AL IBTIDA: JURNAL PENDIDIKAN GURU MI (2023) VOL 10 (2): 189 - 210
DOI: http://dx.doi.org/10.24235/al.ibtida.snj.v10i2.13123

Al Ibtida: Jurnal Pendidikan Guru MI
ISSN: 2442-5133, e-ISSN: 2527-7227
Journal homepage: http://syekhnurjati.ac.id/jurnal/index.php/ibtida
Journal email: alibtida@syekhnurjati.ac.id

An Innovative Approach to Environmental Literacy: The Sustainable RADEC Learning Model for Elementary Schools

Hana Lestari*
*Department of Madrasah Ibtidaiyah Teacher Education, Faculty of Tarbiyah and Teacher Training, Institut Agama Islam Sahid Bogor, Indonesia
E-mail: hanalestari3011@gmail.com

Ima Rahmawati**
**Department of Islamic Management Education, Faculty of Tarbiyah and Teacher Training, Institut Agama Islam Sahid Bogor, Indonesia
E-mail: dafenta.ima13@gmail.com

Mohammad Ali***
***Department of Education Technology, Faculty of Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
E-mail: emaa.laith@upi.edu

Wahyu Sopandi****
******Department of Elementary Education, School of Postgraduates, Universitas Pendidikan Indonesia, Bandung, Indonesia
E-mail: wsopandi@upi.edu

Ana Ratna Wulan*****
*******Department of Biology Education, Faculty of Mathematics and Natural Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
E-mail: anaratnawulan@upi.edu

Received: February 27th, 2023. Accepted: September 28th, 2023. Published: October 31st, 2023.

Abstract

This study aims to design and develop an Education of Sustainable Development-oriented RADEC learning design model for enhancing the environmental literacy of elementary school students. The research approach employed consists of four key stages: (1) problem identification, (2) defining various objectives, (3) design and development, and (4) product validation. The research sample was selected using purposive sampling and comprised six elementary school teachers from various grade levels, ranging from grade 1 to grade 6. Data collection involved the use of scaled questionnaires and interviews. The collected data were then analyzed using the Explanatory Sequential Mixed Method. The results indicate that the curriculum design for the ESD-oriented RADEC learning model is suitable for implementation in elementary schools. This conclusion is supported by the mean score of 3.98 and a standard deviation of 0.22, showing a consistent range of responses among experts. In other words, the experts unanimously agree that the product design is appropriate for classroom learning. To further assess the validity of the design, a one-way ANOVA test was conducted to determine if there were significant differences in the

opinions of experts across various domains (ESD, RADEC, Environmental Literacy, and Basic Education). The results revealed that the F score and p-value exceeded α = 0.05, indicating no significant differences in the perceptions of the experts involved in the study. In summary, the experts reached a consensus that the product design exhibits a high level of feasibility, earning a "proper" rating in each component developed.

Keywords: *environmental literacy, ESD, RADEC learning model.*

Abstrak

Penelitian ini bertujuan mengembangkan model pembelajaran RADEC berorientasi *Education of Sustainable Development (ESD)* untuk mengembangkan literasi lingkungan siswa sekolah dasar. Penelitian ini menggunakan penelitian design and development. Prosedur *Design and Development* yang terdiri dari beberapa langkah yaitu : (1) identifikasi masalah, (2) mendeskripsikan berbagai tujuan, (3) rancangan dan pengembangan artefak, (4) uji validasi artefak. Penelitian ini melibatkan enam orang guru sekolah dasar dari kelas 1 sampai 6 dengan teknik *purposive sampling.* Pengumpulan data dilakukan dengan kuesioner tertutup berskala likert dan wawancara. Data yang diperoleh kemudian dianalisis menggunakan *Explanatory Sequential Mixed Method* yaitu metode analisis data yang menggunakan analisis data kuantitatif dan kualitatif. Hasil penelitian menunjukkan bahwa desain kurikulum model pembelajaran RADEC berorientasi ESD layak diterapkan di sekolah dasar, hal ini ditunjukkan dari skor mean (3,98) dan standar deviasi (0,22) dengan rentang yang tidak jauh berbeda. Dapat diartikan persepsi ahli bersifat homogen (setuju) bahwa desain produk layak diterapkan dalam pembelajaran di kelas. Selanjutnya dilakukan uji one way ANOVA untuk mengetahui apakah terdapat perbedaan pendapat para ahli yang signifikan dari para ahli (ahli ESD, RADEC, Literasi lingkungan dan Pendidikan Dasar). Didapatkan hasil skor F dan p-value lebih besar dari α = 0,05 dari uji tersebut. Hasil ini menunjukkan persepsi para ahli yang terlibat dalam penelitian ini tidak berbeda nyata. Artinya, para ahli sepakat bahwa desain produk yang dikembangkan memiliki kriteria tingkat kelayakan dengan kategori “layak” untuk setiap komponen produk yang dikembangkan.

Kata kunci: *literasi lingkungan, ESD, model pembelajaran RADEC.*

INTRODUCTION

Development does not only have positive impacts, such as increasing the welfare of society through rapid economic growth, but also has negative impacts, such as environmental problems (Ali, 2018; Komarudin & Mohammad, 2019). The environment can be interpreted as a place where the activities of living things interact and depend on one another. Indonesia, with progress in various sectors, has not been immune to damage and environmental pollution. According to data from Walhi (Indonesian Forum for the Environment), throughout 2017 there were 302 environmental damage problems, amounting to 6.39% in very bad condition good. Indonesia has forests with an area of approximately 95 million hectares. Most forest exploitation is carried out up to 1.09 million hectares. Forest exploitation (deforestation) occurred due to ongoing forest fires and nearly 250.9 thousand hectares (Ali, 2018; Purba & Safitri, 2017).

In addition to deforestation, Indonesia contributes to total greenhouse gas emissions reaching 1,808 million tons of CO2 which consistently shows an increase in emissions by

3.5% per year from 2000-2015. The increase in emissions was contributed to various sectors namely land use, forestry, and agriculture with contributions of 60.44% and 31.93% by the energy sector, namely the use of fossil energy consumption (Ali, 2017; Didham & Ofei-Manu, 2019). Based on these data, Indonesia contributes gas Greenhouse emissions are the cause of climate change. Climate change will impact the water and clean air resource system in Indonesia. The impact of climate change that is felt today by the community is the drought that causes water scarcity and flooding (Murniningtyas & Endah, 2018).

The various problems that have been described are complex issues that occur as a result of the negative impact of development. The management and use of the environment for development must be based on principles of sustainability (Chotimah et al., 2018). The environmental damage that continues to occur repeatedly from time to time due to a lack of adequate human resources has an awareness of sustainable development (Kurniasari et al., 2020). Human resources as executors of development play an important role in sustainable development (Shutaleva & Nikonova, 2020).

Sustainable development can be defined as a development by utilizing natural resources that can meet human needs present without reducing or eliminating the need for future generations (Mcgregor, 2019). Thus, it can be assumed management and utilization environment by prioritizing the principle of sustainability, namely utilizing natural resources without destroying the environment to meet current human needs this is so that future generations can also make use of these resources environment (Gericke & Olsson, 2019; UNESCO, 2017).

To be able to implement sustainable environmental management, humans need to be equipped with environmental literacy skills. NAAEE (North American Association for Environmental Education) is one of the associations that have researched the concepts and components of environmental literacy (Kusumaningrum, 2018). NAAEE suggests that environmentally literate individuals are someone who can take responsibility for what they will do for environmental preservation (Mulyana & Lidinillah, 2020). Individuals with abilities Environmental literacy is not only related to knowledge related to the environment but more to behavior to be able to act and make decisions with wise to use and preserve the environment (Ha et al., 2022).

Environmental literacy can be interpreted as a conscious behavior to maintain environmental balance for life now and also for future generations. Someone who has environmental literacy skills will know and be responsive and able to provide solutions to environmental issues (Tuncer et al., 2009). Environmental literacy ability can be measured from four components namely environmental knowledge, attitudes toward the environment, and cognitive skills and behavior toward the environment (Kusumaningrum, 2018). Four components as a reference which is used to measure the extent of environmental literacy abilities of somebody.

Human survival is closely related to the environment. so efforts are needed to protect and preserve the environment and the other is by printing an environmentally literate generation (Spinolo, 2015). Thus, environmental literacy skills need to become a habit instilled early on, especially among elementary school students (Lestari & Siskandar, 2020; Ulfah et al., 2020). Education Elementary school is the most appropriate level for the formation of a literacy skills environment. The habit of environmental literacy cannot be developed in a time short, should be sought to be instilled early and continue continuously

consistently (Ulfah et al., 2020). However, the results of research from Deswari & Supardan (2016) argued that the environmental literacy of elementary school students can be said to be low category due to a lack of awareness to act and take responsibility responsible for environmental problems.

One of the results of an international comparative study followed by students Indonesia, namely Trends in International Mathematics and Science Study (TIMSS). TIMSS is a form of international-scale assessment for grade 4 students' elementary school and grade 8 middle school students to measure their ability in mathematics and science learning. TIMSS is held regularly every 4 years once namely 1995, 1999, 2003, 2007, 2011, 2015, and lastly 2019. According to the results TIMSS survey, the ability of Indonesian students in 2003 ranked 35 of 46 countries; in 2007, ranked 36th out of 49 countries; in 2011, the order 32 of 49 countries and in 2015, 46 out of 51 countries (Hadi & Novaliyosi, 2019; Lestari & Widodo, 2021).

TIMSS survey results show that the ability of Indonesian students has decreased from year to year, whereas in 2019, Indonesia did not participated in the study (Lestari & Widodo, 2021). According to the analysis results from this study, student's numeracy and literacy abilities were classified as low students find it difficult to understand the concepts and problems presented in the questions TIMSS is mainly a form of word problem related to environmental issues. Students tend to only be able to solve questions related to the cognitive dimension of knowledge and understanding (Hadi & Novaliyosi, 2019; Wandira et al., 2023). But students have not been able to synthesize, analyze, reason, and generalize over something problem. Based on the above information, higher-order thinking skills, literacy, and numeracy skills are abilities that must be developed in the learning process at school. Environmental literacy is one of the abilities that is the highlight of the results of TIMSS in elementary school students. Therefore, efforts are needed to improve these abilities in the learning process. Enhancement environmental literacy skills in students can be done by developing curriculum that integrates environmental concepts in a sustainable manner (Kusumaningrum, 2018).

The curriculum in Indonesia is continuously being refined to be adapted with the need for education in Indonesia. The curriculum is customized to develop and improve knowledge, thinking skills, literacy as well as student character (Hutauruk et al., 2022; Maesaroh et al., 2021). To achieve a curriculum like that mentioned, the government suggests using various models of innovative learning in learning activities. Various innovative learning models have been created by experts to help students not only develop their knowledge but skills thinking and attitude (Kandangama, 2018). Among these innovative models namely the inquiry learning model (Inquiry) that stimulates students to do an investigation like a scientist and find his concept based on investigations carried out; Cooperative Learning emphasizes learning in groups to achieve learning objectives; Based Learning Problems emphasize problem-solving skills; Based on Learning Projects emphasize learning using projects as learning activities, which are currently being widely tested in Indonesia, namely science learning, technology, engineering, and mathematics (STEM) (Lestari & Sopandi, 2021; Sopandi & Agustin, 2020). But facts in the field are difficult for teachers to apply this learning model so that the learning process does not experience many changes.

According to Sopandi (2019), innovative learning models created by the experts above can develop the various abilities of students, but if these innovative learning models are

illustrated as a vehicle, the vehicle in fact cannot be used in Indonesia due to incompatibility with existing roads. Sopandi (2017) to develop a learning model that adapts to the typical conditions of the curriculum, teachers, and students in Indonesia. The learning model in question is the Read-Answer Discuss-Explain-and Create (RADEC) learning model. The RADEC learning model is a learning strategy with stages read, answering, discussing, explaining, and making what can be implemented to increase environmental literacy. This learning model created by Sopandi (2017) by optimally considering the conditions typical in Indonesia, both in terms of curriculum, teacher, and student characteristics. The RADEC learning model has the characteristics of being easy to implement in the learning process because each stage is easy to remember and apply by the teacher (Setiawan, Hartati, Sopandi, 2019; Pratiwi, 2020).

The RADEC model has centered learning steps for students and encourages students to be able to develop their abilities well knowledge, skills, and attitudes holistically and comprehensively (Lestari & Sopandi, 2021). This can be seen from several research results, namely, (Purba et al., 2022) suggest that the RADEC learning model can develop students' understanding of concepts and reading interest; improve thinking skills critical (Yulianti et al., 2022); improve creative thinking skills (Sopandi & Agustin, 2020); develop an attitude of integrity, cooperation, independence, and religion (Sukmawati et al., 2020); and improve literacy culture (Sopandi & Agustin, 2020; Suryana & Sopandi, 2021).

The RADEC model has centered learning steps for students and Based on the findings above, each stage of the RADEC. learning model stimulates students to carry out activities that develop student character including reading, answering, discussing, explaining, exploring, doing investigation, solving problems, and creating works. Each of these stages stimulates students to learn actively, and maximize their potential to develop the required skills, knowledge, skills, attitudes, and literacy culture. This learning model is very suitable for the development of the stages of learning that researchers want to develop to improve student literacy skills (Setiawan & Hartati, 2019).

This can be seen from several research results, namely Suryana & Sopandi (2021) explaining that the RADEC model of learning can improve reading culture in elementary school students by 5.1. In addition, Pratiwi & Sopandi (2018) suggests that the RADEC learning model can develop students' understanding of concepts, in the hypothesis test (t-test) the value of p (0.00) is <0.05, there are differences in students' understanding of concepts between classes using the RADEC learning model with classes that do not use the RADEC learning model.

Karlina (2020), researching the RADEC model in developing students' critical thinking skills, found the results of the study that there were significant differences in students' critical thinking abilities in the material properties of light before and after learning. From this study, the average pre-test score for students' critical thinking skills was 68.33 and the average post-test score was 82.22, with a value of p = 0.000 <0.005. Sopandi & Handayani (2020) stated that the RADEC model can develop students' creative thinking abilities, the results obtained were a significant increase in students' creative thinking abilities for each indicator of creative thinking. The aspect of fluency increased by 40.1%, flexibility by 43.81%, originality by 37%, and elaboration by 45.04%. Another study was conducted by Sukmawati (2020) and it was found that after learning with the RADEC model, student characters showed attitudes of

integrity, cooperation, independence, and religion. Each stage of the RADEC learning model stimulates students to carry out activities that develop student character.

Based on the findings above, the RADEC model stimulates active learning in students, maximizes their self-potential, improves critical thinking skills, fosters creative thinking, and instills positive attitudes and behaviors. Unlike previous studies, this research focuses on how the RADEC learning model is highly suitable for developing the desired learning stages. This model can be oriented with an ESD approach to achieve the 4th SDGs and develop an awareness of sustainability. The ESD-oriented RADEC model can facilitate students in developing not only a conceptual understanding of sustainable development but also sustainable attitudes and behaviors.

Development of the RADEC Model to improve environmental literacy will orient with the ESD approach. The United Nations defines ESD as an approach to the learning process that is oriented toward principles and ideals of sustainable (Kelly & Erduran, 2019; Makrakis, 2014; UNESCO, 2018). ESD (Education for sustainable development) was born from the need for education to respond to evolving sustainability challenges (UNESCO, 2017). ESD empowers people of all ages to participate in creating a sustainable future (Bezeljak & Scheuch, 2020; Lestari, Ali, Sopandi, Wulan, et al., 2022; Sukardi et al., 2022).

ESD not only embeds the concept and principles of sustainability but the skills needed to get used to behaving in a sustainable way through a measurable, targeted, and systematic educational process. ESD aims to build interactions between each component of education starting from the development of policy, planning, program implementation, learning, teaching, administration, assessment, and other components coherently to stimulate the transformation of education so that it can effectively contribute to the reorientation towards sustainable development. ESD uses an innovative, action-oriented pedagogy to develop knowledge and awareness and take action to transforming society into a more sustainable society (Ali, 2017; Lestari, Ali, Sopandi, & Wulan, 2022). ESD drives educational transformation using teaching student-centered, focusing on development problems sustainable, resulting in sustainable solutions that involve a variety of holistically relevant disciplines (Lestari & Sopandi, 2021; Mahat & Idrus, 2016). ESD designed with interactive and center teaching and learning in mind exploratory, action-oriented, and learning-enabled students transformative to stimulate students to be able to think systemically, and critically, collaborate, take the right decisions, and act responsibly to the environment.

Based on the explanation about ESD above, the RADEC model is ESD-oriented and can facilitate students in developing not only a conceptual understanding of sustainable development but also attitudes and behaviors towards the environment. Research on the development of ESD-oriented RADEC learning models can offer a solution. The development of the ESD-oriented RADEC learning model itself has not been previously undertaken by Sopandi or other researchers, making it a novel direction for a pedagogical approach. The development of ESD-oriented RADEC learning can be observed through the learning tools created by the researchers, including learning implementation plans, student activity sheets, pre-learning questions, teaching materials, and assessments. In this study, the RADEC learning model is ESD-oriented to enhance students' environmental literacy in elementary schools.

METHODS

This study employs the Design and Development approach, which falls under two categories based on its objectives: product development research and model development research. It involves systematic and empirically controlled stages and processes that follow specific scientific methods (Richey & Klein, 2007). The choice of the Design and Development method for this study is rooted in its systematic approach to creating learning products and tools, as well as perfecting existing models or developing new ones. The Design and Development procedure in this study encompasses several key steps, including: (1) problem identification, (2) describing various objectives, (3) product design and development, (4) product validation (Ellis & Levy, 2010).

The study's population includes elementary school students' environmental literacy abilities following their participation in learning with the ESD-oriented RADEC model. For the research sample, a purposive sampling method was used, involving six elementary school teachers from various grade levels, ranging from grade 1 to grade 6. The research design was structured to facilitate the various research steps, such as data collection, compilation, analysis, and presentation, allowing researchers to address research questions in a comprehensive and focused manner. The research design in this study is presented in Figure 1.

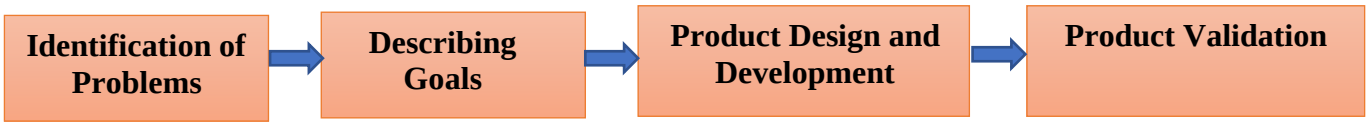

Figure 1. Research Design (Ellis & Levy, 2010)

Identification of Problems

Formulating the objectives and uses of research theoretically and empirically to go through preliminary studies by collecting interview data qualitatively and rating scales quantitatively.

Describing Goals

Based on the results of problem identification, the various research objectives that underpin this study are described before designing the product to be developed. These research objectives serve as the foundation for this research and are closely related to the issues identified in the initial stage, providing a basis for product design preparation. In essence, this research aims to design and develop an ESD-oriented RADEC learning program for the enhancement of environmental literacy skills. The specific research objectives in this study include: (1) Developing an ESD-oriented RADEC learning program for enhancing environmental literacy, and (2) Assessing the feasibility of the ESD-oriented RADEC learning program in promoting environmental literacy.

Product Design and Development

Refers to micro curriculum development namely formulating competencies, formulating learning objectives, planning curriculum content, curriculum implementation, and assessment.

Product Validation

Knowing the feasibility of product design from aspects of curriculum development which includes the preparation of basic competencies, ESD indicators, and ESD themes that are likely and relevant to be oriented to thematic learning in elementary schools to develop environmental literacy. Testing the feasibility of the design through the intermeter method quantitatively using the SPSS application (Descriptive and one-way ANOVA).

Data were collected with scale-rated questionnaires and interviews. The data obtained were then analyzed using the Explanatory Sequential Mixed Method, which is a data analysis method that uses quantitative and qualitative data analysis. Quantitative data analysis was carried out first and then qualitative data analysis was carried out to be able to explain in more depth and comprehensively the quantitative findings (Creswell, 2014). Quantitative data analysis, namely data in the form of numbers or scores and qualitative data analysis, namely data in the form of words (Ali & Hayat, 2019).

RESULTS AND DISCUSSION

The results of this study are in the form of an ESD-oriented RADEC model learning design to develop ESD competence students in thematic learning, theme 8 "Our Friend's Environment" Class V to increase environmental literacy. The stages of product design and development are described as follows:

Problem Identification

Data collection regarding the teachers' experience in implementing ESD in learning was conducted through structured interviews. Based on the interview results, the ESD competencies that need to be developed by students include: 1) Knowledge: Assisting students in gaining an understanding of the environment and the role of humans in environmental responsibility, socio-culture, and the economy; 2) Thinking skills: Helping students acquire skills in finding solutions to environmental problems through critical and creative thinking; 3) Environmental literacy: Encompassing knowledge and attitudes that enable students to develop a sense of concern, empathy, social values toward environmental preservation, and behavior. This helps students become more sensitive and aware of the overall environment and all issues related to the environment influenced by socio-culture and the economy.

The three competencies above need to be developed starting from each individual as part of society to act in complex situations sustainably, to participate in protecting and maintaining the environment, and socio-culture, and sustainably drive the community's economy (Ali, 2018). Teacher competencies in implementing ESD that need to be mastered, namely professional and pedagogical competencies include being able to explain teaching materials related to ESD themes well, mastering basic competencies, indicators and goals of ESD to be achieved, being able to design active, innovative, effective, creative and fun learning and able to utilize ICT in the learning process and can do self-development (Ali, 2017; Cebrián & Junyent, 2015; Hendriawan & Ali, 2019).

The findings obtained are that the first challenge in implementing ESD in elementary schools is that teachers do not understand the holistic ESD concept which emphasizes the learning process integrating the three dimensions of sustainable development, namely the economic, social, and environmental dimensions. In practice, the practice of ESD-related

activities is prioritized in schools through extracurricular activities such as environmental preservation through Adiwiyata activities. The teacher understands that the implementation of ESD is an application of environmental education for students. Preferably, there are interconnection activities between environmental, sociocultural, and economic aspects such as Eco-School activities with the main activity namely optimizing the production of natural resources from the results of environmental preservation into healthy food and beverage products. Environmental and social aspects are active participation between school members and the community around the school. This is because, in principle, ESD is a concept that is oriented towards prioritizing the improvement of the quality of education and considers contributions to the sustainability of the environmental, economic, and social sectors (Lestari, Ali, Sopandi, & Wulan, 2022).

The results of this study are relevant to research conducted by Sinakou & Boeve-de Pauw (2019) entitled Academics in the Fields of Education for Sustainable Development: Their Conceptions of Sustainable Development. The results of this study state that the level of integration of the implementation of ESD is interconnected, which means that it has not been perfectly integrated with the core level of connectedness, namely aspects of the economic environment and social environment. The research states that the conception held by the teacher is one of the factors in the successful implementation of ESD practices, both in an integrated and interconnected manner.

The second challenge is that the ESD theme discussed in the lesson doesn't yet address socio-eco-scientific issues. Teaching materials related to the concept of ESD aren't available, and the learning model currently in use isn't effective in fully developing ESD competencies. As a result, students don't yet possess sufficient knowledge of sustainable development goals, attitudes, or behaviors needed to lead more sustainable lives.

Instilling environmental literacy values in students is not something that can be done instantly, but requires constant effort from the teacher consistently. This is because environmental literacy that is formed at this time may be the cultivation of environmental literacy values in earlier times and the results of instilling environmental literacy values at this time may only become daily behavior in the following year. Teachers must be skilled at choosing ways and creating situations that can foster student activity in internalizing environmental literacy values through optimal learning activities (Lestari & Siskandar, 2020).

Considering the findings above, it's evident that teachers play a significant role in conveying the concept of ESD to students. As explained by Mustadi et al. (2021), the integration of ESD into the curriculum and various school activities should begin at an early stage. Therefore, primary school students should be a primary focus as targets of ESD. The incorporation of ESD will help instill in primary school students a sense of responsibility for environmental, economic, cultural, and social sustainability, contributing to a sustainable and resilient life. It's crucial for the curriculum and learning in elementary schools to integrate ESD into all aspects of academic and non-academic activities.

The reality is that, in the field, many teachers struggle to comprehend how to implement the concept of ESD in their teaching. This challenge arises from their limited understanding of ESD. According to the research conducted by Rahman in 2019, a significant 66.7% of teachers lack a comprehensive and in-depth understanding of the concept of ESD. Therefore, enhancing teachers' grasp of ESD implementation in school learning can be achieved through the development of ESD-oriented teaching tools, including lesson plans (RPP), teaching

materials, worksheets, learning media, and evaluation methods. The development of ESD-oriented teaching tools aims to assist teachers in connecting the curriculum material to issues of sustainable development. The selected teaching methods and models are expected to engage students actively in developing knowledge, critical thinking skills, and sustainable behaviors.

Describing Various Objectives

One of the ESD themes chosen by the researcher to be developed into a learning design is climate change, prevention of water crises, cultural diversity, and poverty reduction. The four ESD themes are oriented towards thematic learning theme 8 "Our friendly environment" for grade V. The four ESD themes are developed into 9 basic ESD competencies and 11 ESD indicators and are presented in Table 1 below:

Table 1. Formulation of ESD themes, basic competencies, and relevant ESD indicators oriented to theme 8 "The environment is our friend".

Dimensions	ESD Theme	ESD Basic Competency	ESD Oriented Learning Indicators
Environment	Climate change	1. Reventing and mitigating the impacts of climate change 2. Prevent and mitigate the impact of environmental pollution 3. Demonstrate waste management behavior as an effort to mitigate the impacts of climate change	1. Understand the causes of climate change. 2. Preventing and mitigating the impacts of climate change. 3. Prevent and mitigate the impact of environmental damage. 4. Describe how to manage waste as an effort to overcome the impacts of climate change.
	Water Crisis Prevention	1. Understand the causes of the water crisis 2. Prevent water pollution, and 3. Efficient in using clean water	1. Understand the causes of pollution and water crisis. 2. Tackling water pollution. 3. Make efficient use of water to prevent water crises. 4. Observe good sanitation management.
Social	Cultural diversity	1. Preserving local wisdom 2. Preserving regional music and dance arts	Make efforts to preserve the cultural diversity of the community through local wisdom, regional music and dance
Economy	Poverty reduction	Analyze the role of the economy in an effort to improve people's lives	1. Identify types of businesses that can be managed by the community. 2. Analyze the effect of the economy on the welfare of society.

After formulating 4 ESD themes and 9 basic ESD competencies that have the opportunity to be oriented towards thematic learning theme 8 "Our Friendly Environment", a learning design was designed that referred to the curriculum development steps. The ESD-oriented RADEC learning design which is oriented towards the thematic learning curriculum of elementary schools refers to an interdisciplinary approach with a shared model. The shared model combines at least two different kinds of disciplines into one focus so that it provides meaningful learning and can fulfill curricular goals in two or more fields of study.

Based on the findings, theme 8 regarding the environment as our friend can optimize the three dimensions of sustainable development, namely environmental, social, and economic. Through this theme, teachers can design ESD-oriented learning by raising issues related to sustainable development from various dimensions, this can be seen from the learning objectives and indicators that have been formulated. ESD-oriented objectives and indicators that are formulated are based on a holistic, interdisciplinary approach and lead to the principles of life skills (lifestyle). The holistic approach in question is to provide learning in a comprehensive manner that integrates one SDG's goal with another which includes economic, social, and environmental perspectives, to develop not only knowledge about sustainable development but thinking skills as well as environmental literacy attitudes and behaviors.

These findings are in line with (Hofman, 2015) idea, which suggests orienting the application of ESD to school subjects and this is done in a thematic teaching-learning mode by embedding each theme in some relevant learning materials. The research results of (Rasmitadila et al., 2020) also explain that the formulation of learning objectives and indicators in thematic learning can provide opportunities while simultaneously implementing ESD holistically and comprehensively which includes environmental, economic, and social dimensions. In connection with the above, every teacher needs to plan an effective teaching and learning process strategy by paying attention to student activities to gain practical experience in cultivating their behavior toward sustainability (Ali, 2017). In addition (Baiquni et al., 2006) view the key to the successful implementation of ESD as a teaching-learning process that emphasizes how students engage in fun, active learning.

Product Design And Development

The design and development of the ESD-Oriented RADEC Learning Model are based on the findings obtained from the needs assessment. The development process follows the curriculum development steps, which include formulating competencies, setting learning objectives, planning curriculum content, curriculum implementation, and determining the evaluation methods to be used. The steps for preparing the design and development of the ESD-Oriented RADEC Model learning can be seen in the Figure 2:

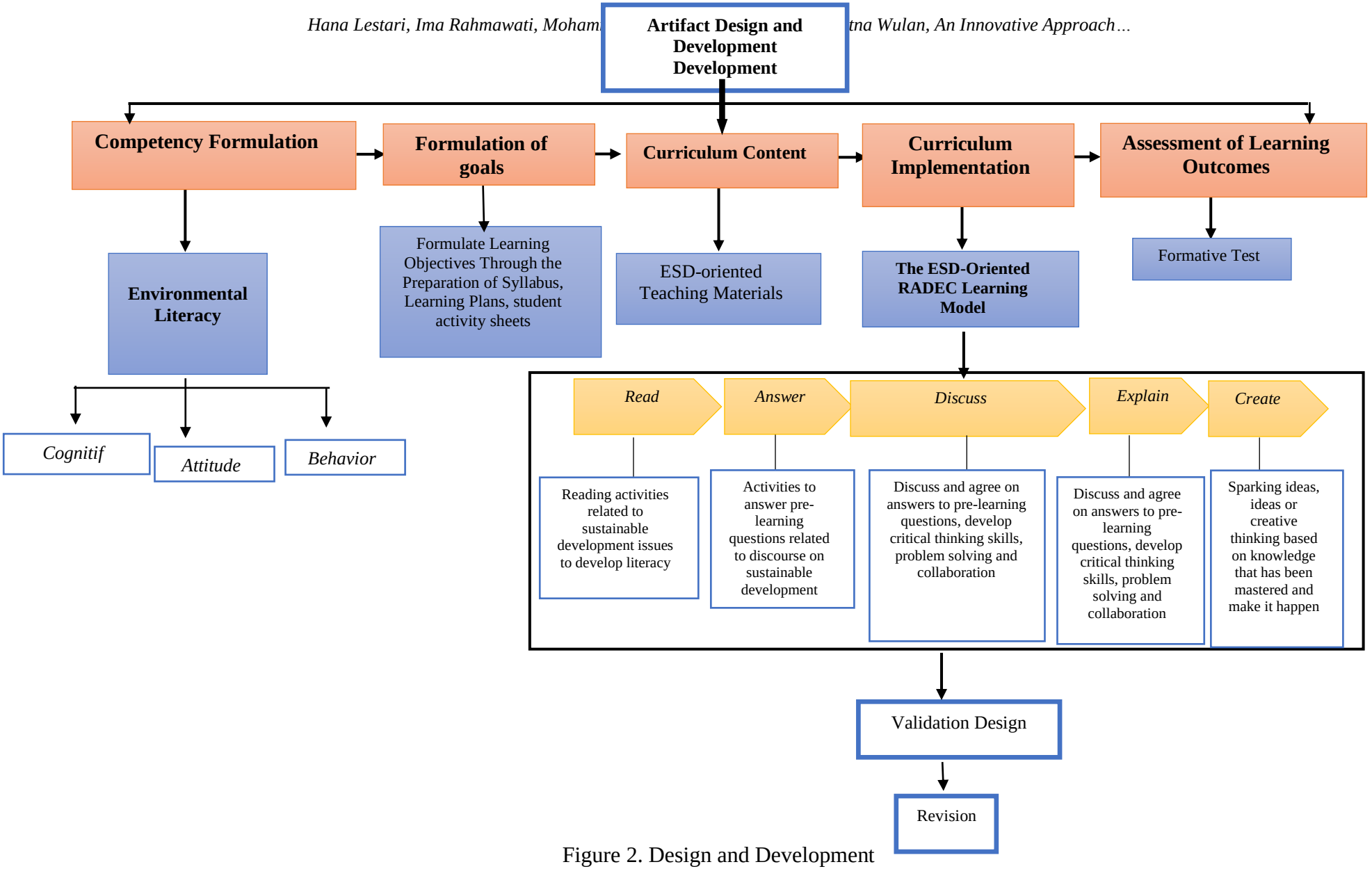

Figure 2. Design and Development

Referring to the picture above, the design of the ESD-oriented RADEC learning model was developed using a systems approach that views the curriculum as including some interrelated components to achieve certain goals. The curriculum components referred to in the ESD-oriented RADEC learning design consist of the formulation of basic competencies, formulation, curriculum content, curriculum implementation, and evaluation. Curriculum design is a general pattern that describes the substance and mapping of these components in a certain set of components, this mapping is made based on the point of view of the curriculum designer which consists of four interrelated components, namely objectives, content, process, and evaluation (Ali, 2017).

The formulation of objectives is carried out referring to the formulation of competencies that have been made in the first stage. The designed curriculum objectives are a formulation of what students want to achieve after studying the material using the developed ESD-oriented RADEC learning design. As stated by Ali (2018), in curriculum design it is necessary to formulate goals to describe the forms of competence that students are expected to have after learning and learning processes. The objectives formulated in this design are linked to each dimension, theme, and competency of ESD to be achieved. This is in line with the results of research by Sienkiewicz et al., (2014), that a curriculum design and development study requires stages of the formulation of objectives to describe forms of knowledge, skills, and attitudes competencies related to subjects or fields of study in the curriculum in educational units.

The selection of curriculum content must be adjusted to the characteristics of teachers and students. For teachers, the contents of the curriculum must be taught or conveyed in curriculum activities such as PKB teacher workshops (continuous competency development). As for students, the content of teaching materials must be studied within the framework of competencies that have been formulated and will be assessed using assessment instruments that are arranged based on learning achievement indicators. This is in line with the opinion of Li (2018), that the teacher first analyzes the competencies to be achieved by students, based on the objectives and indicators of learning achievement.

The contents of the teaching materials developed by the researcher are adapted to the ESD theme, basic competencies, ESD goals, and indicators that have been formulated in the previous stage. So that environmental literacy ESD competencies can be developed to the maximum. Apart from being adjusted to the competencies to be achieved, the selection of the content of teaching materials is reviewed from the learning model and methods for studying the contents of the teaching materials. The results of Mitchell's research (2016), explain that the benchmark for curriculum content is a balance between depth and breadth. The breadth of the scope relates to the learning experience achieved through the learning model used.

In the product design being developed, the competencies students must achieve are environmental literacy competencies. Environmental literacy is a competency that includes components of knowledge, attitudes, and behavior based on awareness of environmental, social, and economic dimensions to develop a more sustainable life (Ha et al., 2022; Igbokwe, 2012; Nugraha et al., 2021). This environmental literacy competency is comprehensively mastered by students as a reflection of the sustainable development goals to be achieved.

Based on the findings, lesson plans were developed under the syllabus that had been designed, themes, basic competencies, indicators, and learning objectives oriented toward sustainable development goals. Learning activities are designed for both online and offline learning, thus facilitating students in any condition. Learning activities are developed based

on student activity. Various activities in this learning provide many opportunities for students to gain learning experience. Therefore, the developed ESD-oriented learning model is a student-centered approach. As stated by Ali (2017), one of the factors that get attention in curriculum implementation is the elements of the learning process, how (method) to make this process work effectively about the competencies to be achieved. This method relates to methods, strategies, or techniques of carrying out activities centered on students actively gaining learning experiences.

Student-centered learning focuses on how these students learn, play an active role, and can collaborate, and think critically and creatively (Cebrián et al., 2020). The learning model used is the RADEC learning model (Read, Answer, Discuss, Explain, Create). The RADEC learning model is oriented towards the objectives and indicators of the ESD developed. Every step of ESD-oriented RADEC is student-centered so that it demands student independence and prioritizes the process of how students acquire knowledge, attitudes, and behaviors to develop a more sustainable life.

The assessment chosen is the assessment of the learning process and learning outcomes to facilitate all stages of the ESD-oriented RADEC model learning design. Assessment of the learning process is carried out during the learning process and is used as a basis for improving the teaching and learning process. While the assessment of learning outcomes is carried out at the end of the learning process. Both assessments are used by researchers to obtain, analyze, and interpret data about student learning processes and outcomes. Assessment is carried out continuously and systematically from one sub-theme to another and becomes a determinant of the success of the learning process in achieving the formulated competencies. This is under the opinion of Black & William (2009), the results of the assessment can be used as meaningful information in making decisions for improvement and determining the success of programs in achieving competence.

Based on the five stages of developing a micro curriculum for product design and development, this research introduces a novel approach. Specifically, the RADEC learning model is oriented towards sustainable development goals, allowing students to not only grasp the concept of sustainable development but also cultivate behavior consistent with environmental literacy. The learning stages are aligned with indicators geared towards ESD goals, covering dimensions of environmental, economic, and social sustainability in a holistic manner. Each component aims to instill knowledge, attitudes, and sustainable skills in students. The development of the ESD-oriented RADEC learning model represents a new pedagogical approach, offering a solution to address various challenges in implementing ESD in elementary schools, particularly in fostering ESD competence, or environmental literacy, in elementary students.

Product Validation

At this stage, after the product design (the learning design of the ESD-oriented RADEC model) is designed, a product feasibility test is carried out to determine the feasibility of the product design from the aspect of curriculum development which includes the preparation of basic competencies, ESD indicators, and ESD themes that are likely and relevant to be oriented to thematic learning in elementary education.

The method used in testing the feasibility of product design uses an intermeter. This method is carried out to test the feasibility of product design by expert validators in fields

related to products developed through the deployment of validation rating scale instruments. The validation rating scale instrument is distributed to expert validators and carried out face-to-face. In this study, the expert validators involved consisted of an ESD expert, RADEC learning model expert, curriculum expert, and basic education expert. The rating scale instrument was prepared using the Likert model to facilitate the expert validator to approve a given statement based on the value chosen. The results of validation product testing can be seen in Table 2 below:

Table 2. Validation Results

No	Category	Validator	*Mean*	*Standar Deviasi*
1.	Formulation of Competence and objectives (Syllabus)	Elementary Education Expert	4	0,214
		RADEC Expert	4	0,221
		Curriculum Expert	3.96	0,215
		ESD expert	3,96	0,220
2.	Curriculum Content (Teaching materials)	Elementary Education Expert	3,95	0,223
		RADEC Expert	4	0,221
		Curriculum Expert	3.93	0,205
		ESD expert	3,92	0,211
3.	Curriculum Implementation (RPP, pre-learning questions and student activity sheets)	Elementary Education Expert	4	0,213
		RADEC Expert	4	0,215
		Curriculum Expert	4	0,220
		ESD expert	4	0,231
4.	Evaluation	Elementary Education Expert	3.96	0,208
		RADEC Expert	4	0,221
		Curriculum Expert	4	0,216
		ESD expert	3,95	0,212

Table 2 shows the mean (3,98) and standard deviation (0,22) values with ranges that are not much different. It can be interpreted that expert perceptions are homogeneous (agreed) that product design is feasible to be implemented in classroom learning. Furthermore, to test the significant differences in the average score of teacher perceptions from various fields, namely from the fields of ESD, curriculum, RADEC model, and basic education, one-way ANOVA was tested. The results of the one-way ANOVA test are presented in Table 3 as follows:

Table 3. Product Validation One Way ANOVA Test Results

Category	F	Sig.
Elementary Education Expert	0.372	0.366
RADEC Expert	0.440	0.375
Curriculum Expert	0.369	0.343
ESD expert	0.421	0.330

Based on Table 3, the differences in the mean perception scores of basic education experts, RADEC experts, curriculum experts, and ESD experts are not significant because the F score and p-value are higher than $\alpha = 0.05$.

The results of the one-way ANOVA data analysis showed that the perceptions of the experts involved in this study were not significantly different. That is, the experts agree that the product design being developed has a level of eligibility criteria with a "proper" category for each component of the product being developed. Based on the research findings, shows that expert perceptions are homogeneous (agreed) and that artifact designs are feasible to be implemented in classroom learning. The experts welcomed the ESD-oriented RADEC learning design in thematic learning to improve students' competencies related to ESD, namely environmental literacy. The ESD-oriented RADEC learning assessment aspect consists of components that have been required, namely objectives, content, methods, and assessment. Thus, the design of this artifact is feasible and can be implemented in classroom learning.

Based on the findings, it was identified that one of the ESD competencies that is perceived by teachers and is important to develop for students is environmental literacy which includes students' knowledge, attitudes, and behavior based on awareness to develop a more sustainable life. Environmental literacy competence can be a reflection of ESD competencies that must be mastered by students, as a result of the implementation of ESD in the learning process (Mcgregor, 2019). Environmental literacy can highlight ESD as a pluralistic approach to education that empowers students. In this regard, this competency can see whether there is a gap between students' environmental literacy and the proper implementation of ESD in schools (Ulfah et al., 2020).

Elementary education is the most appropriate level for building awareness of sustainable values because habituation of sustainable behavior cannot be developed in a short time, efforts must be made to instill it continuously and consistently. Therefore, integrating ESD into the curriculum and school activities can stimulate students from an early age about responsibility and sensitivity for environmental sustainability, progress, and resilience of economic, social, and cultural conditions in their surroundings. ESD needs to be oriented into the elementary education curriculum for inclusion in subject syllabuses, textbooks, learning models, and assessments (ESD-oriented learning tools) (Lestari et al., 2021). The development of ESD-oriented learning tools is sought to facilitate teachers in linking the material in the syllabus to issues of sustainable development. The selected learning methods and models are expected to stimulate students to play an active role in developing knowledge, thinking skills, and sustainable behavior. In this study, ESD was oriented towards learning the RADEC model and implemented it in thematic learning (Lestari, Ali, Sopandi, & Wulan, 2022).

The results of research by Oe et al., (2022), explain that ESD is needed to be oriented towards the curriculum in elementary schools which is recommended as an approach to developing environmental literacy competencies. In line with the results of research (Olsson & Gericke, 2016; Timm & Barth, 2020) shows the necessity of developing a primary madrasah education framework, aiming not only to enhance students' knowledge of sustainable development but also to instill attitudes and behaviors of environmental literacy that contribute to achieving sustainable development goals. This underscores the importance of incorporating ESD into the basic education curriculum, which should focus on not only increasing students' knowledge of sustainable development but also fostering attitudes and behaviors related to environmental literacy, contributing to the achievement of sustainable development goals. This aligns with the idea put forth by Fadeeva & Payyapppalimana (2012) that ESD involves the development of values and attitudes pertaining to the relationship

between humans and the environment, encompassing both the natural and social aspects. In practice, it should not only focus on knowledge transfer but also prioritize behavior change and the growth of environmental awareness.

CONCLUSION

Basic education is the most suitable level to initiate the development of environmental literacy. The integration of ESD into the basic education curriculum should incorporate a critical and reflective learning process that nurtures the development of creative thinking skills. This, in turn, can produce human resources capable of sustainable utilization of natural resources for both current and future generations. One of the learning models that can cultivate these thinking skills is the RADEC learning model. The RADEC model stimulates active learning among students, optimizes their thinking skills, and promotes positive attitudes and behavior. The ESD-oriented RADEC model can facilitate not only students' conceptual understanding of sustainable development but also their attitudes and behaviors related to sustainability (environmental literacy). The curriculum design of the ESD-oriented RADEC learning model meets the criteria for eligibility and validity, making it suitable for implementation in elementary schools to develop environmental literacy skills.

REFERENCES

Ali, M. (2017). Curriculum Development for Sustainability Education. In *Environmental* Progress (Vol. 24, Issue 4). https://doi.org/10.1002/ep.10116.

Ali, M. (2018). Education Quality Improvement from The Perspective of Sustainable Development Goals Achievement. *The 3rd International Seminar on Education, 1*(1), 1–9.

Ali, M., & Hayat, B. (2019). Non-academic factors influencing students' achievement: A study in the Indonesian madrasahs. *International Journal of Learning and Intellectual Capital, 16*(2), 180–192. https://doi.org/10.1504/IJLIC.2019.098932.

Baiquni, M., Sulaiman, M., & Budiarto, R. (2006). UGM'S Best Practices Sustainable Development Goals (SDGs). In Yogyakarta: Direktorat Pengabdian Masyarakat UGM (Vol. 1999, Issue December).

Bezeljak, P., & Scheuch, M. (2020). Understanding of sustainability and education for sustainable development among pre-service biology teachers. *Sustainability (Switzerland), 12*(17). https://doi.org/10.3390/SU12176892.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, *21*(1), 5–31. https://doi.org/10.1007/s11092-008-9068-5

Cebrián, G., & Junyent, M. (2015). Competencies in education for sustainable development: Exploring the student teachers' views. *Sustainability (Switzerland), 7*(3), 2768–2786. https://doi.org/10.3390/su7032768

Cebrián, G., Junyent, M., & Mula, I. (2020). Competencies in Education for Sustainable Development: Emerging Teaching and Research Development. *Sustainability, 12*(579), 1–9. https://doi.org/10.3390/su7032768 T4 - Exploring the Student Teachers' Views M4 - Citavi

Chotimah, U., Alfiandra, Faisal, E., Sulkipani, Cammelia, Iqbal, & Arpannudin. (2018). Pengintegrasian nilai-nilai kearifan lokal dalam pendidikan multikultural. *Jurnal Civics: Media Kajian Kewarganegaraan, 15*(1), 170–179.

Creswell, J. W. (2014). *Four Edition Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. University of Nebraska Lincoln.

Deswari, N., & Supardan, D. (2016). Upaya Peningkatan Environmental Literacy Peserta Didik Di Sekolah Adiwiyata (Studi Inkuiri Naturalistik Di Sd Negri 138 Pekanbaru). *Jurnal Socius, 5*(2). https://doi.org/10.20527/jurnalsocius.v5i2.3331

Didham & Ofei-Manu. (2019). The Role of Education in the Sustainable Development Agenda: Empowering a learning society for sustainability through quality education. *Journal of Chemical Information and Modeling, 53*(9), 1689–1699.

Ellis, & Levy, Y. (2010). A Guide for Novice Researchers: Design and Development Research Methods. *Proceedings of the 2010 InSITE Conference, December*, 107–118. https://doi.org/10.28945/1237

Gericke, N., & Olsson, D. (2019). The Sustainability Consciousness Questionnaire: The theoretical development and empirical validation of an evaluation instrument for stakeholders working with sustainable development. *Sustainable Development, 27*(1), 35–49. https://doi.org/10.1002/sd.1859

Ha, C., Huang, G., Zhang, J., & Dong, S. (2022). Assessing ecological literacy and its application based on linguistic ecology: a case study of Guiyang City, China. *Environmental Science and Pollution Research, 29*(13), 18741–18754. https://doi.org/10.1007/s11356-021-16753-7

Hadi, S., & Novaliyosi. (2019). TIMSS Indonesia (Trends in International Mathematics and Science Study). *Prosiding Seminar Nasional & Call for Papers*, 562–569.

Hendriawan, D., & Ali, M. (2019). High School History Education and Education for Sustainable Development. An Integrated Curriculum Approach. *Journal of Physics: Conference Series, 1179*(1), 0–6. https://doi.org/10.1088/1742-6596/1179/1/012048

Hofman, M. (2015). What is an Education for Sustainable Development Supposed to Achieve— A Question of What, How and Why. *Journal of Education for Sustainable Development, 9*(2), 213–228. https://doi.org/10.1177/0973408215588255

Hutauruk, A., Subakti, H., Simarmata, D., Lestari, H., Al Haddar, G., Da'i, M., Purba, S., Khalik, M., & Cahyaningrum, V. (2022). Media Pembelajaran dan TIK. In Jakarta: Yayasan Kita Menulis (Vol. 5, Issue 3).

Igbokwe, A. B. (2012). Environmental Literacy Assessment: Exploring the Potential for the Assessment of Environmental Education/Programs in Ontario Schools. *International Journal for Cross-Disciplinary Subjects in Education, 3*(1), 648–656. https://doi.org/10.20533/ijcdse.2042.6364.2012.0091.

Kandangama, K. G. C. (2018). Challenges and Barriers for Implementing Education for Sustainable Development (Esd) in Secondary Schools in Sri Lanka. *Proceeding of the International Conference on Future of Education, 1*, 1–7. https://doi.org/10.17501/26307413.2018.1101.

Karlina, D., & Sopandi, W. (2020). Critical Thinking Skills of Fourth Grade in Light Properties Materials through the Radec Model. *The 2nd International Conference on Elementary Education, 2*(1), 1743–1753.

Kelly, R., & Erduran, S. (2019). Understanding aims and values of science: developments in the junior cycle specifications on nature of science and pre-service science teachers' views in Ireland. *Irish Educational Studies, 38*(1), 43–70. https://doi.org/10.1080/03323315.2018.1512886

Komarudin, & Mohammad, A. (2019). Integration of Sustainable Development Education Concerning Environment Conservation into Senior High School Islamic Education Curriculum. *Journal of Physics: Conference Series, 1179*(1). https://doi.org/10.1088/1742-6596/1179/1/012063

Kurniasari, N. D. R., Sigit, D. V, & Komala, R. (2020). Correlation Between Local Wisdom Knowledge with Ecoliteracy and Green Behavior of Students of Adiwiyata School, Bandung, West Java. *International Journal of Multicultural and Multireligious Understanding, 1*(1), 411–416. https://doi.org/http://dx.doi.org/10.18415/ijmmu.v7i4.1627

Kusumaningrum, D. (2018). Literasi Lingkungan Dalam Kurikulum 2013 Dan Pembelajaran IPA di Sd. *Indonesian Journal of Natural Science Education (IJNSE), 1*(2), 57–64. https://doi.org/10.31002/nse.v1i2.255

Lestari, H., Ali, M., Sopandi, W., & Wulan, A. R. (2021). Infusion of Environment Dimension of ESD into Science Learning Through the RADEC Learning Model in Elementary Schools. *Jurnal Penelitian Pendidikan IPA, 7*(SpecialIssue), 205–212. https://doi.org/10.29303/jppipa.v7ispecialissue.817

Lestari, H., Ali, M., Sopandi, W., & Wulan, A. R. (2022). Integration of Sustainable Development Education into Thematic Learning in Elementary Schools. *AIP Conference Proceedings, 2468*(December). https://doi.org/10.1063/5.0102663.

Lestari, H., Ali, M., Sopandi, W., Wulan, A. R., & Rahmawati, I. (2022). The Impact of the RADEC Learning Model Oriented ESD on Students' Sustainability Consciousness in Elementary School. *Pegem Journal of Education and Instruction, 12*(2), 113–122. https://doi.org/10.47750/pegegog.12.02.11

Lestari, H., & Siskandar, R. (2020). Literasi Sains Siswa Melalui Penerapan Model Pembelajaran Blended Learning Dengan Blog. *NATURALISTIC: Jurnal Kajian Penelitian Pendidikan, 4*(2), 597–604. https://journal.umtas.ac.id/index.php/naturalistic/article/view/769

Lestari, H., & Sopandi, W. (2021). Radec Learning To The Elementary School Teachers' Competence In Training Students' Critical Thinking Skills: A Case Study During Covid-19 Pandemic. *Jurnal Pendidikan IPA Indonesia, 10*(3), 346–356. https://doi.org/10.15294/jpii.v10i3.28655.

Lestari, H., & Widodo, A. (2021). Peranan Model Pembelajaran Nature of Sains Untuk Meningkatkan Pemahaman Sains Siswa Sekolah Dasar. *Jurnal Cakrawala Pendas, 7*(1), 1–9. https://doi.org/http://dx.doi.org/10.31949/jcp.v6i1.2425

Li, L. (2018). The Application of Micro-curriculum on College Education Teaching. *International Conference on Educational Technology, Training and Learning (ICETTL 2018)*, Nanyang Institute of Technology, 111–114. https://doi.org/10.23977/icettl.2018.71125

Maesaroh, S., Bahagia, B., & Kamalludin, K. (2021). Strategi Menumbuhkan Literasi Lingkungan Pada Siswa. *Jurnal Basicedu, 5*(4), 1998–2007. https://doi.org/10.31004/basicedu.v5i4.1048

Mahat, H., & Idrus, S. (2016). Education for sustainable development in Malaysia: A study of teacher and student awareness. *Geografia: Malaysian Journal of Society & Space*, *12*(6), 77–88.

Makrakis, V. (2014). Transforming university curricula towards sustainability: A euro-mediterranean initiative. *Handbook of Research on Pedagogical Innovations for Sustainable Development, January 2014*, 619–640. https://doi.org/10.4018/978-1-4666-5856-1.ch032

Mcgregor, S. L. T. (2019). *David Selby's Radical Approach to Sustainability Education*. 21(December).

Mitchell, B. (2016). Curriculum Construction and Implementation. *International Journal of Liberal Arts and Social Science*, *4*(4), 45–56.

Mulyana, E. H., & Lidinillah, D. A. M. (2020). Science Learning Quality to Promote Sustainable Development in Early Childhood Education: A Case Study of Teachers in Tasikmalaya. *Education and Humanities Research*, *454*(1), 86–90. https://doi.org/10.2991/assehr.k.200808.016

Murniningtyas, A., & Endah, S. A. (2018). *Tujuan Pembangunan Berkelanjutan di Indonesia*. UNPAD Press.: Vol. III (Issue 2).

Mustadi, A., Fauzani, R. A., & Rochmah, K. (2021). *Teori Landasan Pendidikan Sekolah Dasar*. Yogyakarta: UNY PRESS.

Nugraha, F., Permanasari, A., & Pursitasari, I. D. (2021). Disparitas Literasi Lingkungan Siswa Sekolah Dasar di Kota Bogor. *Jurnal IPA & Pembelajaran IPA*, *5*(1), 15–35. https://doi.org/10.24815/jipi.v5i1.17744

Olsson, D., & Gericke, N. (2016). The effect of implementation of education for sustainable development in Swedish compulsory schools – assessing pupils' sustainability consciousness. *Environmental Education Research*, *22*(2), 176–202. https://doi.org/10.1080/13504622.2015.1005057

Pratiwi. (2020). Manajemen Berbasis Sekolah Dalam Meningkatkan Kualitas Sekolah. *EduTech*, *2*(1), 86–96. https://doi.org/10.31219/osf.io/9bv4y

Pratiwi, N., & Sopandi, W. (2018). the Students' Conceptual Understandings on Global Warming Through Read-Answer- Disscuss-Explain-and Create (Radec) Learning. *International Conference on Elementary Education Universitas Pendidikan Indonesia*, 635–639.

Purba, Chamidah, D., Anzelina, D., Nugroho, A., Mary, M., Lestari, H., Salamun, Suesilowati, Rahmawati, I., & Kato, I. (2022). Keterampilan Berpikir Tingkat Tinggi. Yayasan Kita Menulis. In *Suparyanto dan Rosad* (2015 (Vol. 5, Issue 3).

Purba, W., & Safitri, P. (2017). *Statistik Lingkungan Hidup Indonesia*.

Rasmitadila, Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020). The perceptions of primary school teachers of online learning during the covid-19 pandemic period: A case study in Indonesia. *Journal of Ethnic and Cultural Studies*, *7*(2), 90–109. https://doi.org/10.29333/ejecs/388

Richey & Klein. (2007). *Design And Development Research*. London: Routledge. file:///C:/Users/youhe/Downloads/kdoc_o_00042_01.pdf

Setiawan, D., Hartati, T., & Sopandi, W. (2019). Kemampuan Menulis Teks Eksplanasi Siswa Kelas 5 Sekolah Dasar melalui Model Read, Answer, Disscuss, Explain, And Create: Radec. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *4*(1), 1-16.

Shutaleva, A., & Nikonova, Z. (2020). Environmental education for sustainable development in Russia. *Sustainability (Switzerland)*, *12*(18), 1–26. https://doi.org/10.3390/su12187742

Sienkiewicz, Trawinska-Konador, & Chlon-Dominczak. (2014). *Competency Based Human Resources Management (Issue 2007)*.

Sinakou, E., & Boeve-de Pauw, J. (2019). Exploring the concept of sustainable development within education for sustainable development: implications for ESD research and practice. *Environment, Development and Sustainability*, *21*(1), 10668. https://doi.org/10.1007/s10668-017-0032-8

Sopandi, & Agustin, M. (2020). Improving Creative Thinking Ability of Prospective Elementary School Teachers through Read-Answer-Discuss-Explain-and Create (RADEC) Project-Oriented Learning Model. *The 2nd International Conference on Elementary Education*, *2*(1), 1298–1308.

Sopandi, W. (2017). The quality improvement of learning processes and achievements through the read-answer-discuss-explain-and create learning model implementation. *Proceeding 8th Pedagogy International Seminar 2017: Enhancement of Pedagogy in Cultural Diversity Toward Excellence in Education*, *8*(229), 132–139.

Sopandi, W. (2019). Sosialisasi dan Workshop Implementasi Model Pembelajaran RADEC Bagi Guru-Guru Pendidikan Dasar dan Menengah [Dissemination and Implementation Workshop of RADEC Learning Models for Primary and Secondary Education Teachers]. *PEDAGOGIA: Jurnal Pendidikan*, *8*(1), 19. https://doi.org/10.21070/pedagogia.v8i1.1853

Spinolo, H. (2015). Environmental literacy comparison between students taught in Eco-schools and ordinary schools in Madeira lsland region of Portugal. *Science Education International*, *26*(3), 392–413.

Sukardi, R. R., Sopandi, W., Riandi, Lestari, H., & Juanda, M. R. (2022). Trends of English as Medium Instruction in Science Learning: Review and Bibliometric Analysis. *Pegem Egitim ve Ogretim Dergisi*, *13*(1), 360–366. https://doi.org/10.47750/pegegog.13.01.39

Sukmawati, D., Sopandi, W., & Sujana, A. (2020). The Application of Read-Answer-Discuss-Explain-and Create (Radec) Models to Improve Student Learning Outcomes in Class V Elementary School on Human Respiratory System. *The 2nd International Conference on Elementary Education*, *2*(1), 1734–1742.

Suryana, N., & Sopandi, W. (2021). Peningkatan budaya literasi siswa melalui implementasi model RADEC. *JPPD: Jurnal Pedagogik Pendidikan Dasar*, *8*(1), 7–15.

Timm, J. M., & Barth, M. (2020). Making education for sustainable development happen in elementary schools: the role of teachers. *Environmental Education Research*, *1*(1), 1–17. https://doi.org/10.1080/13504622.2020.1813256.

Tuncer, G., Tekkaya, C., Sungur, S., Cakiroglu, J., Ertepinar, H., & Kaplowitz, M. (2009). Assessing pre-service teachers' environmental literacy in Turkey as a mean to develop teacher education programs. *International Journal of Educational Development*, *29*(4), 426–436. https://doi.org/10.1016/j.ijedudev.2008.10.003

Ulfah, M., Suyanto, S., & Aminatun, T. (2020). The completeness of environmental literacy aspects studied in the articles published in several countries. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *6*(1), 75–82. https://doi.org/10.22219/jpbi.v6i1.10813

UNESCO. (2017). Education for Sustainable Development Goals: Learning Objectives; UNESCO: Paris, France. In *International Journal of Trend in Scientific Research and Development (Vol. 2, Issue 1).* https://doi.org/10.31142/ijtsrd5889

UNESCO. (2018). *Guidebook on Education for Sustainable Development for educators. Effective teaching and learning*.

Wandira, P. N., Lestari, H., & Mukri, R. (2023). Efektivitas Media Big Book Untuk Meningkatkan Kemampuan Minat Membaca Siswa Madrasah Ibtidaiyah Negeri 1 Bogor. *Primer Edukasi Journal*, *2*(1). https://jurnal-inais.id/index.php/JPE/article/view/134

Yulianti, Y., Lestari, H., & Rahmawati, I. (2022). Penerapan Model Pembelajaran RADEC Terhadap Peningkatan Kemampuan Berpikir Kritis Siswa. *Jurnal Cakrawa Pendas*, *8*(1), 47–56.