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The Potential of ESD-Oriented Learning in Environmental Change Materials

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A B S T R A C T

The issues of sustainability and environmental degradation require learning strategies that equip students with 21st-century knowledge, values, and skills. This study aims to analyze teachers' needs, the potential for implementing differentiated learning designs, understanding of ESD values, and schools' readiness to support its implementation. The study uses a qualitative descriptive method through a survey of 50 biology teachers from high schools in Semarang Regency, Semarang City, and Kendal. Data were collected through questionnaires, interviews, observations, and documentation, then analyzed using triangulation techniques in the form of data reduction, data presentation, and conclusion drawing and verification. The results showed that teachers had a high need for more effective and adaptive learning designs and viewed positively the potential application of differentiated learning in helping students understand environmental change material. In addition, teachers demonstrated a strong understanding of the importance of integrating ESD values into biology learning. The readiness of schools was also considered quite good, as evidenced by the availability of facilities and innovation spaces for teachers. Overall, the results of the study confirm that the implementation of ESD-oriented differentiated learning has great potential to be optimally applied because it is supported by teacher readiness, school support, and its relevance to the needs of contemporary biology learning.

1. Introduction

Education is understood as a directed process that helps students develop the intellectual potential, attitudes, and skills needed to face the dynamics of 21st-century life (Hermansyah & Muslim, 2020). In biology, particularly in the subject of environmental change, learning outcomes require students to be able to analyze the factors causing environmental change, its impacts, and formulate sustainable solutions relevant to contextual issues (Nisak, 2023). This requirement indicates

that students not only need to understand concepts, but are also expected to have critical thinking skills and adequate ecological awareness (Khoerunisa, 2024; Labobar & Kapojos, 2023; Maharani, 2024)). However, various reports indicate that Indonesian students' understanding of science literacy is declining. The 2022 PISA results show that Indonesia's science literacy has improved significantly, as evidenced by Indonesia's rise of six places in the rankings compared to the previous assessment (OECD, 2022). However, Indonesia's score also declined due to the impact of the Covid-19 pandemic, falling by 13 points from 396 to 383.

Preliminary study results conducted on all 10th grade students at the Indonesian Institute High School showed that the majority of students were unable to identify forms of environmental change and had difficulty relating them to their daily lives. Students also appeared to be passive in the learning process and showed low motivation when asked to evaluate environmental issues around them (Zhang & Crawford, 2024). This situation shows that learning is still oriented towards memorization, thus providing fewer opportunities for students to develop higher-order thinking skills and problem-solving skills (Gradini et al., 2025; Sumarli et al., 2021). This situation also emphasizes the need for learning innovations that can provide meaningful and relevant learning experiences for students (Nabila et al., 2025). One solution that can be implemented is the use of the Education for Sustainable Development (ESD) approach, which encourages students to understand environmental issues in a more critical, contextual, and applicable manner (Kusumasari et al., 2025; Latifah et al., 2023; Purnamasari & Hanifah, 2021; Rahma et al., 2025; S. T. Wahyuni & Rusli, 2024)).

(Vioreza et al., 2023) states that Education for Sustainable Development (ESD) is an educational approach that emphasizes the development of knowledge, values, and skills necessary to achieve sustainable development. In environmental change material, ESD provides a learning framework that guides students to understand the relationship between human activities, environmental damage, and the choices that can be made to maintain ecosystem sustainability (Ferguson et al., 2022; Oe et al., 2022). The substance of ESD, which covers ecological, social, and economic aspects, is highly relevant in helping students view environmental change in an integrated manner (Hung & Pan, 2025; Najwa & Suhartini, 2023). Through this approach, students can understand that environmental issues cannot be separated from human behavior and the social systems that surround them (Misiaszek, 2023). However, in order for each student to be optimally involved, learning needs to be designed according to their individual needs. Thus, the presence of a learning approach that is able to accommodate the diversity of students, such as differentiated learning, is very important in supporting the ESD-based learning process (Erlinawati et al., 2024; S. Wahyuni et al., 2024).

Differentiated learning is an approach that adapts the learning process, content, and products based on the readiness, interests, and learning profiles of students (Sukma & Fajriyah, 2025). This approach allows each student to learn in the way that suits them best, making learning more effective and meaningful (Siganglingging, 2023). In ESD, differentiated learning enables the creation of diverse learning experiences that remain oriented towards sustainability goals (Latifah et al., 2023). In

environmental change material, students can choose learning activities that suit their learning styles, such as conducting field projects, analyzing environmental data, reviewing case studies, or designing creative solutions to ecological problems around them. The synergy between ESD and differentiated learning allows students to not only understand environmental change, but also develop critical thinking, collaboration, communication, and real actions relevant to sustainability issues.

A number of previous studies have shown that ESD can increase students' environmental awareness, concern, and literacy through contextual and reflective learning experiences. Several other studies related to differentiated learning report that this approach is effective in increasing student engagement, critical thinking skills, and learning outcomes, especially in analytical subjects (Masrukhah et al., 2024). However, although these findings indicate the potential benefits of each approach, studies that integrate ESD with differentiated learning simultaneously are still limited. Specifically, regarding environmental change material at the high school level, there is still little research examining the effectiveness of combining these two approaches. The majority of previous studies have focused only on the implementation of ESD or differentiation separately, thus failing to provide a comprehensive picture of how the two can reinforce each other in learning. Based on this description, this study was conducted with the aim of analyzing teachers' needs, the potential for implementing differentiated learning designs, understanding of ESD values, and schools' readiness to support its implementation.

2. Methodology

The research method used in this study was qualitative descriptive research (Furidha, 2024), which aimed to describe in depth the implementation of ESD (Education for Sustainable Development)-oriented differentiated learning in environmental change material (John W. Cresswel & Poth, 2020). Data collection was conducted through a survey of 50 biology teachers teaching at high schools in Semarang Regency, Semarang City, and Kendal. Respondents were selected randomly to ensure diversity of perspectives and to obtain a more representative picture of current teaching practices. Data collection techniques included observation, questionnaires, interviews, and documentation studies, so that the information obtained could complement each other.

The research procedure was carried out through several systematic stages. The first stage was the preparation stage, which included the preparation of research instruments in the form of observation guidelines, questionnaires, interview guidelines, and document analysis formats, as well as content validity testing through expert judgment. The second stage is the collection of data in the field, starting with the distribution of questionnaires to respondents, followed by observation of the learning process, in-depth interviews with selected teachers, and the collection of supporting documents such as teaching modules and learning tools. The third stage is the continuous processing and analysis of data from the moment it is collected, through the processes of reduction, categorization, and presentation of data in accordance with the principles of triangulation techniques. The final stage

is drawing conclusions and verifying findings by comparing the results from various data sources to ensure the consistency and validity of the information obtained.

All data were analyzed using triangulation techniques, referring to the stages of data reduction, data presentation, and conclusion drawing and verification. This approach was chosen so that the research results could provide a comprehensive picture of how ESD and differentiated learning are integrated in biology classes, as well as the extent of their contribution to improving students' understanding of environmental change. Data triangulation was conducted by integrating data from questionnaires, interviews, observations, and documentation to provide a comprehensive understanding of the research findings. Questionnaire data are presented as percentages to illustrate teachers' needs, perceptions, and readiness. The data are then explored in greater depth through the interpretation of interview results to clarify and elaborate on the findings. Observations and documentation are also used to support and validate the consistency between teachers' statements and actual school conditions. The integration of all data can strengthen the validity of the findings.

3. Results and Discussion

This study conducted a survey to identify the potential for applying differentiated learning oriented towards Education for Sustainable Development (ESD) in environmental change material at the high school level. The survey was conducted in the Biology MGMP community in Semarang Regency, Semarang City, and Kendal Regency as representatives of Biology teachers in the region. A total of 50 teachers participated as respondents and provided answers through a questionnaire designed to capture their needs, potential, understanding of ESD values, and readiness to implement differentiated learning designs. The collected data are presented in the form of a graph in Figure 1 to illustrate teachers' perceptions of the integration of differentiated learning and ESD in environmental change material. These results also serve as a starting point for analyzing how such learning designs can be developed and implemented more effectively in schools.

Based on the graph, it can be seen that the majority of Biology teachers show a strong need for more effective learning designs that are able to accommodate the diversity of students. Regarding the statement "the current Biology learning design is ineffective," most respondents agreed (52%) and strongly agreed (22%), indicating that teachers see limitations in the current learning model. In addition, 48% of teachers agreed and 20% strongly agreed that the learning design used was not sufficient to help students understand Biology material, with only 32% disagreeing.

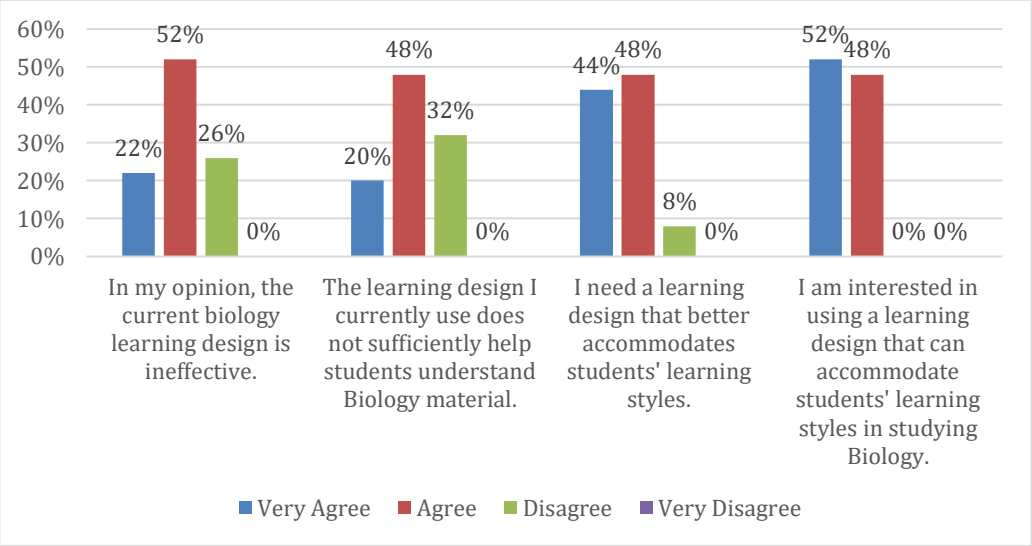

Figure 1. Teachers' Responses to Learning Design Needs

This condition reinforces the picture that teachers feel that existing learning does not provide optimal support for students. The need for learning designs that can accommodate students' learning styles is also very apparent. Regarding this statement, 48% agreed and 44% strongly agreed, with only 8% disagreeing. Furthermore, teachers' interest in using adaptive learning designs is also very high, as evidenced by 48% agreeing and 52% strongly agreeing, with no teachers disagreeing. These findings indicate that the need for learning innovation, particularly through differentiated learning, is highly relevant and receives strong support from teachers.

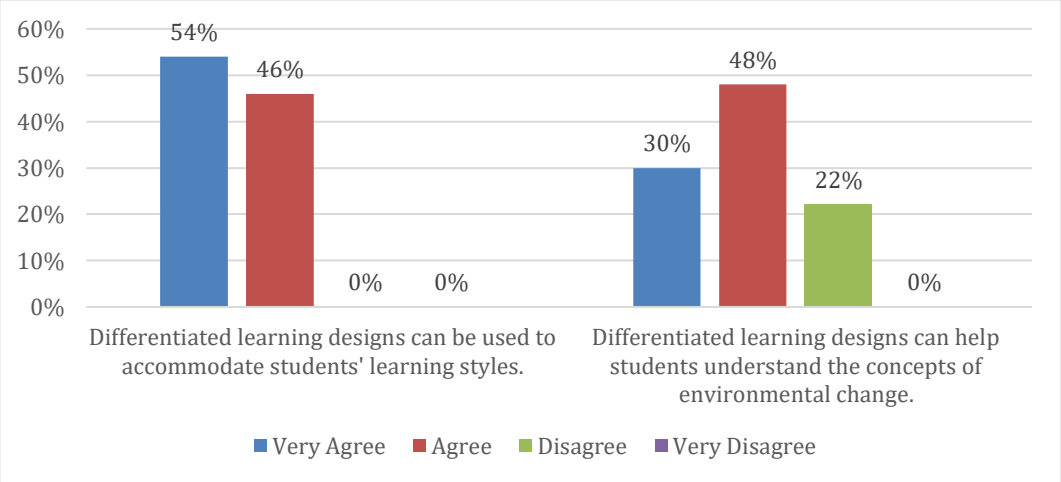

Figure 2. Teachers' Responses to the Potential of Differentiated Instruction Design

Based on the graph, teachers' perceptions of the potential of differentiated instruction design show a very positive trend. On the first indicator, namely the ability of differentiated learning design to help students understand the concepts of environmental change, the majority of teachers gave affirmative responses, with 48% agreeing and 30% strongly agreeing. However, there were still 22% who

disagreed, indicating that some teachers may not fully understand the operational mechanisms of differentiation or do not have direct experience in its application. This condition may indicate the need to improve teacher competence through more intensive training or mentoring related to the planning and implementation of differentiation. On the second indicator, namely the ability of differentiated learning design to accommodate student learning styles, all respondents expressed full support, with 46% agreeing and 54% strongly agreeing. The absence of respondents who disagreed indicates a very high level of acceptance. This shows that teachers have recognized learning style diversity as one of the fundamental factors in successful biology learning, especially for material that requires conceptual understanding and analysis, such as environmental change. The high level of agreement also confirms that teachers view differentiation as an approach that is not only theoretical but also practical for improving learning effectiveness in the classroom.

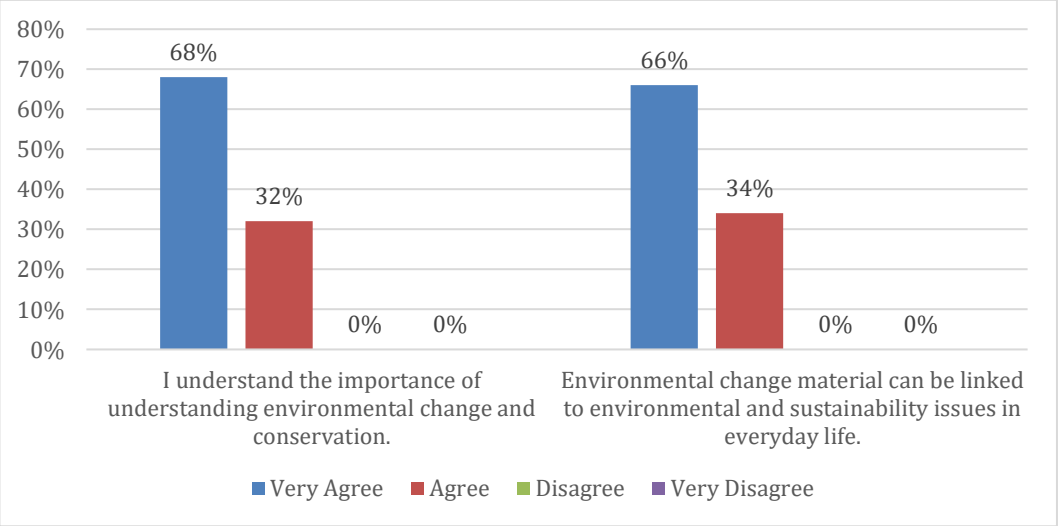

Figure 3. Teachers' Responses to the Integration of ESD Values

The diagram shows that teachers have a very positive view of the integration of Education for Sustainable Development (ESD) values in teaching environmental change. All teachers agreed or strongly agreed that environmental change can be linked to sustainability issues and everyday life, as seen from 66% strongly agreeing and 34% agreeing. In addition, 68% of teachers also strongly agreed that understanding environmental change and conservation is important to teach students. These findings show that teachers recognize the high relevance of ESD and the urgency of its integration into learning, so that teachers are prepared and committed to developing learning designs that not only teach concepts but also instill environmental awareness in students.

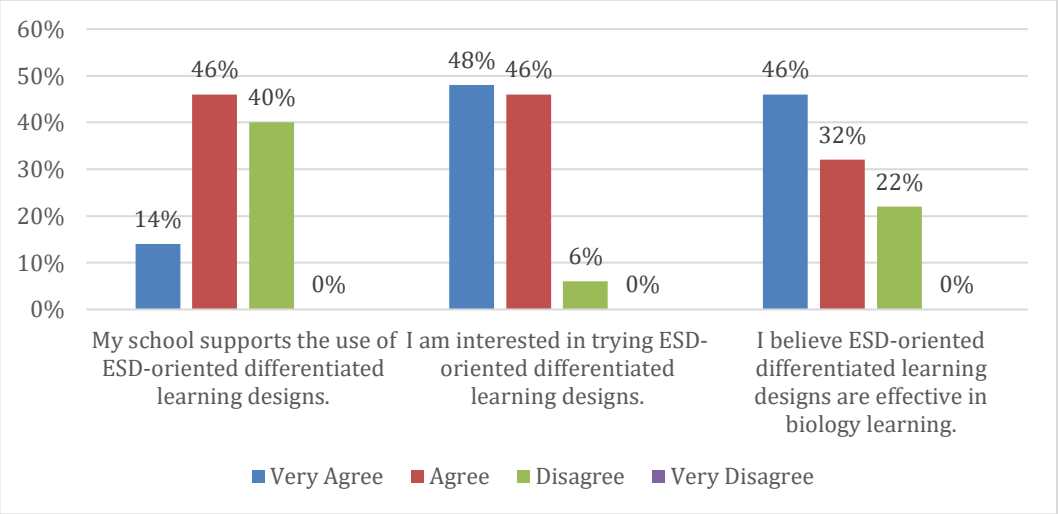

Figure 4. Teachers' Responses to Implementation Readiness in Schools

Based on the questionnaire results, teachers showed a high level of readiness to implement ESD-oriented differentiated learning designs in schools. The majority of teachers believed that the application of these designs was effective for biology learning, as seen from the dominance of agree and strongly agree responses. Teachers' interest in trying this learning model is also very strong, as shown by the high percentage of respondents who gave positive ratings, while only a small number of teachers disagreed. In addition, teachers also rated the school's support for the use of ESD-oriented differentiated learning design as high, indicating that the school environment is relatively ready to support learning innovation. These findings show that both teachers and schools are adequately prepared to implement ESD-based differentiated learning, thereby increasing the chances of its successful implementation in the classroom.

Discussion

The results of the study show that teachers have a high need for more adaptive biology learning designs. The research findings are presented through data triangulation, which integrates quantitative and qualitative data to strengthen the findings. Questionnaire data, presented as percentages, describe teachers' needs, perceptions, and readiness. The findings are then confirmed and clarified using in-depth interview data with contextual responses. Observation and documentation data are also included to provide a comprehensive explanation of the relationship between teachers' statements and actual conditions. This method allows for an objective explanation through questionnaire data confirmed by other supporting data.

The questionnaire data shows that most teachers stated that the learning designs that have been used so far are not fully effective, mainly because they are unable to accommodate the diversity of learning styles and learning readiness of students. Teachers assessed that classroom learning is still dominated by lectures and activities that are the same for all students, making it difficult to meet the learning

needs of a heterogeneous group. This finding was reinforced by interviews, in which teachers said they needed a more flexible and responsive learning design that could support the understanding of abstract concepts such as environmental change. Teachers also revealed that current learning activities do not engage all students, so a model that facilitates participation and task differentiation is needed. Overall, teachers view the renewal of learning design as an urgent need for biology learning to be more effective and contextual. This conclusion is in line with research (Goyibova et al., 2025; Nabila et al., 2025) which demonstrates the need for varied learning designs that are tailored to classroom needs, as well as research (Adiniyah & Utomo, 2023) which confirms that differentiated learning is an important solution in addressing student diversity.

The research shows that teachers have a positive view of the application of differentiated learning design in biology lessons. The questionnaire results show that the majority of teachers agree and strongly agree that differentiation can help students understand the concept of environmental change and adapt learning to their learning styles. Interviews reinforce these findings, with teachers stating that differentiation allows students to learn according to their individual needs, making it easier for them to understand complex material. Teachers also see that differentiation can increase motivation because students feel that their differences are valued. However, teachers acknowledge the need for skills in mapping student learning profiles and providing appropriate task variations. Despite the challenges, teachers still see differentiation as having great potential to improve the quality of Biology learning. This view is in line with research (Rohmah & Zulfitria, 2024) which states that differentiation increases student motivation and learning achievement, as well as research (Fitriani, 2020) which found that differentiation is effective for science learning because it facilitates diverse learning needs.

The results of the study show that teachers have a strong understanding of the importance of integrating ESD values into biology learning. The questionnaire data showed that the majority of teachers strongly agreed that environmental change material was highly relevant to sustainability and everyday environmental issues. Interviews reinforced this finding, with teachers stating that issues such as global warming, pollution, and the waste crisis were real-life examples that could help students understand the concept of environmental change in a more practical way. Teachers assessed that ESD integration not only builds knowledge but also fosters students' attitudes of care and responsibility towards the environment. They emphasized that ESD-based learning helps students understand the relationship between human actions and the sustainability of the earth. Overall, teachers see ESD integration as an important part of modern Biology education. These findings are supported by research (Khoiri et al., 2023; Vioreza et al., 2023) which shows that ESD is capable of shaping students' awareness of sustainability, as well as research (Agusti et al., 2019) which found that ESD integration improves students' pro-environmental awareness and behavior.

The results of the study show that teachers consider schools to be sufficiently prepared to support the implementation of ESD-oriented differentiated learning. The questionnaire shows that teachers agree to strongly agree that schools support

learning innovation and that ESD-oriented differentiated design is effectively applied in biology learning. Teachers in interviews stated that schools have provided basic facilities such as LCDs, internet access, and an environment that supports teacher creativity. They also felt that the principal and colleagues provided moral support to try new learning models. However, teachers emphasized the need for further training, the development of differentiation tools, and collaboration time to design more mature learning (Grecu, 2023; Wibowo et al., 2025). Overall, teachers saw that the school's readiness was quite good, but still needed improvement, especially in the provision of facilities, training, and implementation assistance. This assessment is in line with research (Rahmawati et al., 2025) which found that institutional support is a key factor in the success of learning innovation and research (Pratiwi, 2022) which confirms that school readiness affects the effectiveness of ESD-based learning integration.

The integration of findings from this research presents a synthesis of results as a guide for developing concrete classroom learning models. The need for adaptive learning designs tailored to classroom needs serves as a crucial foundation for accommodating the diverse needs of students in the classroom. These needs are reinforced by teachers' strong understanding of ESD values, thereby providing a conceptual and factual foundation for biology instruction. High levels of school readiness, marked by the fulfillment of facility needs and institutional support, foster a conducive learning environment (Mambwe et al., 2024; Sher & Inamullah, 2025). The convergence of these three aspects indicates that ESD-oriented differentiated instruction can be implemented through contextual and student-centered activities. Through this approach, students can understand concepts of environmental change and develop environmental literacy and critical thinking. Thus, the findings of this study reflect teachers' perceptions and demonstrate the strong potential for the practical implementation of ESD-based differentiated instruction in biology education.

4. Conclusion

Based on the overall findings of the study, it can be concluded that teachers' readiness to implement ESD-oriented differentiated learning design is in the excellent category. Teachers not only believe in the effectiveness of this approach in improving the quality of biology learning, but also show a high interest in trying and adopting it in their teaching practices. The support of the school further strengthens this readiness, creating an institutional environment that is conducive to the sustainable implementation of ESD. These findings indicate that the integration of ESD through differentiated learning has great potential for optimal implementation, as it is supported by adequate institutional beliefs, motivation, and facilities. Therefore, this study confirms that schools have strong potential to develop sustainability-oriented learning, and the next steps can be directed towards strengthening training, mentoring, and providing resources as efforts to expand and deepen ESD practices in the educational environment.

References

Adiniyah, N., & Utomo, A. P. (2023). Implementasi Model Project Based Learning Berdiferensiasi berdasarkan Kesiapan belajar Peserta Didik pada Materi Sistem Imun Kelas XI SMA. *Jurnal Teknologi Pendidikan*, *1*(1), 1–9. https://doi.org/10.47134/jtp.v1i1.36

Agusti, K. A., Wijaya, A. F. C., & Tarigan, D. E. (2019). *Problem Based Learning Dengan Konteks Esd Untuk Meningkatkan Keterampilan Berpikir Kritis Dan Sustainability Awareness Siswa Sma Pada Materi Pemanasan Global*. *VIII*, 175–182.

Erlinawati, B., Roshayanti, F., & Nugroho, A. S. (2024). Profil Pembelajaran Berdeferensiasi Berorientasi ESD pada Materi Ekologi dan Keanekaragaman Hayati di SMP N 1 Wirosari Kabupaten Grobogan. *Jurnal Inovasi Pembelajaran Di Sekolah*, *5*(1), 071–076. https://doi.org/10.51874/jips.v5i1.207

Ferguson, T., Roofe, C., Cook, L. D., Bramwell-Lalor, S., & Hordatt Gentles, C. (2022). Education for Sustainable Development (ESD) Infusion into Curricula: Influences on Students' Understandings of Sustainable Development and ESD. *Brock Education Journal*, *31*(2), 63–84. https://doi.org/10.26522/brocked.v31i2.915

Fitriani, D. (2020). *Implementasi Pembelajaran Diferensiasi Berdasarkan Aspek Kesiapan Belajar Murid Di Sekolah Menengah Atas*. 1–12.

Furidha, B. W. (2024). Comprehension Of The Descriptive Qualitative Research Method: A Critical Assessment Of The Literature. *Journal of Multidisciplinary Research*, *2*(4), 1–8. https://doi.org/10.56943/jmr.v2i4.443

Goyibova, N., Muslimov, N., Sabirova, G., Kadirova, N., & Samatova, B. (2025). Differentiation approach in education: Tailoring instruction for diverse learner needs. *MethodsX*, *14*, 103163. https://doi.org/10.1016/j.mex.2025.103163

Gradini, E., Firmansyah, B., Noviani, J., & Ulya, K. (2025). Fostering Higher-Order Thinking Skills in Mathematics Education: Strategies, Challenges, and Classroom Practices. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *13*(2), 135. https://doi.org/10.33394/j-ps.v13i2.15099

Grecu, Y. V. (2023). Differentiated instruction: Curriculum and resources provide a roadmap to help English teachers meet students' needs. *Teaching and Teacher Education*, *125*, 104064. https://doi.org/10.1016/j.tate.2023.104064

Hermansyah, H., & Muslim, M. (2020). Urgensi Pengembangan Keterampilan Belajar Abad 21 Di Pendidikan Dasar. *EL-Muhbib: Jurnal Pemikiran Dan Penelitian Pendidikan Dasar*, *3*(2), 184–199. https://doi.org/10.52266/el-muhbib.v3i2.395

Hung, L.-C., & Pan, H.-J. (2025). Innovative Approach to ESD Integration into School-Based Curriculum Development Modules for Elementary Schools. *Sustainability*, *17*(4), 1427. https://doi.org/10.3390/su17041427

John W. Cresswel, & Poth. (2020). *Qualitative inquiry and research design: Choosing among five approaches (4th ed.)*. SAGE Publication.

Khoerunisa, S. (2024). Karakter Peduli Lingkungan Peserta Didik Dalam Penerapan Eco Literacy untuk Mendukung ESD Di Sekolah Dasar. *Jurnal Penelitian Pendidikan*, *24*(1), 110–118.

Khoiri, N., Hayat, M. S., & Siskawati, D. (2023). Sustainability Awareness Profile of Locational School Students Through ESD-Oriented Project Based Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 932–938. https://doi.org/10.29303/jppipa.v9iSpecialIssue.6239

Kusumasari, S., Patonah, S., & Sumarno, S. (2025). Pengembangan Perangkat Pembelajaran Berbasis Steam Berorientasi Esd Untuk Meningkatkan Kreativitas Dan Kemandiarian Siswa. *LEARNING : Jurnal Inovasi Penelitian Pendidikan Dan Pembelajaran*, *5*(2), 609–619. https://doi.org/10.51878/learning.v5i2.4860

Labobar, J., & Kapojos, S. (2023). Membangun Kesadaran Lingkungan: Implementasi Pendidikan Lingkungan Hidup di SMP Negeri Distrik Sentani. *Civic Education and Social Science Journal (CESSJ)*, *5*(2), 94–109.

Latifah, N., Hayat, M. S., & Khoiri, N. (2023). Potensi Implementasi Pembelajaran Berdiferensiasi Berorientasi ESD dalam Projek IPAS Aspek Zat dan Perubahannya. *Jurnal Penelitian Pembelajaran Fisika*, *14*(2), 261–268. https://doi.org/10.26877/jp2f.v14i2.16955

Maharani, A. (2024). Membangun Kesadaran Lingkungan melalui Pendidikan Sains dalam Pelestarian Alam. *JSE: Journal Sains and Education*, *2*(1), 14–18.

Mambwe, R., Phiri, D., Kalinde, B., Sichula, N., & Kaluba, C. (2024). Exploring School Readiness and Transition Dynamics: Enablers and Disablers in Early Childhood Education Programmes of Zambia. *Journal of Law and Social Sciences*, *5*(4). https://doi.org/10.53974/unza.jlss.5.4.1164

Masrukhah, N., Zawawi, I., & Huda, S. (2024). Pembelajaran Berdiferensiasi dengan Model Problem Based Learning (PBL) dalam Mengembangkan Kemampuan Pemecahan Masalah Matematika Peserta Didik. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *4*(3), 539–552. https://doi.org/10.53299/jagomipa.v4i3.760

Misiaszek, G. W. (2023). Ecopedagogy: Freirean teaching to disrupt socio-environmental injustices, anthropocentric dominance, and unsustainability of the Anthropocene. *Educational Philosophy and Theory*, *55*(11), 1253–1267. https://doi.org/10.1080/00131857.2022.2130044

Nabila, B. A., Badruzsaufari, Wati, M., Suyidno, & Fahmi. (2025). Project Based Learning (Pjbl) Terintegrasi Pembelajaran Berdiferensiasi Untuk Melatih Keterampilan Numerasi Dan Sains Peserta Didik. *Journal of Banua Science Education*, *6*(1), 2745–7222.

Najwa, H. A., & Suhartini. (2023). Development of E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 12130–12138. https://doi.org/10.29303/jppipa.v9i12.6105

Nisak, E. F. K. (2023). Development of Problem Based Learning Based Environmental Change e-LKPD to Improve Students' Problem Solving Skills Esa F. *BioEdu Berkala Ilmiah Pendidikan Biologi*, *12*(3), 683–694.

Oe, H., Yamaoka, Y., & Ochiai, H. (2022). A Qualitative Assessment of Community Learning Initiatives for Environmental Awareness and Behaviour Change: Applying UNESCO Education for Sustainable Development (ESD) Framework. *International Journal of Environmental Research and Public Health*, *19*(6), 3528. https://doi.org/10.3390/ijerph19063528

OECD. (2022). *Digital education for a digital age: Policy implications and country practices.* OECD Publishing.

Pratiwi, Y. (2022). *Pengembangan Keterampilan Berpikir Kreatif Peserta Didik Melalui Model Pbl-Esd*. 154–162.

Purnamasari, S., & Hanifah, A. N. (2021). Education for Sustainable Development (ESD) dalam Pembelajaran IPA. *Jurnal Kajian Pendidikan IPA*, *1*(2), 69. https://doi.org/10.52434/jkpi.v1i2.1281

Rahma, N. T., Suratmi, & Nurani, D. C. (2025). Studi Pendahuluan: Pengembangan E-LKPD Berorientasi ESD untuk ngan Siswa Kelas VI SD. *Jurnal Satya Widya*, *41*(1), 74–88.

Rahmawati, U., Widiansyah, S., Hidayat, S. P., Kamil, S. I., Dwi, I., Br, L., Miftah, F., Khairo, A., Jalan, A., Palka, R., Km, N., Pabuaran, K., & Serang, K. (2025). *Kesiapan Guru dalam Menghadapi Tantangan Implementasi Kurikulum Merdeka (Studi Kasus di Sekolah Menengah Atas) kebutuhan masyarakat . Salah satu upaya untuk menjawab tantangan tersebut adalah dengan dalam sistem sosial yang dikenal dengan nama AGIL , ya*. (2004).

Rohmah, A., & Zulfitria, Z. (2024). Strategi Pembelajaran Diferensiasi Berbasis Aktivitas Dalam Meningkatkan Motivasi Belajar Siswa SD. *Journal of Instructional and Development Researches*, *4*(4), 214–222. https://doi.org/10.53621/jider.v4i4.330

Sher, K., & Inamullah, H. M. (2025). Building a Supportive Learning Environment: A Qualitative Study on Conducive School Culture in Public Secondary Schools. *Social Science Review Archives*, *3*(2), 1939–1946. https://doi.org/10.70670/sra.v3i2.812

Siganglingging, R. (2023). *Pembelajaran Diferensiasi pada Implementasi Kurikulum Merdeka*.

Sukma, Y. E., & Fajriyah, K. (2025). *Efektivitas Pjbl Berbasis Diferensiasi Produk Dan Pendekatan Crt-Tarl Dalam Meningkatkan Hasil Belajar Ipas Siswa Kelas 5c Di Sd Negeri Sendangmulyo*. *5*(1), 499–507.

Sumarli, Utama, E. G., & Ayu, K. (2021). Pengaruh Model Pembelajaran Conceptual Understanding Procedures (CUPs) terhadap Kemampuan Pemahaman Konsep Siswa Kelas IV SD pada Materi Sumber Energi * Sumarli , Erdi Guna Utama , Kristina Ayu Pendidikan Guru Sekolah Dasar , STKIP Singkawang , Singkawa. *Jurnal Kependidikan Fisika*, *9*(2), 149–156.

Vioreza, N., Hilyati, W., & Lasminingsih, M. (2023). Education for Sustainable Development: Bagaimana Urgensi dan Peluang Penerapannya pada Kurikulum Merdeka? *PUSAKA: Journal of Educational Review*, *1*(1), 34–48. https://doi.org/10.56773/pjer.v1i1.11

Wahyuni, S., Khoiri, N., & Novita, M. (2024). Validasi LKPD Konsep Energi Berorientasi ESD dengan Pendekatan Pembelajaran Berdiferensiasi. *Jurnal*

Penelitian Pembelajaran Fisika, *15*(1), 95–104. https://doi.org/10.26877/jp2f.v15i1.17471

Wahyuni, S. T., & Rusli, Z. (2024). *Evaluasi Implementasi Education Of Sustainable Development (ESD) dalam Mendukung SDGs di Kota Pekanbaru (Studi pada Sekolah Menengah Atas)*. 47–53.

Wibowo, S., Wangid, M. N., & Firdaus, F. M. (2025). The relevance of Vygotsky's constructivism learning theory with the differentiated learning primary schools. *Journal of Education and Learning (EduLearn)*, *19*(1), 431–440. https://doi.org/10.11591/edulearn.v19i1.21197

Zhang, Z., & Crawford, J. (2024). EFL learners' motivation in a gamified formative assessment: The case of Quizizz. *Education and Information Technologies*, *29*(5), 6217–6239. https://doi.org/10.1007/s10639-023-12034-7

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