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# The Effect of Deep Learning-Based Contextual Problem on Science Concept Understanding in Slow Learners at Inclusive Schools

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**ABSTRACT**

Exploring deep learning in inclusive schools is urgent, as it plays a crucial role in fostering meaningful learning experiences for students with diverse abilities. This study aims to determine the effect of deep learning based contextual problem on science concept understanding among slow learners in inclusive schools. The research method used is a quasi-experimental design with a pretest-posttest control group design, involving two inclusive classes in the Yogyakarta region. One class served as the experimental group and received deep learning based contextual problem treatment for three weeks, while the control class received conventional instruction. The main instruments were multiple-choice tests to measure understanding of ecosystem concepts, as well as observation sheets of learning activities. The results of the analysis using the Mann-Whitney test showed a significant difference between the experimental and control groups ($p = 0.000$), indicating that this approach is effective in improving science concept understanding among slow learners. Learning was conducted through stages of understanding, application, and reflection, utilizing contextual media, field trips, and environmental management projects that involved the local community. These findings reinforce the relevance of constructivism, situated learning, and experiential learning theories in inclusive education. In addition to supporting cognitive aspects, this model also contributes to students' social skills and learning motivation. The practical implications of this study encourage teachers to apply adaptive and contextual learning strategies, as well as the importance of developing modules and teacher training.



## 1. INTRODUCTION

Science education plays an important role in shaping critical, logical, and systematic thinking skills in students. However, science education in inclusive schools often faces unique challenges, especially when dealing with slow learners. Students with mild intellectual disabilities or slow learners face particular challenges in understanding abstract concepts in science (Kohli et al., 2020). This is due to limitations in working memory, information processing, and difficulty in connecting new information with prior knowledge (Farooq & Aslam, 2020). Slow learners have intellectual abilities slightly below average, are slow in processing information, and have difficulty quickly understanding abstract concepts (Sukma, 2021). These students with special needs require adaptive, contextual, and meaningful learning approaches to optimally understand abstract concepts in science (Wahyuni et al., 2022).

Inclusive schools as educational institutions for students with and without special needs emphasize the importance of flexible, responsive, and individualized learning approaches. In this context, teachers are required not only to deliver general material but also to design learning experiences that take into account the diversity of students' abilities and learning styles (Tomasik et al., 2021). In inclusive school environments, their needs are often inadequately addressed in conventional learning, which tends to be one-sided and does not allow for in-depth exploration. Therefore, it is necessary to apply a learning approach that is participatory, meaningful, and relevant to their real-life contexts. According to Yuwono et al. (2021) an effective inclusive approach is not only about providing physical access to the classroom but also providing pedagogical access through adaptive and participatory learning strategies.

One relevant approach to improving conceptual understanding in slow learners is deep learning. This approach emphasizes high cognitive engagement, meaningful understanding, and the development of strong connections between concepts (Adytia et al., 2022). Deep learning encourages students to construct meaning from the knowledge they learn, rather than simply memorizing facts, making it highly suitable for the learning characteristics of slow learners who require gradual and meaningful learning (Yulianto, 2024). However, for deep learning to be effective for slow learners, the learning materials and methods need to be adapted to real-life contexts that are close to the students' experiences.

The application of deep learning approaches will be more effective when combined with contextual learning approaches. This approach focuses on solving real-world problems that are relevant to students' lives (Dewi et al., 2021) thereby stimulating active engagement, learning motivation, and building bridges between everyday experiences and scientific concepts (Suryawati & Osman, 2018). In the context of slow learners, presenting real-world problems allows them to connect their personal experiences with the scientific concepts being studied, making them easier to understand and remember (Farah et al., 2022). Various studies have shown that contextual learning can improve conceptual understanding, critical thinking, and student engagement (Siry, 2020), including among students with special needs.

Specifically in science subjects, slow learners often face challenges in understanding abstract concepts such as force, energy, or the human body system. Conventional approaches that rely on lectures or memorization are often ineffective for them. Therefore, a method is needed that can facilitate them to “experience” concepts directly through problem-solving based on real contexts (Waite, 2018) . For example, understanding the concept of force can be done through real-life problems such as pushing heavy objects at home, or understanding the digestive system through case studies of daily eating patterns. On the other hand, Suryanti et al. (2020) explain that active and contextual learning approaches can increase the learning motivation of students with special needs. According to Obi et al. (2019), learning that is within the student's proximal development zone, which is between what they can do on their own and what they can achieve with assistance, will be more effective when accompanied by appropriate scaffolding or guidance.

In the context of deep learning based contextual problem, teachers act as facilitators who guide students in understanding concepts through exploratory stages that are appropriate to their abilities. In addition to academic aspects, this approach also has the potential to strengthen the social competencies of slow learners, as it emphasizes group work and collaborative discussion. In an inclusive environment, this is particularly important as it can help build self-confidence, communication skills, and social acceptance. Thus, the benefits of this learning approach extend beyond the cognitive domain to include students' social-emotional development (Hidayah & Utami, 2024). However, there remains a gap in inclusive education practices, particularly in the provision of science learning strategies tailored to individual needs. Teachers often lack explicit guidelines or models that integrate deep and contextual learning approaches for slow learners. Additionally, there are limited studies that explicitly examine the effectiveness of deep learning based contextual problem approaches on science concept understanding among slow learners in inclusive schools. Most previous research has focused on regular students or examined only one approach separately (Tambunan et al., 2020). This gap indicates an urgent need for further research to address science learning issues for students with special needs. Therefore, empirical research is needed to systematically examine the impact of this model based on data. This is also in line with the needs of the independent curriculum, which requires flexibility and fairness for all students.

Based on the above explanation, this study aims to determine the extent of the influence of deep learning based contextual problem on the understanding of science concepts among slow learners in inclusive schools. This study is important to enrich scientific studies on inclusive and deep science learning, as well as to provide practical contributions for teachers in developing meaningful, relevant, and adaptive learning for all students.

## 2. METHODS

This study uses a quantitative approach with a quasi-experimental design to determine the effect of deep learning based contextual problem models on the science concept comprehension of slow learners in inclusive schools. This approach was chosen because the researcher could not randomly assign classes, but could still provide different treatments between the experimental and control groups (Creswell & Creswell, 2018). Jenis desain yang digunakan adalah *Pretest-Posttest Control Group Design*. Desain ini disajikan pada Tabel 1.

**Table 1.** Research design

| Group | Pretest | Treatment | Posttest |
|---|---|---|---|
| Experiment | $O_1$ | X | $O_2$ |
| Control | $O_3$ | Y | $O_4$ |

Description:
O1, O3 : pretest
X : treatment using deep learning based contextual problem
Y : treatment using conventional learning
O2, O4 : posttest

This study was conducted in two inclusive elementary schools in the Special Region of Yogyakarta. The research subjects were slow learners in inclusive classes. The sampling technique used purposive sampling with the following criteria: 1) students identified as slow learners based on psychological assessments or recommendations from special education teachers, 2) actively participating in science lessons, and 3) receiving support from classroom teachers and special education teachers. Two classes were selected as research samples, one class as the experimental group (receiving contextual problem-based deep learning) and one class as the control group (using conventional learning). Each class consisted of 10 slow learner students.

The research instruments are as follows.

a. Science concept comprehension test. The test was developed from the science curriculum indicators for inclusive elementary school students and consists of 20 multiple-choice questions. The test was validated by three experts in science education and special education and has been tested for empirical validity using Pearson's correlation and reliability using Cronbach's Alpha.
b. Learning guide. The lesson plan was developed based on the principles of deep learning and contextual problem syntax, which includes problem orientation, concept exploration, discussion, and reflection.

c. The learning activity observation sheet was used to record student engagement in the learning process, based on indicators of participation, concentration, and response to tasks.

The research procedure is as follows.

a. Preparation stage. The preparation stage involves developing learning tools and instruments, followed by instrument validation by experts, and then obtaining research permission from the school.
b. Implementation stage. The implementation stage involves delivering contextual problem-based deep learning for 6 sessions (3 weeks) in the experimental class and delivering conventional learning in the control class.
c. Evaluation stage. The evaluation stage was conducted by administering pretest and posttest questions to both groups. Additionally, observations were conducted during the learning process.

Data analysis was performed quantitatively using the non-parametric Mann-Whitney test to assess differences in science concept understanding between the experimental and control groups after the intervention. The test was conducted at a significance level of $\alpha = 0.05$. The analysis was performed using SPSS 22.

## 3. RESULT AND DISCUSSION

This study aims to determine the effect of deep learning based contextual problem on science concept understanding, particularly regarding biotic-abiotic relationships in ecosystems, among slow learners. The results were obtained through pretest and posttest in the experimental group with contextual problem-based deep learning and the control group with conventional learning. The results of the Mann-Whitney test using SPSS 22 are presented in Table 2.

**Table 2.** Mann-whitney test results

| Group | Average | Significance |
|---|---|---|
| Experiment | 57 | 0.000 |
| Control | 37 | |

Based on Table 2, there is a difference in science concept understanding between the class using deep learning based contextual problem (experimental class) and the conventional learning class (control class). The results indicate that the use of deep learning based contextual problem significantly influences science concept understanding.

The results of this study indicate that a deep learning based contextual problem significantly improves the understanding of science concepts among slow learners in inclusive schools. The significant increase in posttest scores in the experimental group compared to the control group indicates that this learning model is effective in helping students with intellectual disabilities understand abstract concepts, particularly regarding the interdependent relationships between biotic and abiotic components within an ecosystem. These findings reinforce the view Widhanarto et al. (2023) that deep learning enables the formation of deep conceptual understanding because it encourages students to actively construct meaning rather than just memorizing facts.

The learning implementation was carried out through three main stages: understanding, applying, and reflecting, designed as a series of meaningful and contextual activities. In the understanding stage, students were introduced to the concept of ecosystems through a video comparing clean and polluted rivers, followed by reading an online article about river pollution. This activity aligns with Piaget's cognitive constructivism theory, which emphasizes that knowledge is actively constructed by students through interaction with the environment and new information (Waite-Stupiansky, 2022). In the context of slow learners, this approach provides time and space for them to connect new information with previous experiences, in line with the need for gradual learning.

In the application stage, students visited rivers near the school, discussed with local communities such as the Sleman River Community Forum (FKSS), and conducted direct interviews with the community. This activity reflects Kolb's experiential learning principle, where effective learning occurs through a cycle of direct experience, reflection, conceptualization, and active experimentation. Additionally, the waste management project activities (ecobricks, waste sorting, and mini waste banks) demonstrate the application of Lave and Wenger's situated learning theory, which emphasizes the importance of social context in learning. In this case, students do not merely learn science as abstract knowledge but as part of practical, relevant activities in their daily lives.

The reflection stage involves individual journals, self-evaluation, and project presentations that receive feedback from teachers and subject matter experts. This reinforces the metacognitive principles of deep learning, where students are encouraged to become aware of their learning processes, evaluate their achievements, and plan their next steps. This activity also aligns with Vygotsky's scaffolding approach, which emphasizes the importance of support from teachers and the environment to help students reach their zone of proximal development (Yıldız, 2025).

In general, this learning not only impacts students' cognitive understanding but also supports the development of social skills such as collaboration, communication, and environmental awareness. This is particularly important in inclusive education, where learning success is not only measured by academic aspects but also by students' social-emotional abilities (Pratama et al., 2021). The strengths of this study lie in its context-rich learning design and diverse activities, which enable slow learners to engage actively and meaningfully. Activities that utilize digital media, field exploration, and collaboration with local communities strengthen the relevance of learning and make it easier to understand. Additionally, project-based learning provides students with opportunities to demonstrate creativity and independence. However, this study also has several limitations. The limited number of participants (18 students) restricts the generalizability of the results. Another limitation is the relatively short duration of the intervention (3 weeks), which is insufficient to observe the long-term impact of this learning model. Furthermore, the assessment focuses on cognitive aspects and does not systematically evaluate the impact of learning on affective and psychomotor aspects.

This study has important implications. Theoretically, it reinforces the position of constructivism, situated learning, and experiential learning as the foundation for developing inclusive and adaptive science education. Practically, teachers in inclusive schools can apply a similar approach to design learning that is relevant and responsive to the needs of slow learners. The science curriculum also needs to provide flexibility so that contextual problem-based approaches can be integrated into learning activities. Recommendations from this study include the need to develop modules or implementation guidelines for deep learning based contextual problem for inclusive teachers, expanding the research with a larger sample and longer duration, and strengthening teachers' capacity through training in deep learning based contextual problem for special needs contexts. Furthermore, further research could explore the impact of this model on students' motivation, social engagement, and environmental awareness as important dimensions in 21st-century education. Thus, the deep learning based contextual problem approach has proven to be a relevant, adaptive, and inclusive strategy in science education for slow learners. This learning places students as active subjects in the learning process, enabling them to connect scientific concepts with their real lives while building important 21st-century skills for the future.

## 4. CONCLUSION

Based on the research findings, deep learning based contextual problem has been proven to significantly improve science concept understanding among slow learners in inclusive schools. This indicates that integrating meaningful cognitive approaches with real-life contexts can bridge limitations in understanding abstract concepts. The theoretical implications reinforce the relevance of constructivism, experiential learning, and situated learning theories in inclusive education. Practically, this approach offers a strategic alternative for teachers in designing adaptive and participatory learning, especially within the independent curriculum. Further research is recommended to involve a larger sample size, longer intervention duration, and to evaluate students' affective and psychomotor aspects. Additionally, the systematic development of learning modules and teacher training is a strategic step to expand the application of this approach in various inclusive school contexts.

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