Jurnal Pengabdian Magister Pendidikan IPA

Original Research Paper

The Empowerment of Science Teachers in Developing *Education Sustainable Development* (ESD)-based Learning Instrument for Teachers Affiliated with Subject Teachers' Working Group (MGMP) for Science in Surakarta City

Bramastia[1*], Budi Utami[2], Kadek Dwi Hendratama Gunawan[3], Suciati[4], Endah Febri Setiya Rini[5] , Tiara Hasna Salsabila[5]

[1,5]Department of Magister Science Education, Faculty of Teacher Training and Education, Sebelas Maret University, Science Education for Sustainable Development (SESD), Surakarta, Indonesia
[2,3,4]Department of Science Education, Faculty of Teacher Training and Education, Sebelas Maret University, Science Education for Sustainable Development (SESD), Surakarta, Indonesia

DOI : https://doi.org/10.29303/jpmpi.v8i3.12353
Sitasi : Bramastia., Utami, B., Gunawan, K, D. H., Suciati., Rini, E. F. S., & Salsabila, T. H. (2025). The Empowerment of Science Teachers in Developing Education Sustainable Development (ESD)-based Learning Instrument for Teachers Affiliated with Subject Teachers' Working Group (MGMP) for Science in Surakarta City. *Jurnal Pengabdian Magister Pendidikan IPA, 8*(3)

Article history
Received: 7 Mei 2025
Revised: 24 Juli 2025
Accepted: 01 Agustus 2025

*Corresponding Author: Bramastia, Department of Magister Science Education, Faculty of Teacher Training and Education, Sebelas Maret University, Science Education for Sustainable Development (SESD), Surakarta, Indonesia, Email: bramastia@staff.uns.ac.id

Abstract: PISA 2022 data shows that Indonesian students' critical thinking skills and scientific literacy are still low. This situation is worsened by science learning having not integrated *the Education for Sustainable Development* (ESD) approach. This community service program held by the UNS SESD RG aims to empower science teachers at the MGMP (Subject Teachers' Working Group) for Science in Surakarta City in developing ESD-based learning instruments. The methods used include needs analysis, workshops, assignments, and evaluation. Problems encountered by teachers include poor awareness of ESD, limited publications of research result, and no implementation of project-based learning. Solutions provided include training, mentoring, and the use of educational technology. The results of activity indicate an increase in teacher capacity in developing contextual and innovative ESD-based learning instrument. This program also supports the achievement of SDGs, particularly in aspects of quality education and climate action.

Keywords: *Education for Sustainable Development* (ESD), IPA, Scientific Literacy, Critical Thinking.

Introduction

Program for International Student Assessment (PISA) reveals that Indonesia is still on low ranking in scientific literacy, reading, and mathematics. These results indicate that the learning process in schools has not fully developed critical, evaluative, and creative thinking skills, but focuses on mastering conventional concepts, principles, and theories (OECD, 2023). This is in line Zubaidah's (2016) research finding that education in Indonesia still lacks the capacity of developing the students' higher-order thinking skills.

Observations on partner schools also reveal that teachers have not utilized pedagogical competencies optimally, particularly in designing learning fostering 21st-century skills such as *critical thinking*, *creativity*, *collaboration*, and *communication* (the 4Cs). This results in students' poor engagement and poor relevance of material to real life (Rusmana & Akbar, 2017).

In school learning practices, the 21st-century skills such as *communication*, *collaboration*, *critical thinking and problem-solving*, and *creativity and innovation* have not been optimally utilized. This is due to the dominance of lecture methods and the limited use

of learning resources in science textbooks, tending to emphasize memorization of concepts more than exploration and contextual meaning. Students' scientific literacy is also still relatively low due to the lack of learning activities connecting science to daily life and local issues in surrounding environment (Azzahra & Ambarwati, 2021; Sumarni, Soesilawati, & Sanjaya, 2021; Zubaidah, 2016).

In addition, learning has not yet utilized the potential of local knowledge possessed by students as a meaningful learning resource (Asrial et al., 2019; Dini & Rini, 2024; Prabowo, Bramastia, Sarwanto, & Cohen, 2024). However, the integration of local contexts can increase the relevance of learning and encourage critical thinking skills and scientific literacy (Andrian & Rusman, 2013; Darmaji, Astalini, Kurniawan, & Rini, 2022; Rini, Rahardjo, & Bramastia, 2025, 2024). Therefore, a contextual, participatory, and transformative learning approach is required to develop these skills effectively.

UN-proclaimed Education for Sustainable Development (ESD) Decade of 2005-2014 is conceived as the educational movement for Sustainable Development (Gaffar, 2025). The concept of ESD or EfSD is intended to ensure that everyone has an opportunity of getting quality education, so that students can learn about values, attitudes, and lifestyles supporting a sustainable future and to realize positive changes in society's perspective (Budiati, Hernani, & Amprasto, 2022; Khoirunnisa & Firmansyah, 2024). Since the beginning of the 21st century, it was proposed at the UN General Assembly in 2002, and UNESCO decided to lead the dissemination of the EfSD mission through the EfSD Decade action (UNESCO, 2005).

The implementation of ESD is highly dependent on curriculum implementation and the strategic role of educators in implementing it. For instance, the 2013 Curriculum focuses not only on knowledge but also on developing students' attitudes and skills that can provide opportunities for implementing ESD. However, in practice, learning remains stuck on the knowledge portion only, resulting in less optimal ESD implementation (Rusmana & Akbar, 2017; Setyowati & Hinduan, 2012; Utami & Vioreza, 2021; N Vioreza & Supriatna, 2020; Zubaidah, 2016). The opinion above is in line with (Vioreza, Hilyati, & Lasminingsih, 2023), stating that learning still focuses more on knowledge without paying sufficient attention to attitudes and skills. That is why ESD implementation has not reached its true potential. Therefore, some attempts are needed for the schools to improve the achievement of curriculum objectives and integrate ESD into learning activities.

Education for Sustainable Development (ESD) movement and campaign are integral elements to supporting the *Merdeka Belajar* (Freedom-to-Learn) policy, currently implemented through the *Merdeka* (Fredoom) Curriculum (Vioreza, Hilyati, & Lasminingsih, 2023). In this context, teachers and schools play a key role as driving agents of educational change. The *Merdeka* Curriculum emphasizes the importance of strengthening the Pancasila student profile, including critical thinking, creativity, mutual cooperation, and global diversity, aligning closely with ESD principles (Kemendikbudristek, 2022; Kurniawaty, Faiz, & Purwanti, 2022; Mery, Martono, Halidjah, & Hartoyo, 2022; Rahayu, Rosita, Rahayuningsih, Hernawan, & Prihantini, 2022). Thus, synergy between policymakers, educators, and community is essential to broaden the dissemination of ESD values and to bring a sustainable and holistic education into reality.

The implementation of ESD in learning encompasses seven important criteria: encouraging students to be active and responsible in the learning process, to be holistic and interdisciplinary, to use various active learning methods, to apply a systemic approach by involving community, developing norms, values, and principles through critical analysis, integrating local wisdom and global culture, and fostering a spirit of lifelong learning (Matitaputty, Ufie, Ima, & Pattipeilohy, 2022; Primasti, 2021; Niken Vioreza et al., 2023).

Similarly, a study conducted by Mofrad, Ebrahimi, & Maleki, (2023) found that ESD-based learning significantly increases the students' participation in meaningful learning activities and strengthens the students' environmental literacy and global awareness. This indicates that ESD is not only relevant within the framework of formal education but also serves as an approach capable of addressing the challenges of 21st-century learning.

In the attempt of achieving this goal,

science teachers serve as facilitators to guide students to explore and apply ESD concepts to their daily lives. Furthermore, ESD encourages collaboration between students, schools, and local communities to create relevant and meaningful learning. Therefore, science teachers are required to empower themselves in developing learning tools based on *Education Sustainable Development* (ESD).

Method

This community service activity would be carried out in the following sequence:

1. Preparation for Community Service

   In this preparation stage, an analysis was carried out on the learning materials for junior high school science subjects taught based on *Education Sustainable Development* (ESD). *Indigenous knowledge*, *values*, and local indigenous ecology were also analyzed to match them with the materials and approaches used. In addition to the learning materials, preparations were also carried out for the implementation of science learning by developing learning materials based on *Education Sustainable Development* (ESD).
2. Implementation stage

   The implementation stage involves empowering science teachers to develop learning instruments based on *Education Sustainable Development* (ESD) to improve critical thinking and scientific literacy. Assignments will then be given to participating teachers and will be reviewed by the community service team.
3. Evaluation of Implementation

   Post-implementation activities involve conducting a direct survey on teachers concerning the use of science learning instrument they have created. Additionally, if possible, the program can be implemented in classrooms in the following year with more teachers involved.

Results and Discussion

Partner Problem

Considering the result of situational analysis aforementioned, several key problems are encountered by the Subject Teachers' Working Group of Surakarta City, particularly in the aspect of *Education Sustainable Development* (ESD)-based learning. The problems that can be analyzed are, among others:

a Science teachers' poor awareness of *Sustainable Development* (ESD)-based learning. Students' poor understanding of the importance of critical thinking and scientific literacy is due to students' predisposition to view science as a difficult subject not too relevant to everyday life, resulting in low interest and motivation in understanding scientific concepts.

b Limited publication of research result and exploration by teachers and students so that only few people know about their achievements.

c The result of research not implemented yet in project-based learning, i.e. the students' research results have not been applied in learning so that they have impacted insignificantly the improvement of scientific literacy.

Problem Solution

As an attempt of solving these problems, the solution offered is to hold seminars and workshops on the empowerment of science teachers in developing *Education Sustainable Development* (ESD)-based learning instrument for the Subject Teachers' Working Group (MGMP) for Science in Surakarta City to improve critical thinking and scientific literacy. The existence of Research Group serves as a mentor or facilitator in the project-based learning process, by involving the participants of the Subject Teachers' Working Group (MGMP) for Science in Surakarta City in various exploratory and analytical activities.

The activity starts with exploring the scientific aspects of school environment. Students will identify various assets and resources related to science. The results of exploration will be developed into various learning media, such as scientific articles, news, digital books, infographics, and documentary videos that can be used by students and general public. This program is expected to empower the science teachers in developing *Education Sustainable Development* (ESD)-based learning instrument.

In the attempt of addressing the challenge of empowering science teachers in developing *Education Sustainable Development* (ESD)-based

learning instruments for Subject Teachers' Working Group (MGMP) for Science in Surakarta City, this program offers a systematic solution. The solution focuses on empowerment and mentoring, with the following details:

Based on the table above, it is can be seen that the problems and solutions encountered in empowering the science teachers in developing *Education Sustainable Development* (ESD)-based learning instruments for Subject Teachers' Working Group (MGMP) for Science in Surakarta City are, among others:

a Science Teachers' Poor Awareness of *Education Sustainable Development* (ESD) - Based Learning
The solution was to explore science by identifying scientific resources in surrounding environment including irrigation, agriculture, and local industry. The students were encouraged to carry out observations to enhance their understanding of scientific concepts. The results were then developed into learning materials, such as video documentation relevant to everyday life.

b Limited Publication of Research and Exploration Results by Student
The solutions are to develop innovative learning media such as scientific articles and to organize presentations related to the result of research carried out by students at school and local community levels. The solutions taken to the problem related to the limited implementation of research results in project-based learning are to develop learning modules and research findings within the school curriculum and to implement project-based learning methods in science and to hold workshops for teachers and students.

This community service activity supports the achievement of *the Sustainable Development Goals (SDGs)*, particularly:

a SDG 4: Quality Education, i.e. ensuring the quality of inclusive and equitable education and promoting lifelong learning opportunities for all. In this case, the program of empowering science teachers to develop ESD-based learning instruments will enhance the educators' capacity to deliver science materials relevant to sustainability, and encourage the students' scientific literacy and critical thinking.

b This program also indirectly supports SDG 13: Climate Action, because the learning materials developed encourage students to understand and engage in environmental and sustainability issues through project-based learning.

Figure 1. Group Research Team and Teachers affiliated with MGMP for Science

By aligning these activities with the SDGs, a transformation will be expected to occcur in science education at the junior high school level that is oriented not only toward academic content, but also towards strengthening character and awareness of sustainability.

Activity Implementation

The Community Service (P2M) activity was carried out by the Research Group (RG) of Science Education Sustainable Development (SESD) Sebelas Maret University (UNS) Surakarta on Thursday, July 10, 2025 at the Hall of SMP Negeri 4 Surakarta City. This activity carried the theme "Empowering Science Teachers in Developing Education for Sustainable Development (ESD)-Based Learning Instruments for the teachers affiliated with MGMP for Science in Surakarta City" and was attended by 30 teachers affiliated with MGMP for Science as an attempt of strengthening the role of teachers as agents of change in bringing sustainable education into reality. This activity was also attended by the RG SESD UNS team, including Dr. Bramastia, S.Pd., M.Pd., Dr. Kadek Dwi Hendratma Gunawan, S.Pd., M.Pd., and Dr. Budi Utami, S.Pd., M.Pd.

Figure 2. Opening

The series of events started at 08.00 WIT (Western Indonesian Time) with participant registration. The activity was officially opened by Mrs. Pontjowati, S.Pd., M.Si., a representative of SMP Negeri 4 Surakarta serving as the host of event. In her welcome speech, she appreciated the collaboration between MGMP for Science in Surakarta City and Sebelas Maret University and hoped that this activity could provide enlightenment and increase the teachers' capacity of developing learning instruments in line with the direction of the national curriculum policy. Next, welcome speech was delivered by Dr. Bramastia, S.Pd., M.Pd., the head of committee, emphasizing that the urgency of ESD implementation has increased post-COVID-19 pandemic, where the world of education is required to adapt to policy dynamics and complex challenges, including issues of climate change, environmental degradation, and the relevance of learning to global socio-economic context. Sustainable education is viewed as a strategic way to equip the future generations with critical awareness, environmental responsibility, and ability of solving real-world problems reflectively.

The next welcome speech was delivered by Amin Wahyu Setyadi, S.Pd., the Chairman of MGMP for Science in Surakarta City, who appreciated the willingness of RG SESD UNS to be a strategic partner responsive to the changes in educational regulations including the implementation of deep learning, STEM, and ESD. He also expressed his hope for the continuous collaboration between MGMP for Science and UNS in the form of training and ongoing professional development.

Following the opening session, the activity was followed with the presentation of three core materials moderated by Hendra Ramadhan. The first material was delivered by Dr. Bramastia, M.Pd., raising the topic "Implementation of Science Learning Based on Education for Sustainable Development (ESD)". In his presentation, he emphasized the importance of integration between science content, critical thinking skills, and a responsible attitude toward sustainability issues. ESD is viewed as a transformative learning approach not only transferring knowledge, but also building awareness of sustainability and capacity of taking real action on local and global scales.

The second material was delivered by Dr. Kadek Dwi Hendratma Gunawan, S.Pd., M.Pd., with the topic "The Use of ESD-Based Science Learning Media". He said that the selection of effective learning media is a crucial factor to deliver sustainability issues. A variety of media such as visual, audiovisual, digital interactive, and artificial intelligence (AI)-based media can be used to support the learning objectives. A concrete example presented was the development of an *IoT project* for a dustbin combining science learning with the use of technology and sustainability values. Such media is considered capable of fostering creativity and 21st-century skills in students.

The third session was delivered by Dr. Budi Utami, S.Pd., M.Pd., with the topic "ESD-Based Science Learning Assessment." He emphasized the importance of formative evaluation in SDGs-based learning, and how the approaches such as problem-based learning and flipped classrooms can be used to encourage in-depth, reflective, and meaningful learning. The assessments used must be able to capture not merely cognitive outcomes but also knowledge, skill, and value dimensions. This session also provided examples of ESD-based science teaching instruments equipped with assessment rubrics compiled based on indicators of critical and creative thinking according to the experts like Facione.

Figure 3. Session of interactive discussion

An interactive discussion concluded the session, generating high enthusiasm from the participants. The questions raised by a participant, Mr. Dwi, concerned concrete examples of ESD implementation, AI media use, and difficulties found in developing assessment rubrics for critical and collaborative thinking skills. The resource person clarified that the exploratory activities carried out by teachers and students using local contexts and technology already reflected the spirit of ESD. Meanwhile, the use of applications such as Blackbox AI, Pictory, and Copilot AI was recommended for developing engaging and contextual learning media.

The activity was ended with a concluding remarks by the MC, also delivering a summary and expressing gratitude to all those who contributed. This activity served not only as a means of empowering the teachers but also as a collaborative space for academics and education practitioners in addressing the challenges of 21st-century learning, requiring sustainability, relevance, and technology integration. This activity is expected to serve as a model for sustainable partnerships between universities and schools that can be replicated in other regions, as a tangible contribution to national education development.

Conclusion

The community service activity carried out by the Science Education Sustainable Development (SESD) Research Group (RG) of Sebelas Maret University has successfully increased the capacity of Subject Teacher's Working Group (MGMP) for Science in Surakarta City in developing Education for Sustainable Development (ESD)-based learning instruments. This program is capable of raising teachers' awareness of the importance of scientific literacy and higher-order thinking skills through contextual, exploratory, and project-based learning approaches. The strength of this program lies in the integration between strengthening ESD concepts, integrating local wisdom, and utilizing learning technologies such as artificial intelligence. However, limited training time is one of obstacles resulting in the quite high need for further mentoring in the field. In general, this activity is potential for further development, especially in strengthening the synergy between universities and schools in supporting sustainability-oriented science education.

Acknowledgment

The author would like to thank the Res The Sustainable Development Science Education (SESD) Research Group (KP) of Sebelas Maret University, Surakarta, which has provided financial support and fully facilitated the implementation of this community service activity. Thanks are also expressed to the teachers who are members of the Surakarta City Science Subject Teacher Working Group (MGMP) for their active participation and enthusiasm during the activity, as well as to SMP Negeri 4 Surakarta (SMP Negeri 4 Surakarta) which has provided a place, support, and a warm welcome during the activity as the host. The collaboration of all parties has made a significant contribution to the joint effort to realize sustainability-based contextual science education. According to number: 370/UN27.22/PT.01.03/2025.

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