perwakilan. Hasil penelitian menunjukkan bahwa guru telah mencapai tingkat keberhasilan yang tinggi dalam beberapa aspek pembelajaran*

*IPA berdasarkan analisis data, termasuk motivasi awal, keterkaitan materi dengan kehidupan sehari-hari, dan penjelasan materi, dengan capaian lebih dari 85%. Hasil wawancara menunjukkan bahwa variasi pendekatan serta kendala terkait kelengkapan fasilitas instrumen teknologi IPA memerlukan perhatian lebih dalam peningkatan fasilitas dan pemahaman guru. Analisis data juga menunjukkan capaian yang baik dengan potensi peningkatan, khususnya pada aspek demonstrasi, metode pembelajaran, dan integrasi konten IPA. Observasi terhadap aktivitas guru memberikan gambaran yang positif, sementara persepsi guru terhadap pendekatan berpusat pada siswa menunjukkan adanya kreativitas dalam mengatasi keterbatasan fasilitas. Dengan demikian, peningkatan akses terhadap teknologi dan sumber belajar digital dapat membantu mengatasi kendala dalam mengintegrasikan konten, media, dan metode pembelajaran dalam pembelajaran IPA. Hasil penelitian ini memberikan wawasan penting bagi pengembangan strategi dan kebijakan untuk meningkatkan efektivitas pembelajaran IPA dalam sistem pembelajaran jarak jauh.*

***Kata Kunci:*** *pedagogi, integrasi pembelajaran, ilmu pengetahuan alam, pembelajaran jarak jauh*

## Introduction

Science education is a very important field in forming the young generation with abilities and skills in science and technology. The teacher's ability to teach in the classroom is the key to educational success. Another factor is the active involvement of students in the learning process provided by the teacher. The learning process in the natural science learning context needs to utilize various resources and facilities to trigger student creativity (Conradty & Bogner, 2020; Smyrnaiou et al., 2020). The teaching profession is not enough to have learning material content that must be mastered; a teacher must have various pedagogical, professional, personality, and social competencies (Khasanov, 2022; Rusilowati & Wahyudi, 2020). Pedagogy in natural science learning can facilitate students' building a deep understanding of scientific concepts. The competency can be achieved by adopting a student-centered learning approach to develop critical and creative thinking skills through independent exploration and discovery. However, bad facts show that many teachers still adopt a teacher-centered learning approach (Baghoussi, 2021). The approach only makes students passive objects in the learning process, hindering the development of students' critical and creative thinking skills and limiting their understanding of scientific concepts.

The current educational context is experiencing a significant transformation with the adoption of distance learning, especially since the emergence of the global pandemic (Taylor et al., 2020; Turnbull et al., 2021). The pandemic's need to change classes to distance learning opened many people's eyes to the potential of using educational technology to create virtual classrooms, online tests, and quizzes, of course, as the use of various learning methods and media in an effective way (Erlina et al., 2022; Mahalakshmi & R. Radha, 2020). Many media or tools are needed to convert classes into distance learning, such as conference software, namely Zoom (Marek et al., 2021). Distance education in Indonesia still needs to be improved due to limited facilities and infrastructure, the provision of resources, and the unavailability of a distance education model to guide its implementation (Churiyah et al., 2020; Padmo et al., 2020; Pramana et al., 2021). However, the development of information and communication technology and social media has developed widely, so the integration of information and communication technology in distance learning needs to be increased (Al-Rahmi et al., 2020; Budiastra et al., 2023; Goh & Sigala, 2020; Maliki et al., 2021).

Natural science content integration is an important step in improving science education. This integration hopes to create a holistic curriculum, allowing students to connect concepts from various branches of natural science (Dare et al., 2021; Johnson et al., 2020). In addition, students are expected to be able to see unity in scientific knowledge, increasing their understanding of the relationships between fields such as physics, chemistry, and biology (Sæleset & Friedrichsen, 2021). Integration between fields will encourage students' critical and creative thinking skills because they will face challenges and problems that combine

different aspects of science (Usak et al., 2022). In conclusion, integrating natural science content will positively impact forming a generation with a deeper and more sustainable understanding of the world of natural science. The development of technology and information has caused several major changes in society, especially in the world of education, which requires technology to support the learning process (Clark, 2020; Sima et al., 2020). The use of technology in the digital era requires teachers to have ideas and innovations regarding the learning media used in classroom learning. Optimizing media use with an interesting learning approach and learning resources is one of the learning objectives to achieve the teaching and learning process well (Laksmi et al., 2021). Learning media is needed in natural science learning to integrate the learning methods used (Eliezanatalie & Deta, 2023).

In reality, learning media in various schools still needs to be improved. School science learning media could be more diverse (Eliezanatalie & Deta, 2023). There are still teachers who need help developing learning media. The slow development process is also caused by teachers needing more time to develop media (Antara & Dewantara, 2022). As a result of the needs analysis, it was found that the development of interactive multimedia for natural science subjects is very important and needs to be used in the learning process. Learning activities with digital media can facilitate and support students learning outside the classroom (Nartiningrum & Nugroho, 2020). A teacher must be able to choose effective teaching methods to achieve learning goals. A learning method is only effective for discussing a particular subject but, on the other hand, needs to be more relevant for achieving learning objectives in other subjects (Nadrah, 2023).

In fact, some natural science teachers face serious challenges in the field in terms of teaching methods. One of the bad realities that occurs is the tendency of some teachers to rely on conventional teaching methods without paying attention to students' learning styles. The bad realities result in non-participation boredom and hinder understanding scientific concepts (Ioannidou et al., 2022). Teachers' lack of creativity in delivering material also causes students to have difficulty connecting lessons with practical applications in everyday life. Learning that is less contextual can hurt students' interest in natural science subjects and a learning environment that could be more motivating (Usak et al., 2022). Expectations for integrating content, media, and teaching methods in natural science learning are very high (Regmi & Jones, 2020; Townley, 2020). Hopefully, This will be a dynamic and interesting learning environment, motivating students to dig deeper into natural science concepts. Teachers can present material in an integrated and relevant way through content integration, allowing students to see the connections between the topics studied (Hinduan et al., 2001). Modern media, such as computer simulations, videos, and interactive software, are expected to improve students' understanding by providing visual and practical experiences (Budiastra et al., 2020; Sæleset & Friedrichsen, 2021).

The reality in the field is that bad things often happen regarding the integration of content, media, and teaching methods in natural science learning; that is a disproportion between the use of technology and conventional approaches in teaching natural science (Abu Talib et al., 2021; Saikat et al., 2021). Some teachers may need help aligning the curriculum with learning technology, resulting in a mismatch between the content taught and the media used. The mismatch between teaching methods and student learning styles is also a serious problem. Some teachers may use approaches that do not consider the diversity of students' learning styles, resulting in decreased interest and understanding in natural science learning (Baptista & Molina-Andrade, 2023). The conclusion is that this bad reality shows the need for a holistic approach to overcoming the challenges of integrating content, media, and teaching methods in natural science learning. Joint efforts are needed between schools, teachers, and the government to improve the quality of science education by identifying and overcoming these obstacles.

Despite the growing body of research on science education and distance learning, limited studies have specifically examined the pedagogical integration of content, media, and teaching methods in natural science learning within a distance learning context, particularly in the Indonesian setting. Most previous studies tend to focus on isolated aspects, such as the use of technology or teaching strategies,

rather than examining their integration as a unified pedagogical framework.

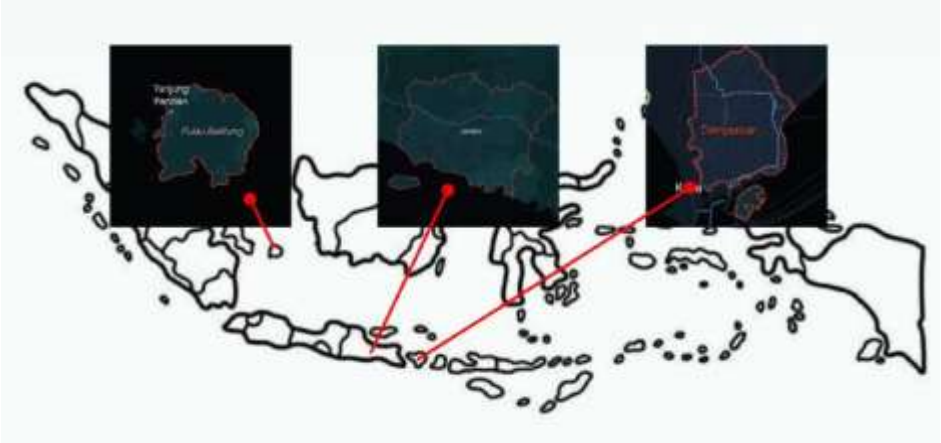
Therefore, the novelty of this study lies in its comprehensive analysis of pedagogical integration by simultaneously examining content, media, and teaching methods within a distance learning system**.** In addition, this study provides empirical insights from diverse geographical contexts, highlighting both the supporting factors and challenges faced by teachers in implementing integrated science instruction.

Accordingly, this study aims to analyze the implementation of pedagogical integration in natural science distance learning, specifically focusing on: (1) the extent to which content, media, and teaching methods are integrated in instructional practice; (2) teachers' pedagogical competence in implementing such integration; and (3) the supporting factors and challenges encountered in the process.

## Method

This type of research is descriptive research. This research describes pedagogical integration in natural science learning in a distance learning system with response sources from 94 teachers and field studies from 9 teachers. The results of the field study include responses, observations, and interviews. The respondents involved were from East Java, Belitung, and Bali.

Figure 1 *Distribution of respondents in the map of Indonesia involved in the research*



The distribution of teachers shows diversity according to the class levels taught, namely class 4 (43 teachers), class 5 (27 teachers), and class 6 (24 teachers). This research involved teachers who had teaching experience varying from 1 to 41 years. This research includes data collection stages with reduction stages as follows.


This reduction stage helps to stay focused on the most important and relevant aspects of the data collected. It is hoped that the research results will provide a clear description of the integration of natural science content, science technology instrument facilities, and teaching methods in distance science learning. Data presentation uses percentages described in the natural science content integration components, science technology instrument facilities, and teaching methods.

## Result and Discussion

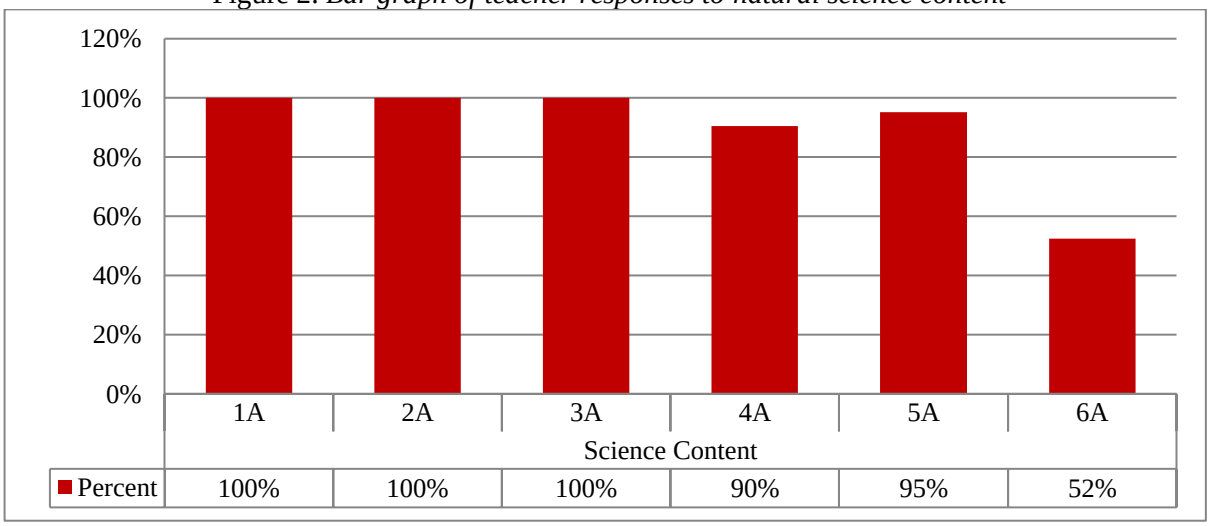
### *Response Result*

Optimizing natural science learning in a distance learning system is crucial in modern education. A focus on pedagogical integration is key to increasing the effectiveness of online learning. Analysis of pedagogical integration in natural science learning is an important step in evaluating the success of distance systems in providing quality learning experiences. This research highlights the importance of integrating natural science content, science technology instrument facilities, and teaching methods in learning. The results of data analysis related to science content, science technology instrument facilities, teaching methods, and integration provide a deep

understanding of the dynamics of natural science learning as a whole.

***Natural Science Content***

Figure 2. *Bar graph of teacher responses to natural science content*




Information:

1A : Teachers are able to prepare students to start learning material by providing motivation and initial questions related to the teaching material.

2A : Teachers are able to provide motivation in the form of examples of phenomena in everyday life.

3A : The teacher is able to provide explanations of material that is easy for students to understand.

4A : Teachers are able to provide assistance and facilitate students' abilities (*scaffolding*) to achieve a higher understanding of the material.

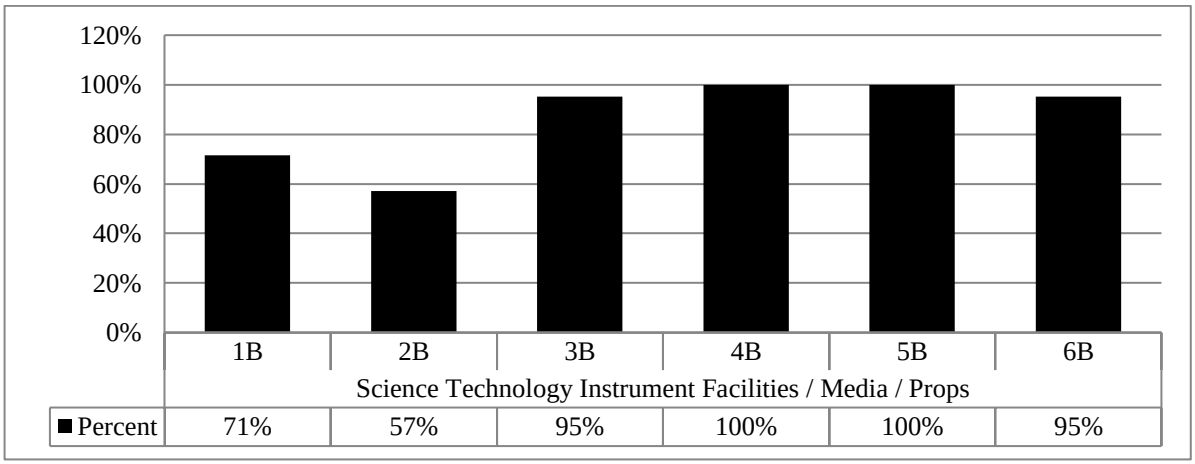
5A : Teachers are able to arrange varied learning activities according to the teaching material.

6A : Teachers never experience misconceptions about science material.

Based on Figure 2, it shows a picture of teacher performance in s natural cience learning. In indicators 1A to 5A, teachers tend to be successful in preparing, providing motivation, explaining the material, providing assistance, and arranging learning activities with percentages tending to be above 85%. However, in indicator 6A, teachers experienced 52% misconceptions about natural science material, indicating the need for improvement or clarification in teachers' understanding of the material. In conclusion, this data provides a holistic view of teacher performance with the identification of strengths and areas requiring further attention.

***Science Technology Instrument Facilities/Media/Props***

Figure 3**.** *Bar graph of teacher response results to science technology instrument facilities / media / teaching aids*




Information:

1B : The school has complete/sufficient science experiment technology instrument facilities.

2B : Teachers always carry out demonstrations or experiments on every science material taught.

3B : Teachers are able to design experimental activities that are appropriate to the teaching material.

4B : Teachers are able to prepare science experiment activity sheets for students.

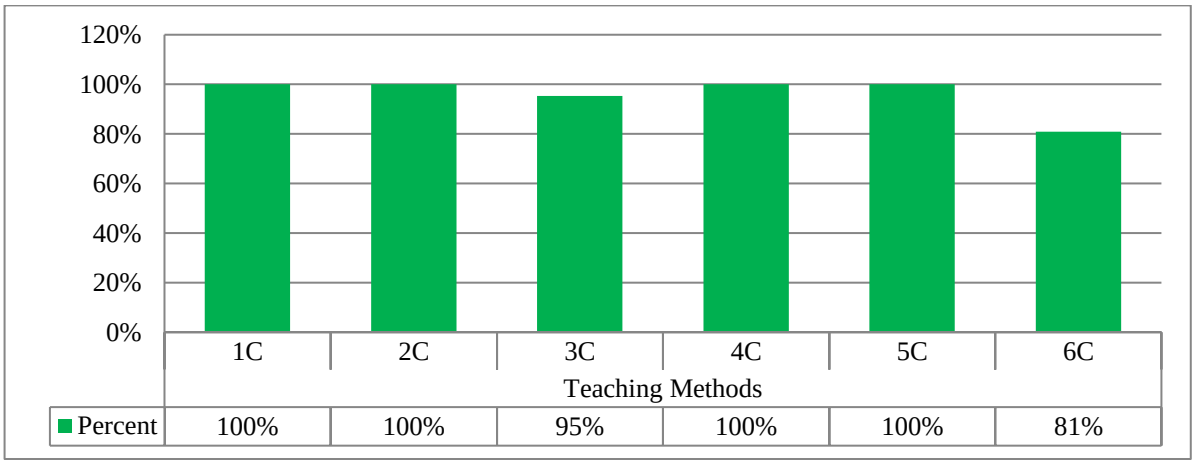
5B : The teacher is able to carry out learning activities in the form of experiments in accordance with the lesson plan.

6B : The teacher is able to carry out science experimental activities well based on the instructions given.

Based on Figure 3, shows a number of aspects related to facilities and implementation of natural science experimental activities in a school. In indicator 1B, it can be seen that the school has complete or sufficient Science Trial technology instrument facilities, with a percentage of 71%, indicating the availability of important facilities to support natural science learning. Indicator 2B shows that 57% of teachers carry out demonstrations or experiments on each science material, reflecting teachers' efforts to provide direct experience to students. Indicator 3B shows that the teacher has the ability to design experimental activities that are appropriate to the teaching material, with the percentage tending to be above 85%, indicating the teacher's skill in preparing activities that are relevant to the curriculum. In indicators 4B and 5B, the teacher succeeded in achieving a percentage tending to be above 85% in preparing experimental activity sheets and carrying out learning activities in the form of experiments in accordance with the lesson plan, showing consistency in planning and implementing experimental activities. Finally, indicator 6B shows that teachers have good abilities in carrying out natural science experimental activities in accordance with the instructions given, with the percentage tending to be above 85%.

***Teaching Methods***

Figure 4. *Bar graph of teacher responses to teaching methods*




Information:

1C : The teacher starts the lesson well so that he gets good attention from the students.

2C : Teachers use varied models/methods that support independent learning.

3C : Teachers are able to organize learning activities that are fun and suit students' needs.

4C : Teachers are able to facilitate students to be active in learning activities.

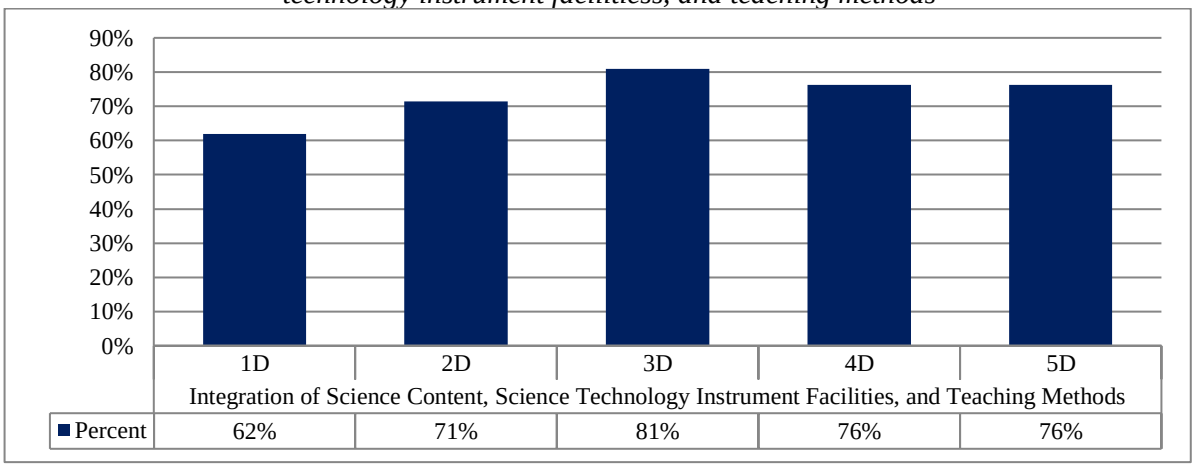
5C : The teacher always closes learning activities with reflection and giving appreciation to students.

6C : Teachers do not experience obstacles in implementing learning models/methods that support independent learning.

Based on Figure 4, it presents teacher performance in the learning context. In indicator 1C, the teacher succeeded in starting the lesson well, attracting students' attention with a success rate tending to be above 85%. Indicator 2C shows the use of varied learning models with similar levels of success. Teachers can also organize fun learning activities according to students' needs, reaching a percentage that tends to be above 85% on the 3C indicator. Even though the results are quite good overall, there are still opportunities for improvement by encouraging teachers to better facilitate students' active participation in learning. At the same time, the 5C indicator shows that teachers are consistent in closing learning with reflection and appreciation. Finally, in the 6C indicator, teachers face few obstacles in implementing learning methods that support student learning independence, with a success rate of 81%.

***Integration of Natural Science Content, Science Technology Instrument Facilities and Teaching Method***

Figure 5. *Bar graph of teachers' responses to the integration of natural science content, science technology instrument facilitiess, and teaching methods*




Information:

1D : Teachers have no difficulty integrating Science Content with Science technology instrument facilities.
2D : Teachers do not have difficulty choosing science technology instrument facilitiess/science teaching aids to teach science in elementary schools.
3D : Teachers have no difficulty integrating science content with the way they teach it.
4D : Teachers do not have difficulty choosing the right teaching method to teach science topics.
5D : Teachers do not experience difficulty integrating science content, and science technology instrument facilitiess with how to teach them.

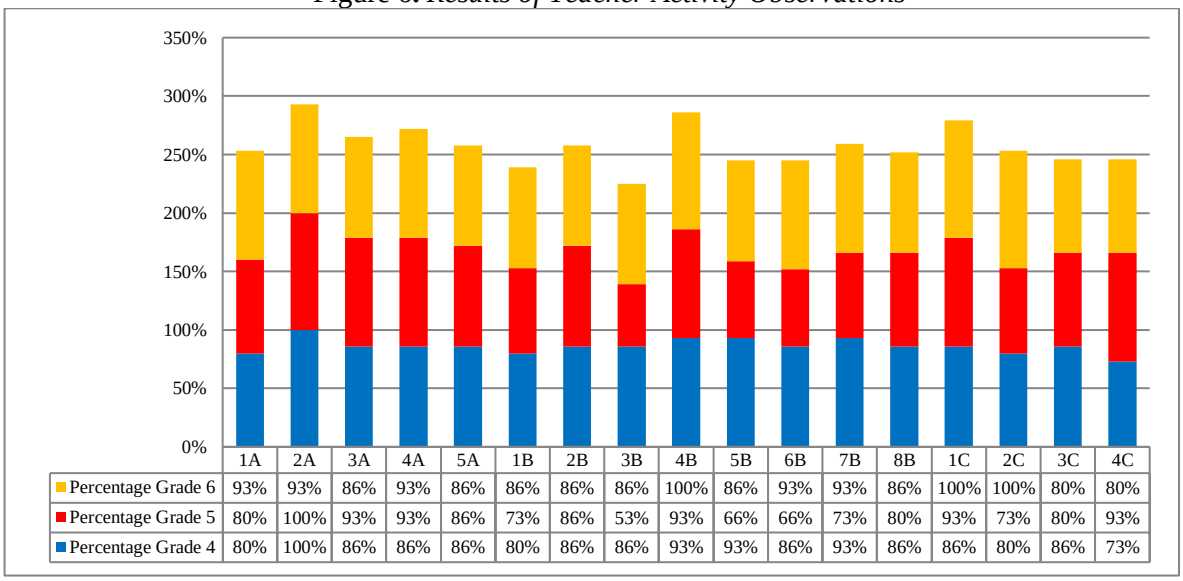
Based on Figure 5, shows the teacher's ability to integrate science content, science technology instrument facilities, and teaching methods in natural science learning in elementary school. Teachers tend to be able to connect lesson material with science technology instrument facilities, as can be seen from the percentage of 62% in indicator 1D. Furthermore, as many as 71% of teachers were able to choose the right science technology instrument facilities to support teaching, as seen in the 2D indicator. The 3D indicator shows that 81% of teachers are able to deliver lesson material using effective methods. In the 4D indicator, as many as 76% of teachers can choose teaching methods that are appropriate to the science topics being taught. Finally, the 5D indicator shows that 76% of teachers can integrate science content, science technology instrument facilitiess, and teaching methods holistically.

***Observation Result***

*Teacher Activities*

The process of improving the quality of learning requires the importance of observing teaching practices to identify emerging patterns and areas that require further attention. Through the results of observations in grades 4, 5, and 6, various aspects of learning that occur in the classroom environment can be explored. This analysis takes us through a series of findings that show a comprehensive picture of teachers' instructional practices across grade levels.

Figure 6. *Results of Teacher Activity Observations*




| | 1A | 2A | 3A | 4A | 5A | 1B | 2B | 3B | 4B | 5B | 6B | 7B | 8B | 1C | 2C | 3C | 4C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage Grade 6 | 93% | 93% | 86% | 93% | 86% | 86% | 86% | 86% | 100% | 86% | 93% | 93% | 86% | 100% | 100% | 80% | 80% |
| Percentage Grade 5 | 80% | 100% | 93% | 93% | 86% | 73% | 86% | 53% | 93% | 66% | 66% | 73% | 80% | 93% | 73% | 80% | 93% |
| Percentage Grade 4 | 80% | 100% | 86% | 86% | 86% | 80% | 86% | 86% | 93% | 93% | 86% | 93% | 86% | 86% | 80% | 86% | 73% |

Information:

1A : Teachers prepare students psychologically and physically to participate in the learning process
2A : The teacher asks questions that link previous knowledge with the material to be studied
3A : The teacher conveys the purpose of studying the material to be discussed
4A : The teacher conveys the scope of the material and explains the activity description
5A : The teacher conducts an apperception before the lesson begins

1B : Teachers use learning models and methods that support independent learning
2B : Teachers connect material/assignments in science subjects with everyday phenomena
3B : The teacher demonstrates the material using learning media and/or science teaching aids
4B : The teacher facilitates students learning in groups
5B : The teacher facilitates students in carrying out experimental activities
6B : The teacher actively involves students in every experimental activity
7B : Teachers facilitate students in cooperative and collaborative learning
8B : The teacher provides accurate material confirmation of the results of student exploration and elaboration
1C : The teacher together with the students makes a summary/conclusion of the lesson that has been carried out
2C : The teacher assesses the activities that have been carried out
3C : Teachers provide feedback on the learning process and outcomes
4C : The teacher presents the lesson plan at the next meeting

Based on Figure 5, it shows that patterns of learning quality can be identified. In the introductory aspect, teachers successfully prepared students psychologically and physically at all levels, increasing the percentage, especially in grade 6. Asking questions that linked previous knowledge to the material showed positive results at all levels, indicating student engagement. In core activities, variations in the use of learning models and methods support independent learning, with grade 6 needing improvement to support students' independent learning. Demonstration of the material and facilitation of students conducting experiments show variations requiring further attention. In the closing activity, the teacher succeeded in making a summary, even though there was a decrease in the percentage in grades 4 and 5, indicating the need for special attention to the evaluation of learning activities. Feedback on the learning process and results and the delivery of learning plans at the next meeting still needs improvement, especially in grade 4.

***Interview Result***

To deepen the understanding of the integration of Natural Science Content, Science Technology Instrument Facilitiess, and Teaching Methods, a series of interviews were conducted with experienced teachers. The results of these interviews provide valuable insight into how teachers integrate science content, utilize science technology instrument facilitiess, and apply teaching methods in natural science learning. The following are the results of interviews that outline best practices and potential improvements in efforts to achieve optimal integration in the learning process.

> *When starting learning in class, I always give greetings, learning objectives, physical preparation, attendance, and remind students of the previous material. The difficulty level is easy because the teaching aids and science technology instrument facilities have facilitated it. Students' understanding of science material varies, depending on each student's abilities. Some of the practicums I have carried out in elementary school involve changes in matter, light, plants, simple machines, and magnetism. I have also taught material about the eye. I faced problems in delivering science material using the Science technology instrument facilities because it was difficult to explain material yet to be real. Supervising equipment during practicum is also a challenge in itself.*

The teacher interviews explained their teaching practices, including class opening routines and assessing the level of learning difficulty which was considered easy thanks to the help of teaching aids and science technology instrument facilitiess. Students' understanding of science material varies according to individual abilities. They have carried out various practicums, such as changes in matter, light, plants, simple machines, and magnetism, as well as teaching

material about the eye. However, teachers face obstacles in delivering abstract material using the Science technology instrument facilities and supervising the tools during practicum.

> *The science experimental technology instrument facilities in schools are sufficient, but not fully adequate for science learning. Student responses during learning were very active and enthusiastic, with a high interest in learning. The advantage is that students understand the material better and are more active in experiments. I overcame the unavailability of a science technology instrument facilities by making it myself, but the obstacles arose from limited practicum time and incomplete tools. I see that there is still a lack of accessible facilities, and I do not always carry out experiments, depending on the availability of tools and materials. Students like to play while learning, especially with experiments. The advantages are that students understand better, it is easier for me to teach, and we gain experience together. I also use learning videos from YouTube and make videos with students, although the main problem lies in preparing the tools and materials, whether I prepare them or ask the students to prepare them.*

The teacher's interview stated that the science experimental technology instrument facilities at his school were adequate but not yet adequate for natural science learning. Students show an active and enthusiastic response, with a high interest in learning, especially in experiments. Even though they overcome the unavailability of science technology instrument facilitiess by making their own, teachers face limited practicum time and complete equipment. Students tend to like learning through play, especially in experiments, which improve their understanding. The use of learning videos from YouTube is also carried out, although the main obstacle lies in the preparation of tools and materials, both by teachers and students.

> *Starting learning optimally is by ensuring that students are physically and mentally ready to participate in learning activities well. The learning methods that I apply include PJBL, PBL, discussion, question and answer, and cooperative approaches. The advantage of these models is that students become more enthusiastic about learning and are able to learn independently. I often use teaching methods with PJBL and discussion because I believe that this method supports the concept of Independent Learning. "The obstacles I face in implementing these models are mainly related to the lack of student activity, interest, and enthusiasm for learning during the learning process.*

The interview describes the teacher's strategy for starting learning optimally by ensuring students' physical and mental readiness. Teachers apply various learning methods such as PJBL, PBL, discussion, question and answer, and cooperative approaches to increase students' enthusiasm for learning and independent learning abilities. Even though they often use PJBL methods and discussions that support the concept of Independent Learning, teachers face major obstacles related to the lack of student activity, interest, and enthusiasm for learning.

***Discussion***

Optimizing the natural science learning process in a distance learning system must be addressed, especially in modern education. One key aspect that needs to be considered is pedagogical integration, which can increase the effectiveness of online natural science learning. Data analysis related to science content, science technology instrument facilitiess, teaching methods, and their integration is a crucial step to understanding the dynamics of science learning as a whole (Hinduan et al., 2001). Figure 2 shows that teachers in Science Content achieved high success in starting learning by providing motivation and relevant initial questions. They succeeded in relating the material to everyday life through examples of phenomena, increasing students' interest and understanding of science concepts. This condition is relevant to research showing that motivation can increase teacher involvement in teaching practices (Hubbard et al., 2022; Ustilaitė et al., 2023). The motivation can contribute to

improving the quality of teaching. Furthermore, the explanation of the material presented by the teacher is easy to understand, reflecting the optimal level of success in increasing student understanding. Although teachers show high commitment to helping students through *scaffolding*, achievement has yet to reach optimal levels. However, the teacher's ability to organize varied learning activities achieved high success. It should be noted that the existence of misconceptions about science material by teachers indicates the need for further efforts to ensure correct and in-depth understanding of the material being taught (Imaduddin et al., 2023).

Based on Figure 3 regarding the results of the science technology instrument facilities response, most aspects have achieved a good level of success. Although most schools have adequate trial science technology instrument facilities, their use has yet to reach optimal levels. Most teachers always demonstrate or experiment on every science material, even though the percentage could be more optimal. Teachers can design experimental activities that are appropriate to the teaching material, achieving high success. They can also prepare science experiment activity sheets, showing readiness to provide clear instructions during experimental activities (Budiastra, 2007). Teachers can carry out learning activities using the lesson plan, showing the link between planning and implementing experimental practice. Although the results are quite good, there is still potential for improvement, especially in increasing experimental science technology instrument facilities in schools and the frequency of demonstrations or experiments by teachers. This increase can improve the overall quality of natural science learning. Relevant research shows that the main function of the practicum is to build students' and teachers' scientific process abilities and support the improvement of teachers' abilities to increase student's interest and motivation toward natural science (Nantsou & Tombras, 2022).

Based on the teaching method responses in Figure 4, most aspects of the teacher's teaching methods achieved high success. Teachers can start learning well, attract students' attention, and use varied models/methods to support independent learning. They organize learning activities that are fun and appropriate to student needs, increasing student motivation and participation. Effective teachers facilitate students to be active in learning, stimulate participation, and increase understanding. Closing learning activities with student reflection and appreciation is important to measure student understanding and provide positive support. Even though there are a few obstacles in implementing the learning model/method, the success rate is still considered good. Evaluation and improvement are needed to minimize these obstacles. Overall, teachers' teaching methods show a good level of success, and a focus on varying methods and diversity of learning activities can be a stepping stone for improving future learning quality. In line with relevant research through various methods, teachers can cover various ways to convey information and enable students to engage in various cognitive abilities (Cao et al., 2023). The various methods can improve understanding and retention of material because students gain broader exposure to the concepts being taught.

Based on the results of responses to the Integration of Natural Science Content, Science technology instrument facilities, and Teaching Methods in Figure 5, it shows that the majority of teachers succeeded in overcoming difficulties in integrating natural science content, Science technology instrument facilities, and teaching methods, reflecting harmony in the presentation of science material in the classroom (Budiastra, 2007). Several aspects that have been successfully addressed include selecting and optimizing science technology instrument facilitiess, selecting appropriate teaching methods, and integrating science content with teaching methods. Even though the results are positive, there are still opportunities for improvement. Teachers in natural science learning have adopted a student-centered approach, dealing with concept understanding with creativity. The support research recognizes the effectiveness of this approach in increasing student engagement and understanding (Ng et al., 2019). A student-centered approach allows the development of students' creativity according to their interests and abilities (Kukulska-Hulme et al., 2022). Learning facilities, such as technology instrument facilities and science laboratories, also influence science learning outcomes in elementary schools (Budiastra et al., 2022).

Factors that support integrating content, media, and teaching methods involve students' enthusiastic responses to learning through experimentation (Fahma et al., 2023). Despite positive support, there are obstacles to integrating science learning, especially in distance learning. (Forbes et al., 2023) identified difficulties in understanding science content, especially with incomplete school science technology instrument facilities. The difficulty level of natural science material in elementary schools varies, requiring increased science technology instrument facilities and adjustments to learning methods according to distance conditions. In addition, some schools need help out with practicums. Science in each material requires an alternative approach. Relevant research shows that virtual simulations and experiments can effectively solve schools with limited participation in direct practicums (Ali et al., 2022). Increasing accessibility to technology and digital learning resources can help overcome obstacles in integrating content, media, and teaching methods in natural science learning (Budiastra et al., 2019).

Based on the results of observations of teacher activities in grades 4, 5, and 6, Figure 6 shows varied learning patterns. In the introduction, students' psychological and physical preparation was generally successful, with increased percentages, especially in grade 6. Asking questions that linked previous knowledge to the material received positive responses at all levels. However, in core activities, variations in the use of learning models are visible, with grade 6 requiring increased support for student learning independence. Students who have independence in learning tend to have the desire to progress and have the ability to take the initiative so that they are more active in learning activities, which will lead to satisfactory learning results (Nurhasnah et al., 2020; Suryani & Maksum, 2020). Demonstration of materials and facilitation of experimental activities also show variations that must be considered. In the closing activity, the teacher succeeded in making a summary, although there was a decrease in the assessment of activities in grades 4 and 5. Feedback on learning processes and outcomes and the delivery of learning plans need to be improved, especially in grade 4. Overall, this observation provides a comprehensive picture of practice teacher learning at various grade levels, and the results can be a basis for designing strategies to improve future learning quality.

Teacher interviews revealed their teaching practices with class opening routines, assessing the level of learning difficulty, and implementing various science practicums. Even though they feel that the science experimental technology instrument facilities are insufficient, teachers need help delivering abstract material using the Science technology instrument facilities and supervising the tools during practicums. Students' responses to natural science learning are active and enthusiastic, with a high interest in learning, especially in experiments. The response is relevant to several previous studies that revealed that experiment-based learning could increase students' interest in learning (Budiastra et al., 2023; Kazula et al., 2022; Nugroho & Waslam, 2020). Even though teachers overcome the unavailability of science technology instrument facilitiess by making their own, the constraints of limited practicum time and completeness of equipment still need to be addressed. Students love learning through play, especially in experiments, which improve their understanding. Even though teachers often use PJBL methods and discussions that support the concept of Independent Learning, the main obstacle is the need for more student activity, interest, and enthusiasm for learning.

## Conclusion

In order to improve the quality of natural science learning at the elementary school level, teachers have achieved high success in several aspects of natural science learning based on data analysis including initial motivation, connection of material to daily life, and explanation of material reaching over 85%. Even though teachers can motivate students, explain the material, and organize varied activities, misconceptions about the material indicate the need for more effort in understanding the concept. Variations in approaches and constraints related to natural science technology instrument facilities were also identified through interviews, emphasizing the need for more attention to improving facilities and teacher understanding. The results of data analysis show good achievements with potential for improvement, especially in demonstrations, teaching

methods, and integration of natural science content. Observations of teacher activities provide a positive picture, while teachers' opinions regarding the student-centered approach show creativity in overcoming facility constraints. Therefore, it is necessary to focus on improving facilities, teacher understanding, and alternative strategies to make natural science learning at the elementary level more effective and enjoyable, using the concept of Merdeka Belajar.

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