Samakta: Jurnal Pengabdian Kepada Masyarakat
https://ejournal.edukhatulistiwa.com/index.php/samakta
ISSN: 3031-3031 (Online)
Volume 3 Issue 1 2026 Pages 77-85

Strengthening the Strategic Thinking Competency of Junior High School Teachers Through Education for Sustainable Development-Based Scenario Training

Suhendar Suhendar[1*], Syane Triwulandari[2], Asriyanik Asriyanik[3]

[1]Department of Biology Education, Universitas Muhammadiyah Sukabumi, Sukabumi, West Java, Indonesia.
[2]Integrated Laboratory Unit, Universitas Muhammadiyah Sukabumi, Sukabumi, West Java, Indonesia.
[3]Department of Informatics Engineering, Universitas Muhammadiyah Sukabumi, Sukabumi, West Java, Indonesia.

* Corresponding author: suhendar@ummi.ac.id

Abstract: Education faces a major challenge in preparing a generation capable of responding to uncertainties caused by climate change and the sustainability crisis. The Education for Sustainable Development framework emphasizes strategic thinking competence as the ability to design adaptive actions based on systemic analysis and future projections. However, learning practices in schools still tend to present climate change in an informative manner without training students' anticipatory capacity. This community service program employed a Participatory Action Research (PAR) approach to strengthen junior high school teachers' strategic thinking competence through ESD-based scenario training. Seventeen teachers in West Java participated in an online training program consisting of planning, action, observation, and reflection cycles. The activities included strengthening ESD concepts, scenario development techniques, and contextual climate change module design. Evaluation was conducted through pretest–posttest comparison and rubric-based module assessment. The results showed an increase in the average score from 67 to 84. The teaching modules produced demonstrated teachers' ability to identify driving forces, formulate key uncertainties, and design multiple logical and contextual future scenarios. The program effectively enhanced teachers' pedagogical capacity and contributed to the transformation of future-oriented learning practices.

Keywords: Education for sustainable development; Strategic thinking; Scenario technique; Climate education; Teacher training.

Received: February 22nd, 2026 ***Accepted***: February 24th, 2026 ***Published:*** February 28th, 2026
DOI: 10.61142/samakta.v3i1.337

How to cite: Suhendar, S., Triwulandari, S., dan Asriyanik, A. (2026). Strengthening the Strategic Thinking Competency of Junior High School Teachers Through Education for Sustainable Development-Based Scenario Training. *Samakta: Jurnal Pengabdian Kepada Masyarakat*, 3(1), 77–85.

INTRODUCTION

Climate change has changed the global education landscape. Education is no longer only in charge of transmitting factual knowledge, but must equip learners with the competence to understand the complexity of systems and design adaptive responses to uncertainty. UNESCO (2020) emphasizes that Education for Sustainable Development must develop transformative competencies, including strategic thinking competencies. This competency allows individuals to analyze causal relationships in socio-ecological systems as well as formulate long-term actions that take into account various future possibilities.

Strategic thinking competencies in the framework of ESD are related to the ability to design and implement strategies towards sustainability through systemic and anticipatory analysis (Wiek et al., 2019). Recent developments in sustainability competence frameworks, such as GreenComp, further emphasize strategic thinking as a core sustainability competence that integrates systems thinking, futures literacy, and adaptive action (Bianchi et al., 2022).

This confirms the urgency of embedding strategic competence within teacher professional development programs. Rieckmann (2018) explained that this competency includes the ability to understand inter-stakeholder interactions, identify uncertainties, and develop solutions based on the desired vision of the future. In the context of climate change, strategic thinking competencies are crucial because this issue involves complex dynamics that cannot be understood through a linear approach. However, learning practices in junior high schools still tend to be oriented towards the delivery of concepts. Teachers often describe the causes and impacts of climate change descriptively without training students to explore various possible futures and strategize responses. Wolff et al. (2020) found that sustainability education often fails to develop reflective and strategic capacity because learning is still centered on information transfer. This gap indicates a gap between the conceptual framework of ESD and pedagogical implementation in schools.

Studies on climate change education indicate that cognitive understanding alone is insufficient; emotional engagement and action-oriented learning are equally important in strengthening sustainability competencies (Ojala, 2022). Therefore, pedagogical innovation is required to bridge conceptual knowledge and anticipatory practice in classroom settings.

A future-oriented learning approach offers a solution to the gap. Miller (2018) emphasizes the importance of future literacy as the ability to use the future as a space for reflection and planning. One of the methods that can develop future literacy is scenario techniques. This technique allows learners to identify the drivers of change, formulate key uncertainties, and develop a range of logical future possibilities. Through the exploration of multiple futures, students learn to understand that the future is open and influenced by current strategic choices. Scenario techniques are not only relevant for the development of student competencies, but also require the pedagogical readiness of teachers. Brundiers et al. (2021) emphasized that strengthening teacher capacity is an important prerequisite for the transformation of sustainable education. Without systematic training support, teachers tend to revert to conventional learning practices. Therefore, training-based interventions are needed to help teachers understand the concept of ESD in depth while implementing concrete learning methods.

Based on these needs, this service program is designed to strengthen the strategic thinking competence of junior high school teachers through training in scenario techniques based on climate change issues. This training not only aims to improve teachers' conceptual understanding, but also produces contextual teaching modules as concrete products that can be implemented in learning. Thus, the program contributes to the transformation of pedagogy towards more anticipatory, reflective, and future-oriented learning.

METHOD

This service program uses the Participatory Action Research (PAR) approach as the main methodological framework. PAR was chosen because it positions participants as active subjects in the process of change, rather than as recipients of passive intervention. In the context of sustainability education, a participatory approach allows teachers to be directly involved in the reflection, planning, action, and evaluation of their own pedagogical practices. This model is in line with the transformation principles in Education for Sustainable Development which emphasizes reflective and collaborative learning (Wiek et al., 2019; UNESCO, 2020).

The PAR approach in this program was implemented through a cycle of reflection and action that includes four main stages, namely planning, action, observation, and reflection. The planning stage begins with the identification of teachers' needs related to future-oriented learning and understanding ESD competencies in strategic thinking. Identification of needs was implemented through initial discussion and analysis of pretest results. This stage aims to formulate a training focus that is in accordance with the pedagogical context of junior high school teachers in West Java. The action stage is manifested in the implementation of online training consisting of program orientation, presentation of ESD competency material for strategic thinking, training on techniques for preparing future scenarios, and assistance in the development of climate change teaching modules. Training was implemented synchronously through Zoom Meeting and asynchronously through Google Classroom. Learning strategies are designed to be participatory by integrating discussions, case analysis, and product development tasks. Teachers are encouraged to examine the local context of each school as the basis for formulating relevant climate change issues.

The observation stage was implemented through the evaluation of the training process and results. Process evaluation includes the active involvement of teachers in the discussion and preparation of teaching modules. The evaluation of the results was carried out through a comparison of pretest and posttest scores and an assessment of the quality of the teaching module using a step-based rubric of scenario techniques. The rubric assesses teachers' ability to identify the drivers of change, formulate key uncertainties, develop multiple futures, and develop logical and contextual adaptive strategies. The reflection stage was implemented through a final discussion with participants to evaluate the learning experiences and challenges faced during the training. This reflection serves as a feedback mechanism to improve program design and strengthen the internalization of strategic thinking competencies. This reflective process is important within the framework of PAR because pedagogical change does not occur instantaneously, but through a continuous cycle of learning.

This program involved 17 junior high school teachers consisting of 10 science teachers and 7 social studies teachers from several districts/cities in West Java. The selection of participants was implemented purposively based on the commitment to participate in the entire series of training and compile teaching modules as program outputs. The training lasted for two weeks with gradual distribution of materials. The evaluation instruments used in this study consisted of a conceptual comprehension test and a teaching module assessment rubric. The comprehension test is designed to measure mastery of ESD concepts, strategic thinking, and scenario techniques. Data analysis was carried out in a comparative descriptive manner by comparing the average pretest and posttest scores. The assessment of the teaching module was analyzed descriptively to identify the trend in the quality of the products produced by the participants. Using the PAR approach, the program serves not only as one-way training, but as a collaborative process that encourages teachers to reflect on learning practices and develop sustainability-based pedagogical innovations. This approach reinforces the social validity of

the program because the changes that occur are sourced from the active participation of participants

RESULTS AND DISCUSSION

Results

The results of this service program are analyzed based on two main focuses, namely improving teachers' conceptual understanding of ESD competencies in strategic thinking and scenario techniques, and the quality of the climate change teaching modules produced as concrete training outputs. The analysis was carried out in a comparative descriptive manner to describe changes in teachers' pedagogical capacity after participating in the Participatory Action Research cycle.

Improving Teachers' Conceptual Understanding

The increase in training effectiveness can be observed quantitatively through the comparison of the results of the initial evaluation (*pretest*) and final evaluation (*posttest*). The data obtained from the two tests provide an objective picture of changes in the level of understanding of participants before and after participating in the program. A statistical summary of the assessment results, including the lowest score, highest score, and average score, is presented in Figure 1 to illustrate the overall learning outcomes.

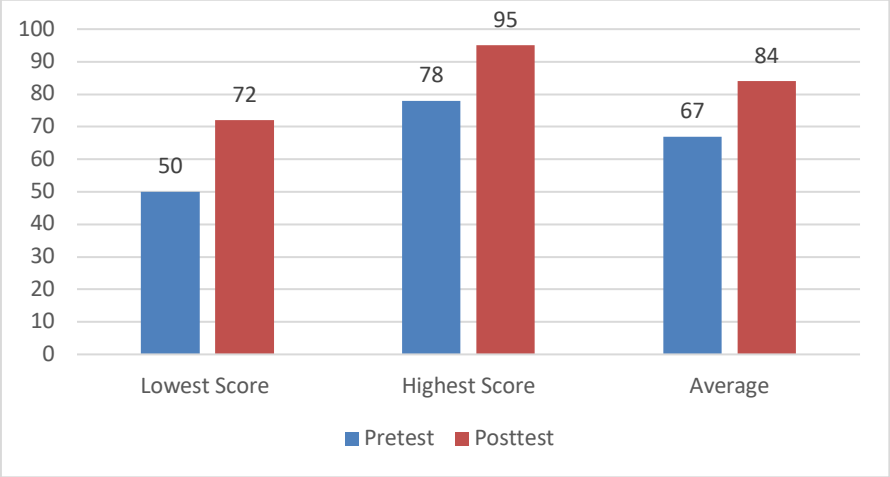

Figure 1 Smallest Score, Largest Score, and Average Score
Pretest and Postest Results of Training Participants

Figure 1 shows that the average score increased by 17 points after training. An increase in the lowest score of 22 points indicates that effective training helps participants with lower initial understanding. The increase in the highest score also showed a strengthening of conceptual capacity in participants who previously had a relatively good understanding. Substantively, this increase shows that the training has succeeded in broadening teachers' perspectives on climate change learning. Before the training, most teachers understood the issue of climate change as a content material that needed to be delivered to students. After the training, teachers show an understanding that the issue can be a context to train systemic analysis, uncertainty identification, and the formulation of adaptive strategies through scenario techniques.

Quality of Teaching Modules Based on Scenario Techniques

As the main output of the program, each participant compiles a climate change teaching module based on scenario techniques. The module is assessed using rubrics that cover six main dimensions, namely clarity of issues and local contexts, identification of factors driving change, formulation of key uncertainties, development of multiple scenarios, formulation of adaptive strategies, and pedagogical structure of modules. Scores are given in the range of 1 to 4.

Table 1. Average Assessment Score of Teaching Modules (Scale 1–4)

Assessment Dimensions	Average Score	Categories
Clarity of Local Issues and Context	3.41	Good
Identification of Driving Forces	3.29	Good
Formulation of Critical Uncertainties	3.18	Good
Multiple Scenario Development	3.12	Good
Adaptive Strategy Formulation	3.06	Good
Pedagogical Structure of Modules	3.47	Good

Table 1 shows that all dimensions are in the good category. The highest score is found in the pedagogical structure of the module, which shows that teachers are able to systematically formulate learning objectives, activities, and reflections. The dimensions with the lowest relative score are the formulation of adaptive strategies and the development of multiple scenarios. These findings indicate that the ability to design strategic responses to various future possibilities still requires further assistance. To give an overview of the overall quality of the product, the teaching modules are classified based on total scores.

Table 2. Distribution of Teaching Module Quality Category

Categories	Total Score Range	Number of Modules	Percentage
Excellent	≥ 21	6	35%
Good	17–20	9	53%
Enough	≤ 16	2	12%

Most of the modules are in the good and excellent categories. Only two modules are still in the sufficient category, mainly due to the lack of depth in uncertainty analysis and the formulation of adaptive strategies. This distribution shows that the majority of participants have been able to internalize the stages of scenario engineering in learning design.

Comparison of Module Quality by Field of Study

To see the tendency to differ in the quality of teaching modules based on the background of the field of study, a descriptive analysis was carried out of the average score of each dimension between science teachers and social studies teachers.

Table 3. Average Score of Teaching Modules by Field of Study (Scale 1–4)

Assessment Dimensions	Science teacher (n=10)	Social Studies Teacher (n=7)
Clarity of Local Issues and Context	3.50	3.29
Identification of Driving Forces	3.45	3.07
Formulation of Critical Uncertainties	3.32	3.00
Multiple Scenario Development	3.20	3.00
Adaptive Strategy Formulation	2.95	3.21

Assessment Dimensions	Science teacher (n=10)	Social Studies Teacher (n=7)
Pedagogical Structure of Modules	3.48	3.46

Table 3 shows a tendency to differ in analytical orientation between the two groups of teachers. Science teachers have a higher average score on the dimensions of identifying driving factors and formulating uncertainties related to environmental and ecological system aspects. On the other hand, social studies teachers showed higher average scores on the dimension of adaptive strategy formulation related to social and policy aspects. This difference reflects the characteristics of analysis influenced by the background of the discipline. Science teachers tend to be stronger in the scientific and ecological analysis of climate change, while social studies teachers are more prominent in designing social and policy responses. The integration of these two perspectives shows the potential for cross-disciplinary collaboration in the development of more comprehensive ESD learning.

The results of observations during the training showed the level of active participation of participants in discussions and reflections. At the stage of identifying the drivers of change, teachers share contextual experiences from their respective regions. Cross-disciplinary discussions enrich systemic analysis of climate change issues. The reflection cycle in the final stage shows that teachers are beginning to realize the need to change the learning paradigm from an informative approach to an anticipatory and strategic approach. This awareness is an early indicator of professional transformation within the framework of Participatory Action Research. Overall, the results of the program show an increase in the conceptual capacity and pedagogical design skills of teachers in integrating ESD-based scenario techniques. This increase is reflected in the evaluation score and the quality of the teaching modules produced

Discussion

The findings of this community service program demonstrate that the ESD-based scenario training significantly enhanced junior high school teachers' strategic thinking competence. The observed increase in the average pretest–posttest score from 67 to 84 indicates a substantial strengthening of conceptual understanding. However, the impact of the program extends beyond quantitative improvement. The results suggest a qualitative shift in how teachers conceptualize climate change learning, moving from content transmission toward anticipatory and systems-oriented pedagogical design. This shift extends beyond declarative knowledge and reshapes teachers' pedagogical perspectives toward anticipatory and systemic learning design.

Within the framework of Education for Sustainable Development, strategic competence involves the ability to formulate sustainability-oriented strategies through systemic and futures-oriented analysis (Wiek et al., 2019). The training operationalized this competence by introducing scenario techniques that require teachers to identify driving forces, formulate critical uncertainties, and construct multiple plausible futures. These structured processes transformed abstract sustainability concepts into actionable classroom design practices. The findings are further aligned with the GreenComp framework, which positions futures thinking and strategic action as interconnected sustainability competencies essential for societal transformation (Bianchi et al., 2022). By embedding scenario techniques into teaching module development, the program translated competence-based sustainability principles into concrete pedagogical innovation.

The improvement in module quality reinforces this transformation. The highest average score was observed in the pedagogical structure dimension, indicating that teachers were able to design learning objectives, activities, and reflective components coherently. Transformative

sustainability education requires structured yet flexible learning environments that encourage critical inquiry and forward-looking reflection (Sterling, 2020). The training design supported this transformation by combining conceptual enrichment with product-based tasks, ensuring that theoretical understanding was directly applied to instructional planning. Recent research on teacher professional development emphasizes that sustainability-oriented transformation requires reflective, practice-based, and collaborative learning models rather than purely theoretical workshops (Shephard et al., 2023). The PAR framework implemented in this program embodies these characteristics by integrating action, observation, and reflection cycles.

Despite these positive outcomes, the relatively lower scores in adaptive strategy formulation and multiple scenario development indicate that designing strategic responses to uncertainty remains challenging for some teachers. This finding highlights the complexity of strategic competence, which requires not only cognitive mastery but also iterative engagement with uncertainty and complexity. Wolff et al. (2020) argue that transformative competencies in ESD develop progressively through repeated experiential learning. The scenario-based approach introduced in this program represents an initial step toward embedding such iterative strategic reasoning within classroom practice.

The comparative analysis between science and social studies teachers reveals an important interdisciplinary dimension. Science teachers demonstrated stronger performance in identifying environmental drivers and systemic uncertainties, while social studies teachers showed greater proficiency in formulating adaptive strategies related to social and policy responses. This disciplinary complementarity reflects the inherently interdisciplinary nature of sustainability challenges. As Rieckmann (2018) emphasizes, ESD requires the integration of ecological, social, and economic perspectives to address complex socio-ecological systems comprehensively. The observed differences therefore do not indicate imbalance, but rather suggest opportunities for collaborative cross-disciplinary teaching models that enrich sustainability learning.

The participatory dynamics observed during the training further strengthen the interpretation of results. The PAR approach positioned teachers as active agents in the change process rather than passive recipients of information. Through collaborative reflection and contextual problem analysis, teachers engaged in professional dialogue that connected theory with practice. Such engagement fosters deeper professional transformation, as action research blends reflective inquiry with practical experimentation (Brydon-Miller & Høj, 2021). The integration of social and emotional dimensions within sustainability education is also crucial for fostering sustained professional change (Rumjaun & Narod, 2023). Reflection cycles embedded within the PAR framework contributed to the development of both cognitive and affective engagement with sustainability issues.

Furthermore, the results confirm that future-oriented pedagogy requires more than conceptual awareness; it demands the capacity to imagine and critically evaluate multiple possible futures. Scenario techniques cultivate future literacy by enabling teachers to treat the future as a space for reflection and planning (Miller, 2018; UNESCO, 2022). In climate change education, emotional engagement and action-oriented learning play a central role in sustaining motivation and agency (Ojala, 2022). The modules produced in this program indicate the initial integration of these dimensions, although continued mentoring would likely deepen their implementation.

From an implementation perspective, competence-based approaches to ESD emphasize iterative design, contextual adaptation, and structured evaluation (Vare et al., 2022). The PAR-based training model aligns with these principles, suggesting its scalability across similar

educational contexts. The structured yet flexible nature of the program allows adaptation to different subject areas and institutional settings, particularly in lower secondary education.

Overall, the discussion demonstrates that the observed improvements are not merely instructional gains but indicators of pedagogical transformation. The integration of scenario techniques within an ESD framework strengthened strategic thinking competence, fostered interdisciplinary awareness, and encouraged reflective professional practice. These findings highlight the value of participatory, competence-based training models in advancing the systemic implementation of Education for Sustainable Development in schools.

CONCLUSION

The ESD-based scenario training program proved effective in strengthening junior high school teachers' strategic thinking competencies. The improvement in pretest–posttest scores confirms the enhancement of conceptual understanding, while the quality of the teaching modules reflects the internalization of scenario techniques into structured and contextual learning design. The Participatory Action Research framework facilitated reflective and collaborative professional transformation, shifting pedagogical practices from informative approaches toward anticipatory and strategic learning. The observed interdisciplinary tendencies between science and social studies teachers highlight the importance of cross-disciplinary integration in sustainability education. This training model demonstrates strong potential for replication and further development through sustained mentoring to ensure long-term pedagogical impact.

ACKNOWLEDGMENTS

The authors express their sincere appreciation to all junior high school teachers in West Java who actively participated in this training program. Their commitment and engagement throughout the process were fundamental to the program's success. Gratitude is also extended to the organizing institution for supporting the implementation of the online activities and facilitating reflective and collaborative learning processes.

REFERENCES

Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp: The European sustainability competence framework*. Publications Office of the European Union. https://doi.org/10.2760/13286

Brundiers, K., Wiek, A., & Redman, C. L. (2021). Real-world learning opportunities in sustainability: From classroom into the real world. *International Journal of Sustainability in Higher Education, 22*(3), 471–486. https://doi.org/10.1108/IJSHE-02-2020-0048

Brydon-Miller, M., & Høj, L. (2021). Action research and participatory action research in education. *Educational Action Research, 29*(4), 517–523. https://doi.org/10.1080/09650792.2021.1951605

Leicht, A., Heiss, J., & Byun, W. J. (2018). *Issues and trends in education for sustainable development*. UNESCO Publishing.

Miller, R. (2018). *Transforming the future: Anticipation in the 21st century*. Routledge.

Ojala, M. (2022). Climate change education and emotional engagement: Exploring students' emotional responses and implications for learning. *Environmental Education Research, 28*(4), 453–467. https://doi.org/10.1080/13504622.2021.1988881

Rieckmann, M. (2018). Learning to transform the world: Key competencies in Education for Sustainable Development. *Sustainability, 10*(8), 1–16. https://doi.org/10.3390/su10082600

Rumjaun, A., & Narod, F. (2023). Social and emotional dimensions of sustainability education. *Journal of Education for Sustainable Development, 17*(1), 5–23. https://doi.org/10.1177/09734082221141562

Shephard, K., Rieckmann, M., & Barth, M. (2023). Embedding sustainability in teacher professional development. *Sustainability Science, 18*(3), 1423–1436. https://doi.org/10.1007/s11625-023-01230-5

Sterling, S. (2020). Learning for resilience, or the resilient learner? Toward a necessary reconciliation in a paradigm of sustainable education. *Environmental Education Research, 26*(3), 287–302. https://doi.org/10.1080/13504622.2019.1707306

UNESCO. (2020). *Education for Sustainable Development: A roadmap*. UNESCO Publishing.

UNESCO. (2022). *Futures literacy: A skill for the 21st century*. UNESCO Publishing.

Vare, P., Lausselet, C., & Rieckmann, M. (2022). Competence-based approaches in Education for Sustainable Development implementation. *International Journal of Sustainability in Higher Education, 23*(5), 1004–1020. https://doi.org/10.1108/IJSHE-08-2021-0307

Wiek, A., Withycombe, L., & Redman, C. L. (2019). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science, 14*(3), 1–17. https://doi.org/10.1007/s11625-019-00668-6

Wolff, L. A., Sjöblom, P., & Hofman-Bergholm, M. (2020). High performance education fails in sustainability? A reflection on ESD competence development. *Sustainability, 12*(3), 1–14. https://doi.org/10.3390/su12030910