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Humanistic and Educational Analysis of Biology Teacher Readiness in Implementing a Deep Learning Approach at State Senior High School 7 North Bengkulu

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Abstract. This study aims to provide a humanistic and educational analysis of Biology teacher readiness in implementing a deep learning approach at State Senior High School 7 North Bengkulu. The deep learning approach is positioned as a learning strategy oriented toward higher order thinking skills, deep conceptual understanding, student autonomy, and reflective learning as key elements of humanistic education. This research employed a qualitative descriptive method. Data were collected through in-depth interviews with Biology teachers, document analysis of lesson plans and learning materials, and questionnaires involving students as respondents. The findings indicate that Biology teacher readiness in implementing the deep learning approach is generally in the "ready" category. Teachers have understood the importance of student-centered learning and the urgency of developing critical and reflective thinking; however, they still face challenges in systematically designing deep learning activities, integrating supportive learning media, and consistently aligning assessment with deep learning principles. These results highlight the need for schools and related stakeholders to provide continuous professional development, intensive training, and mentoring so that the deep learning approach can be implemented more effectively and sustainably in Biology learning as part of a broader humanistic education agenda.

Keywords: Deep Learning Approach, Teacher Readiness, Humanistic Education, Biology Learning.

1. Introduction

Education in the 21st century is required to continuously adapt to technological advances and the increasing demand for critical thinking skills [1]. In this context, the deep learning approach has become increasingly relevant because it aligns with rapid global change and the need to prepare an adaptive future generation [2]. As a paradigm shift, deep learning moves education away from mere content delivery toward learning processes that emphasize conceptual understanding, reflection, and real-life application [3], [4]. This orientation is also reflected in national education policies through the Independent Curriculum, which places deep learning principles at the center of student competency development to ensure relevance and adaptability in a changing world [5], [6]. To meet global competence challenges, today's students must master not only basic knowledge but also higher-order thinking abilities, flexibility, collaboration, communication, and creativity. Sejarah et al. [7] highlight that individuals in the modern era must possess advanced skills to deal with complex issues, indicating a learning paradigm that encourages critical investigation, problem-solving, digital literacy, and creativity. Accordingly, 21st-century learning requires approaches that help students analyze, evaluate, and create meaningful solutions in authentic learning contexts [8].

Deep learning further supports these demands by encouraging students to build complex ideas through critical thinking, reflective engagement, and meaningful social

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interaction. It promotes strong cognitive involvement, information processing, and character development, allowing students to become reflective problem solvers and collaborative learners [9], [10]. This process integrates meaningful, mindful, and joyful learning, enabling students to build deep understanding across cognitive, emotional, and psychomotor domains [7]. The relevance of deep learning is also seen across diverse educational settings, including Islamic-based schools, where reasoning, teamwork, imagination, and expression play central roles in supporting 21st-century competencies [11], [12]. Findings by M. Elbashbishy et al. show that deep learning enhances students' readiness for higher education and future careers by strengthening adaptive and critical thinking skills, improving retention, and promoting knowledge application across contexts [13].

In parallel with these pedagogical demands, teachers are required to adapt learning content, strategies, and resources to the latest curriculum standards. This includes identifying and modifying outdated material, collaborating with colleagues, and engaging in continuous reflection to ensure that instructional practices align with curricular developments [14]. The implementation of the Independent Curriculum in biology learning has significantly transformed key aspects such as lesson planning, material selection, and assessment. The curriculum requires teachers to understand deep learning principles, select contextual materials linked to real-world issues, and apply authentic assessments that capture students' thinking processes rather than merely final outcomes [15]. Biology education, which emphasizes the study of living systems and scientific inquiry, requires teachers who are not only knowledgeable but also capable of guiding students to connect biological concepts with natural phenomena through reasoning and exploration [16]. The effectiveness of classroom learning is strongly influenced by teachers' preparedness, particularly in designing learning experiences aligned with curriculum principles. Limited teacher preparedness often results in low-quality learning processes. Therefore, thorough lesson planning and deep understanding of learning approaches are essential to improving the quality of biology education in the Independent Curriculum era [17].

Based on this understanding, teacher readiness emerges as a crucial factor in ensuring the success of deep learning implementation. Although initial observations at SMA Negeri 7 Bengkulu Utara show positive efforts toward student-centered learning, no previous research has specifically examined biology teachers' readiness to apply deep learning strategies in this context. This gap highlights the need for a comprehensive study focusing on teachers' conceptual understanding, pedagogical application, and the internal and external factors supporting or hindering implementation. Therefore, this study aims to assess the readiness of biology teachers at SMA Negeri 7 Bengkulu Utara in implementing a deep learning approach and to contribute to the growing body of knowledge regarding deep learning practices in Indonesian secondary schools.

2. Method

This study employed a qualitative approach with a descriptive design, as qualitative research is inherently descriptive because it uses narrative explanations and analytical interpretation of textual or visual data [7]. This approach was chosen to obtain a comprehensive understanding of Biology teachers' perspectives, attitudes, and experiences in implementing the deep learning approach in classroom practice. The research was conducted at SMA Negeri 7 Bengkulu Utara from October to November 2025 and involved four Biology teachers who taught Grades X, XI Science, and XII Science. These teachers were selected using purposive sampling because they had experience in lesson planning and had begun to integrate deep learning-oriented strategies into their

teaching. Individuals with extensive experience or expertise in the topic under study are appropriate key informants; therefore, the four teachers served as primary key informants. Students from Grades X, XI, and XII were also included as supporting informants through open-ended questionnaires to validate and enrich the data on classroom implementation.

Data were collected through semi-structured interviews, classroom observations, document analysis, and student questionnaires. Semi-structured interviews were conducted in two sessions of approximately one to two hours with each teacher, guided by an interview protocol focusing on conceptual understanding of deep learning, learning strategies used, perceived readiness, and challenges faced. Classroom observations were carried out to examine the actual implementation of deep learning principles, particularly related to four readiness indicators: pedagogical competence, professional competence, technological readiness, and school environmental support. Document analysis was conducted on lesson plans (RPP), learning modules, and teaching materials to identify the extent to which deep learning stages—such as exploration, elaboration, and reflection—were integrated into instructional design. In addition, open-ended questionnaires were distributed to students in Grades X, XI, and XII to cross-check and triangulate teacher interview and observation data, especially regarding the use of deep learning strategies in Biology lessons.

The data were analyzed using qualitative descriptive analysis. First, data reduction was conducted by transcribing interviews, coding teacher statements, selecting relevant student responses, and summarizing observation notes and document contents. Second, the reduced data were organized and displayed in thematic categories aligned with the research focus, namely conceptual understanding, implementation of deep learning strategies, technological readiness, and environmental and institutional support.

3. Result and Discussion

3.1 Teachers' Conceptual Understanding of the Deep Learning Approach

The results of interviews conducted on October 27, 2025 with Biology teachers at SMA Negeri 7 Bengkulu Utara showed that the level of teachers' understanding of the deep learning approach was in the *good* category, but not yet fully comprehensive. Based on questionnaires, interviews, and analysis of lesson plan documents, most teachers already knew that deep learning is a learning approach that emphasizes active student involvement, the development of higher-order thinking skills, and meaningful, problem-solving-oriented learning. One teacher, for example, stated,

> *"In my view, deep learning means that students are active and do not just memorize, but can explain in their own words".*

Teachers also understand that the primary goal of this approach is for students not only to memorize concepts but also to connect the knowledge gained to real-life situations. However, this understanding remains largely at the conceptual level. Only a small number of teachers were able to explain the concrete steps for implementing deep learning in classroom activities, such as the exploration, elaboration, and reflection stages. One teacher admitted,

> *"For the detailed steps I am still confused; usually I just use an existing lesson plan and adjust it a little".*

Some teachers also tended to equate deep learning with Project-Based Learning or Problem-Based Learning, as reflected in the statement,

"Deep learning is similar to PjBL or PBL, basically there are projects and students work in groups".

This indicates that teachers have not yet fully grasped that deep learning emphasizes in-depth thinking processes involving reflection and integration of knowledge across concepts, beyond merely using certain models or methods. This situation suggests that teachers' understanding still needs to be strengthened through more systematic training and mentoring so they can translate deep learning concepts into contextual Biology lesson plans. These findings align with previous research [18], which emphasizes that deep learning methods are crucial for facilitating the development of relevant learning procedures and the introduction of efficient teaching strategies. The development of higher-order thinking skills, including analytical and critical thinking, is fostered through meaningful learning experiences for students. By actively participating in their own learning, students can enhance their long-term cognitive development and acquire skills that are useful in the workplace and in everyday life. Education experts further underline that purposeful learning helps students develop in-depth knowledge, retain information for the future, and apply what they have learned in real-world situations [18].

Deep learning itself emerged in response to the need to develop higher-order thinking skills as an effort to comprehensively increase individual capacity. According to Ahmed and Mikail [19], major changes that occur in a short time generate new demands for individuals involved in the change process, and these demands can be met through the application of deep learning skills. The implementation of deep learning encompasses fundamental principles that characterize it [20]. One of the three main elements is meaningful learning, which serves as the primary foundation for implementing the deep learning approach. Through meaningful learning, students integrate new information with prior knowledge so that cognitive activity does not merely add isolated pieces of information but builds more complex and interconnected conceptual structures. By linking new experiences to existing understanding, students gain deeper and more lasting insights, in contrast to shallow, rote learning.

3.2 Teacher Readiness in Implementing the Deep Learning Approach

The research results indicate that Biology teachers at SMA Negeri 7 Bengkulu Utara fall into the ready category for implementing the deep learning approach. This conclusion is based on interviews and observations covering four main indicators: pedagogical competence, professional competence, technological readiness, and school environmental support. Observations show that teachers have good skills in designing lessons that involve students' exploratory activities. One teacher explained,

"I have tried to make students explore, for example through simple practicums or observing the environment around the school".

However, implementing deep learning requires more systematic lesson planning and a stronger focus on in-depth thinking processes. Although some teachers have tried to integrate student reflection activities into Biology lessons, this has not yet been carried out consistently in every session. As another teacher admitted,

"I usually do reflection when I have enough time, if the time is tight I often miss it".

From a professional competence perspective, Biology teachers at SMA Negeri 7 Bengkulu Utara generally have a good grasp of subject matter, but are not yet fully able to relate the material to real-life phenomena. The deep learning approach requires teachers to provide meaningful and relevant learning contexts so that students can

connect Biology concepts with everyday experiences and develop higher-order thinking skills. Some teachers acknowledged that time constraints and administrative burdens are inhibiting factors in developing deep learning-oriented lessons. One teacher stated,

> *"Actually, I want to relate the material to everyday life, but sometimes it is hampered by a lot of time and administration".*

As a result, learning often still focuses primarily on cognitive achievement and content coverage, without significantly involving the reflective and applicative aspects that are the hallmarks of deep learning. Teachers' readiness to utilize technology to support deep learning is considered adequate but not optimal. Interviews revealed that some teachers already use simple digital media such as PowerPoint and instructional videos. A teacher mentioned,

> *"Usually I use PPTs and sometimes YouTube videos to explain difficult material".*

However, the use of more interactive technologies such as learning management systems (LMS), virtual labs, or Biology simulation applications remains very limited. This lack of utilization is largely due to limited training opportunities and inadequate supporting facilities. One teacher noted,

> *"For LMS or virtual labs, I have never received special training, so I am still confused about starting it".*

In fact, technology is a crucial component for supporting the deep learning approach, as it enables students to explore concepts more deeply, engage in simulations, and reflect on their learning processes in a more interactive and student-centered manner.

3.3 School Environmental Support

School support for the implementation of innovative approaches has been quite positive, as evidenced by policies encouraging teachers to participate in training and share best practices. However, limited laboratory facilities and technological equipment are key challenges hindering the optimal implementation of deep learning .

Although teachers' conceptual understanding is quite good, their technical readiness for implementation is not yet fully optimal. One teacher stated,

> *"I feel about 80% ready, because I actually still need training and need to understand student characteristics more deeply, and need optimal time preparation to prepare teaching materials and learning media."*

This statement illustrates that although teachers have a positive attitude and are open to innovation, there are still limitations in terms of skills, limited time, and practical experience in the field. These results align with a study [7] that found that educators possess the knowledge and skills necessary to incorporate deep learning into their lessons using methods such as group work, individual reflection, and concrete examples. Curriculum flexibility and institutional support were positive aspects, while limited learning time, varying levels of preparedness, and the lack of process-based assessment tools were negative aspects. According to their feedback, students found the material both engaging and difficult to think about. The study found that having prepared teachers is crucial for implementing deep learning-based history education. This, in turn, requires the right learning infrastructure and intensive training.

Biology learning not only emphasizes mastery of concepts and facts about nature but also fosters a sense of discovery. Students are required to understand basic biological

concepts through reasoning, exploration, and linking various concepts with diverse approaches. This is crucial given that biology is a complex field, filled with unfamiliar terms and abstract concepts. The implementation of the Independent Curriculum in biology learning can facilitate teachers and students to explore biological concepts more broadly. This provides students with the opportunity to learn and deepen concepts at their own pace [21]. Deep Learning approach in biology aims to encourage students to understand biological concepts more deeply through exploratory activities, the use of technology, and the application of knowledge in real-life situations [22].

3.4 Strategies in Implementing the Deep Learning Approach

Based on research results, most biology teachers at SMA Negeri 7 Bengkulu Utara have demonstrated a good understanding of strategies for implementing deep learning approaches in the learning process. The most frequently used strategies include problem-based discussions, collaborative learning, and reflection on learning. Through these strategies, teachers strive to encourage students to think critically, reason logically, and connect biology concepts to real-world phenomena. Interview results indicated that teachers found the discussion strategy highly effective in stimulating active student engagement. This strategy was considered to help students understand the material in depth because they were required to explore information, ask questions, and seek solutions from multiple perspectives. Furthermore, some teachers began implementing mini-projects to integrate theoretical concepts with practical work.

Several teachers expressed challenges in implementing deep learning strategies, particularly related to limited learning time and varying levels of student readiness. These factors prevent teachers from consistently implementing deep learning strategies in every session. Teachers also recognize that the strategy cannot be implemented consistently. Several obstacles, such as limited learning time, differences in student readiness levels, and the need to adapt to technology, are factors that contribute to the gradual implementation of the deep learning approach. One teacher stated,

> *"I want to create more in-depth learning projects, but time constraints and classroom conditions often don't support it, so I implement them gradually, depending on the situation."*

These results are in line with research conducted by [23]which shows that student learning outcomes, including conceptual understanding, higher-order thinking skills, and engagement in the learning process, are positively influenced by the use of continuous immersive learning methodologies. More substantial learning that is tailored to the needs of students in the 21st century can be achieved by using this method, according to the evaluated research. Evidence from teacher-designed lesson plans demonstrates an emphasis on developing students' critical, introspective, and collaborative thinking skills. Lesson plans that incorporate student exchanges, open-ended questions, and assignments that encourage independent investigation are some examples. As a result, teachers are following the guiding principles of deep learning methods in their lesson designs, although their implementation is not yet fully organized .

In this rapidly evolving and increasingly complex information era, schools are required to provide not only theoretical knowledge but also to equip students with critical thinking and problem-solving skills. Since its inception, immersive learning has been recognized as an approach that provides opportunities for students to hone their creativity, critical thinking, and problem-solving skills. This approach can be applied at the elementary level to improve the quality of learning, foster 21st-century competencies, and deepen students' understanding of subject matter. In the 21st century, critical

thinking, collaboration, communication, and creativity are essential elements of an effective learning process. An education system that fails to adapt to these demands has the potential to leave students unprepared for future challenges. In line with these demands, successful curriculum implementation requires various supporting factors, one of which is improving the quality of the learning process [24].

Problem-solving ability is one of the essential 21st-century skills needed in various areas of life [25]. This skill plays a crucial role not only in helping students overcome academic challenges but also in dealing with problems that arise in real-life contexts. However, research shows that many students still struggle to develop effective problem-solving skills, particularly in learning focused on mathematics, science, and technology. Deep learning approach aims to prepare students to face global challenges through meaningful and in-depth learning experiences. For its implementation to be effective, teachers, as the primary facilitators, need to possess and implement a similar mindset in the learning process. The role of teachers is crucial in fostering a deep learning mindset in students. As learning facilitators, teachers must comprehensively understand this concept and be able to integrate it into teaching activities [24]. Through this approach, students not only deepen their conceptual understanding but also develop character, soft skills , and technical skills (hard skills) relevant to the context of life. Thus, students can become competent, independent, and adaptive individuals to global change and challenges.

Teacher readiness is a crucial factor in determining the success of this learning model [26]. In Indonesia, teachers often face challenges adapting to new learning methods, particularly those that require a more interactive and technology-based approach. Deep learning models require teachers not only to understand the subject matter but also to design meaningful and in-depth learning experiences for students. Therefore, teacher training and professional development programs are crucial to ensuring the successful implementation of this learning model.

3.5 Reflection and Self-Development in Implementing the Deep Learning Approach

Based on the research results, biology teachers at SMA Negeri 7 Bengkulu Utara demonstrated a fairly high level of awareness of the importance of reflection and self-development as part of the implementation of the deep learning approach . Most teachers stated that reflection activities were carried out after the learning process, both individually and through discussions with colleagues. The forms of reflection carried out included evaluations of the effectiveness of learning strategies, the level of student engagement, and the achievement of deep learning objectives. Interview results indicate that teachers strive to reflect to identify strengths and weaknesses in the learning process, then make adjustments in the next meeting. One teacher stated,

> *"I reflect to evaluate the strengths and weaknesses of the learning process using the deep learning approach that has been implemented for future improvements."*

This reflection process demonstrates a strong pedagogical awareness in supporting the implementation of deep learning . Teachers still face several obstacles in conducting reflection and self-development, including time constraints due to high administrative burdens and the lack of structured reflective forums at the school level. These conditions prevent the reflection and self-development process from running optimally and sustainably.

These findings are in line with research conducted A study by [27] shows that teachers' reflective, literacy, and philosophical competencies are still not optimal to support the implementation of a deep learning approach. These limitations have the

potential to obscure the true meaning of deep learning and hinder the educational transformation process oriented towards the development of critical thinking. Therefore, this study confirms that strengthening teachers' reflective, literacy, and philosophical competencies is a strategic requirement in facing the epistemological challenges of implementing deep learning in Indonesia.

4. Conclusion

This study concludes that Biology teachers at SMA Negeri 7 Bengkulu Utara are in the ready but not yet optimal category for implementing the deep learning approach. They have a good initial conceptual understanding and have begun to apply compatible strategies, but implementation is still partial and inconsistent, especially in terms of systematic reflection, linking concepts to real-life contexts, and using technology interactively. Limited time, administrative burdens, and inadequate facilities further hinder full application. Therefore, continuous training, mentoring in designing deep learning-oriented lesson plans, and strengthened institutional and technological support are needed to realize truly in-depth and meaningful Biology learning. Schools are expected to provide support in the form of providing adequate learning facilities and infrastructure, as well as creating a reflective culture in the school environment.

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6. Declaration

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