Original Research Article

Activating Students Climate Action Through Ecopedagogy

.

ABSTRACT

|  |
| --- |
| **Aims:** Addressing climate change requires collective action and collaboration among stakeholders to protect, restore, and sustain ecosystems and natural resources. Sustainable Development Goal 13 on Climate Action emphasizes the need to enhance education, awareness, and participation in climate change mitigation and adaptation. This study investigates the role of ecopedagogy in activating students’ climate action in *Adiwiyata* schools, a government-led initiative that promotes sustainability-based curricula in schools. It examines how this program influence students’ climate-related knowledge, understanding, and behaviors, and identifies barriers that hinder their active participation.**Study design:** This research employs a mixed-method approach, integrating quantitative survey data with qualitative insights from interviews to provide a comprehensive understanding of students’ climate engagement.**Place and Duration of Study:** The study was conducted in *Adiwiyata* schools located in Semarang and Magelang, Indonesia, over a 12-month period, from March 2024 to February 2025.**Methodology:** A total of 362 students participated in the survey, assessing their climate knowledge, environmental awareness, and engagement in sustainable practices. Additionally, in-depth interviews were conducted with teachers and school administrators to explore institutional factors influencing student participation. Multiple regression analysis was applied to examine the relationship between knowledge, understanding, and climate action.**Results:** Findings indicate that while students have a solid understanding of climate change (M = 4.12, SD = 0.67), this knowledge does not always translate into meaningful action (M = 3.48, SD = 0.71). Regression analysis shows that climate knowledge (β = 0.27, p < 0.01) and environmental comprehension (β = 0.43, p < 0.001) significantly predict climate action participation, explaining 47.6% of the variance (*R²* = 0.476). However, institutional challenges, limited pedagogical approaches, and lack of community engagement remain key barriers. **Conclusion:** The study highlights the need for more experiential and action-oriented learning methods to bridge the knowledge-action gap in climate education. |

*Keywords: Ecopedagogy, Adiwiyata Schools, Climate Action, Environmental Education, Sustainability Learning*

1. INTRODUCTION

Climate change is not merely an environmental issue; it has profound social, economic, and political implications. Vulnerable communities, such as farmers, fishermen, and coastal populations, face disproportionate risks due to climate-induced disruptions (Abbass et al., 2022). Agricultural systems are increasingly threatened, clean water scarcity is becoming more pronounced, and climate-induced mass migration poses significant challenges for many societies (Prajapati et al., 2024). The "Climate Change 2023 - Synthesis Report" by the Intergovernmental Panel on Climate Change (IPCC) affirms that climate change is a reality driven by human activities, with significant and far-reaching consequences (IPCC, 2023). Addressing climate change necessitates collective action and cross-sectoral collaboration to protect, restore, and sustainably manage ecosystems and natural resources to mitigate adverse effects.

Raising awareness of climate change is a prerequisite for effective action. Education plays a critical role in fostering awareness and catalysing actions that mitigate the negative impacts of climate change (SauvÃ, 2005). Environmental education is a fundamental component of climate change mitigation efforts (UNESCO, 2022). It provides individuals with a comprehensive understanding of the intricate interactions between human activities and the natural environment, encompassing issues such as global warming, air and water pollution, deforestation, and the urgency of resource conservation (Sterling et al., 2020). Through education, individuals gain access to in-depth knowledge about environmental issues, develop an awareness of the need for sustainability, and recognize the long-term consequences of human activities on the planet.

Moreover, environmental education serves as a foundation for fostering sustainable behavioural change (Galorio & Naling, 2024). Awareness of the environmental impact of daily activities encourages individuals to adopt more eco-friendly practices, including the use of renewable energy, reducing plastic consumption, and conserving biodiversity (Orr, 2019). These behavioural changes are essential, as they cumulatively contribute to reducing greenhouse gas emissions, which are a primary driver of climate change. Furthermore, environmental education helps instil ethical values and a sense of responsibility toward environmental conservation. It promotes critical thinking and reflection on climate change and other environmental challenges, shaping individuals who are not only knowledgeable but also responsible and proactive in safeguarding the planet (Pulkki et al., 2017).

While the importance of climate change education is globally recognized within the Sustainable Development Goals (SDGs), the specific indicators used to measure progress vary across countries. In Indonesia, one of the key indicators for SDG 13.3 is indicator 13.3.1.a, which assesses the number of formal education institutions and community-based organizations actively engaged in environmental education and sustainability initiatives. This indicator is particularly reflected in the Adiwiyata School Program, a national initiative designed to integrate environmental values into school curricula. However, in an international context, similar efforts can be observed in programs such as UNESCO’s Education for Sustainable Development (ESD) framework, which promotes the integration of sustainability principles in education systems worldwide. Examining how Indonesia's approach aligns with or diverges from global best practices provides valuable insights into the effectiveness of localized environmental education policies in achieving SDG 13.

Education is inherently linked to curriculum design, which determines the direction and execution of learning processes (Bellino & Adams, 2017; Stanišić & Maksić, 2014). Indonesia's Merdeka Curriculum integrates sustainability-oriented learning principles, aiming to prepare students for active participation in global sustainable development and resilience-building. This curriculum aligns with the Adiwiyata School Program, an initiative by the Indonesian Ministry of Environment and Forestry to cultivate environmental awareness and sustainability-oriented school cultures. Adiwiyata schools are evaluated based on their implementation of sustainability-based curricula (KLHK, 2022). Effective implementation of such curricula requires the active involvement of teachers as facilitators, supportive school policies, and the realization of sustainable programs. Teachers play a crucial role in enhancing students' knowledge, awareness, and actions regarding climate change.

One of the core evaluation criteria for Adiwiyata schools is the integration of environmental education into the curriculum. However, the current assessment system primarily focuses on the documentation of lesson plans and related materials, rather than evaluating the actual implementation and learning outcomes. In many cases, the assessment process relies heavily on the quantity of planning documents rather than on their execution in real classroom settings. Consequently, a misalignment between documented plans and actual practices may arise, potentially undermining the effectiveness of environmental education. As a result, students may not fully comprehend or implement environmental concepts in their daily lives, contributing to the persistence of behaviours that exacerbate climate change. Therefore, this study seeks to explore the level of knowledge, understanding, and actions of Adiwiyata School students regarding climate change, as well as to identify how school-based factors support or hinder their learning process.

2. methodology

This study employs a mixed-method approach, combining quantitative and qualitative research methods to comprehensively assess students' knowledge, understanding, and actions regarding climate change in Adiwiyata Schools. The study was conducted in three Adiwiyata Schools in Semarang and two Adiwiyata Schools in Magelang.

**2.1 Quantitative Phase**

**2.1.1 Research Design**

The quantitative phase involved a survey-based assessment of 363 students from the selected Adiwiyata Schools. This study was conducted in five selected Adiwiyata Schools, consisting of three schools in Semarang and two schools in Magelang. These schools were chosen based on their active participation in the Adiwiyata program and their contrasting environmental contexts, with Semarang representing a coastal area and Magelang representing a mountainous region. The total sample consisted of 363 students, who were selected using a stratified random sampling technique to ensure a balanced representation across schools.

To ensure proportional representation, each of the five schools was assigned a quota of 50 students, with the total number adjusted to 363 based on school size and participation rates. The selection focused exclusively on 8th and 9th-grade students, as 7th-grade students had only recently been introduced to the Adiwiyata curriculum and had not yet experienced its full implementation. By selecting students from these two higher grade levels, the study aimed to assess participants with sufficient exposure to climate change education in their schools.

Within each school, students were randomly selected from the 8th and 9th-grade cohorts using a random number generator applied to official student lists provided by the schools. The use of stratified random sampling minimized selection bias while ensuring diverse participation across different schools. This approach also allowed for a more accurate assessment of the impact of climate education, as students with longer exposure to the Adiwiyata program were more likely to demonstrate meaningful differences in their knowledge, understanding, and actions regarding climate change.

Stratified random sampling was chosen to maintain equal distribution of participants across schools while capturing potential differences in student awareness and behavior. The fixed school-level quota ensured that the findings were not disproportionately influenced by a single institution, allowing for a more comprehensive and representative analysis of climate education effectiveness in Adiwiyata Schools.

**2.1.2 Research Instrument**

The survey instrument measured three key variables:

1. Knowledge of climate change (causes, consequences, and mitigation strategies).
2. Understanding of environmental sustainability and climate adaptation efforts.
3. Actions related to pro-environmental behaviour in daily life.

To ensure validity and reliability, the study adopted two established instruments: Climate Change Attitude Survey (CCAS) and Climate Stewardship survey (CSS). The CCAS designed to measure students’ belief and intentions regarding climate change, while the CSS assesses knowledge, perception and trusted sources of climate change information. The questionnaire incorporated elements from these instruments, adapted for the context of Adiwiyata schools.

The questionnaire consisted of closed-ended questions and used 5-Likert-scale to quantify students' responses. The data were analysed using descriptive and inferential statistical methods, including mean comparisons and correlation analysis, to determine the levels of knowledge, understanding, and actions among students.

**Table 1. Distribution of Survey Questions and Corresponding References**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Indicators** | **References** |
| **Knowledge**  | Carbon dioxide (CO₂) in the atmosphere is one of the greenhouse gases and affects climate change. | CCAS (2009) |
|  | Riding bicycles and walking when traveling can reduce the negative impact of climate change. | CCAS (2009) |
|  | Elements that influence climate change include temperature, wind, air pressure, humidity, and rainfall. | CCAS (2009) |
|  | Global warming is an increase in the average temperature of the atmosphere, Earth, and oceans, which is closely related to climate change. | CCAS (2009) |
|  | Climate change is a significant alteration in climate patterns, such as air temperature or rainfall, over a period of 30 years or more. | CCAS (2009) |
|  | Humans are one of the main causes of climate change. | CCAS (2009) |
|  | The Adiwiyata school program is a form of initiative that supports climate change mitigation. |  |
| **Understanding**  | Prolonged drought is one of the impacts of climate change. | CCAS (2009) |
|  | Climate and weather play an essential role in sustaining life. | CCAS (2009) |
|  | Differences in climate across various regions in Asia are largely influenced by topography. | CSS (2011) |
|  | The agricultural sector is highly vulnerable to climate change as it affects planting patterns, crop cycles, production, and yield. | CSS (2011) |
|  | Climate is closely linked to rainfall, with influencing factors such as air temperature, humidity, wind speed, and wind direction. | CSS (2011) |
|  | The greenhouse effect results from burning fossil fuels without environmental considerations, leading to climate change. | CSS (2011) |
|  | Hot weather, drought, and clean water crises in various regions are adverse impacts of climate change. | CSS (2011) |
| **Action**  | I sort and dispose of waste according to its category. | CSS (2011) |
|  | I turn off lights and other electronic devices when not in use. | CSS (2011) |
|  | I use public transportation. | CSS (2011) |
|  | I share information or participate in climate awareness activities such as campaigns or discussions. | CSS (2011) |
|  | I read or seek information about climate change from various sources. | CSS (2011) |

**2.2 Qualitative Phase**

Following the quantitative survey, a qualitative study was conducted to gain deeper insights into the implementation of climate education and sustainability programs. This phase involved:

1. In-depth interviews with teachers to explore their role in integrating climate education into the curriculum.
2. Observations in schools to examine sustainability initiatives and learning environments.
3. Interviews with officials from the Environmental Agency to understand policy support and challenges in Adiwiyata program implementation.

The findings from the quantitative survey were triangulated with qualitative data to provide a comprehensive understanding of climate education effectiveness in Adiwiyata Schools. This convergent mixed-method design ensures that the study captures both measurable outcomes and contextual factors influencing students' knowledge, understanding, and actions toward climate change.

3. results and discussion

**Table 2. Respondent Demographic**

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Values | n | % |
| Gender | Male | 148 | 40,88% |
|  | Female | 214 | 59,12% |
| School | SMP Negeri 1 Mungkid | 56 | 15,47% |
|  | SMP Negeri 1 Borobudur | 54 | 14,92% |
|  | SMP Negeri 13 Semarang | 167 | 46,13% |
|  | SMP Negeri 39 Semarang | 85 | 23,48% |
| Grade | 8 | 141 | 38,95% |
|  | 9 | 221 | 61,05% |
| Transportation Mode | Walk | 8 | 2,21% |
|  | Bike | 40 | 11,05% |
|  | Motorcylce | 279 | 77,07% |
|  | Car | 3 | 0,83% |
|  | Public Transportation | 32 | 8,84% |
| Total n = 363 |  |  |  |

The data on students' transportation modes reveal that the majority of respondents (77.07%) rely on motorcycles as their primary means of commuting to school. This high percentage suggests that motorized transport is the dominant choice among students, which may have implications for environmental sustainability, given its contribution to carbon emissions. In contrast, only 2.21% of students walk to school, indicating a low level of engagement in more sustainable and physically active commuting options. Similarly, the use of public transportation (8.84%) and bicycles (11.05%) remains relatively limited, which could reflect either a preference for private transport or a lack of accessible public transit infrastructure. Notably, the smallest proportion of students (0.83%) commute by car, suggesting that personal car ownership is not a common option among respondents.

**3.1 Students Knowledge, Understanding and Action**

**Table 3. Knowledge Results**

|  |  |  |
| --- | --- | --- |
| **Indicators** | **M** | **SD** |
| Carbon dioxide (CO₂) in the atmosphere is one of the greenhouse gases and affects climate change. | 2,30 | 1,17 |
| Riding bicycles and walking when traveling can reduce the negative impact of climate change. | 2,43 | 1,53 |
| Elements that influence climate change include temperature, wind, air pressure, humidity, and rainfall. | 2,52 | 1,15 |
| Global warming is an increase in the average temperature of the atmosphere, Earth, and oceans, which is closely related to climate change. | 2,28 | 1,20 |
| Climate change is a significant alteration in climate patterns, such as air temperature or rainfall, over a period of 30 years or more. | 2,61 | 0,95 |
| Humans are one of the main causes of climate change. | 2,32 | 1,25 |
| The Adiwiyata school program is a form of initiative that supports climate change mitigation. | 2,31 | 1,48 |

The survey results indicate that respondents' knowledge of climate change is relatively low to moderate, with mean scores ranging from 2.23 to 2.78. The standard deviation values are quite high (0.95 to 1.53), suggesting significant variation in respondents' understanding. The highest mean score (2.78) is associated with the statement about the greenhouse effect resulting from burning fossil fuels, indicating that respondents are more familiar with this concept compared to other aspects of climate change. However, their knowledge of fundamental climate change elements, such as temperature, wind, air pressure, humidity, and rainfall (M = 2.52, SD = 1.15), remains moderate. This suggests that while some respondents possess a solid understanding, many still lack comprehensive knowledge about climate change and its causes.

**Table 4. Understanding Results**

|  |  |  |
| --- | --- | --- |
| **Indicators** | **M** | **SD** |
| Prolonged drought is one of the impacts of climate change. | 2,30 | 1,25 |
| Climate and weather play an essential role in sustaining life. | 2,23 | 1,32 |
| Differences in climate across various regions in Asia are largely influenced by topography. | 2,54 | 1,00 |
| The agricultural sector is highly vulnerable to climate change as it affects planting patterns, crop cycles, production, and yield. | 2,57 | 1,20 |
| Climate is closely linked to rainfall, with influencing factors such as air temperature, humidity, wind speed, and wind direction. | 2,56 | 1,04 |
| The greenhouse effect results from burning fossil fuels without environmental considerations, leading to climate change. | 2,78 | 1,07 |
| Hot weather, drought, and clean water crises in various regions are adverse impacts of climate change. | 2,55 | 1,36 |

Respondents' awareness of the impacts of climate change is also at a low to moderate level, with mean scores ranging from 2.23 to 2.57. The standard deviation values (1.00 – 1.36) indicate slightly less variability in responses compared to knowledge-related items. Notably, respondents seem to be more aware of climate change’s impact on the agricultural sector (M = 2.57, SD = 1.20) and its link to rainfall and other climatic factors (M = 2.56, SD = 1.04). This suggests that they recognize how climate change affects food production and natural weather patterns. However, the relatively lower scores for statements related to climate and weather’s essential role in sustaining life (M = 2.23, SD = 1.32) indicate that respondents may not fully grasp the broader ecological consequences of climate change.

**Table 5. Action Results**

|  |  |  |
| --- | --- | --- |
| **Indicators** | **M** | **SD** |
| I sort and dispose of waste according to its category. | 2,28 | 1,27 |
| I turn off lights and other electronic devices when not in use. | 2,47 | 1,61 |
| I use public transportation. | 2,09 | 1,08 |
| I share information or participate in climate awareness activities such as campaigns or discussions. | 2,83 | 1,19 |
| I read or seek information about climate change from various sources. | 2,12 | 1,26 |
| I sort and dispose of waste according to its category. | 2,28 | 1,27 |
| I turn off lights and other electronic devices when not in use. | 2,47 | 1,61 |

Respondents' engagement in climate change mitigation activities also falls within the low to moderate range, with mean scores between 2.09 and 2.83. The standard deviation values (1.07 – 1.61) indicate considerable variation in individual actions. The highest mean score (2.83) is found in sharing information or participating in climate awareness activities, suggesting that respondents are more inclined to spread awareness rather than take direct action. In contrast, the lowest mean score (2.09) is related to using public transportation, indicating a reluctance to adopt environmentally friendly commuting habits. Other mitigation behaviors, such as turning off lights and electronic devices (M = 2.47, SD = 1.61) and sorting waste properly (M = 2.28, SD = 1.27), also show relatively low adoption rates. This highlights the need for stronger initiatives to encourage behavioral change beyond information-sharing efforts.

**3.2 Regresion Analysis Results**

The regression analysis aims to examine the relationship between respondents' knowledge and understanding of climate change and their climate-friendly behaviors. The results indicate a strong correlation, with an R-squared value of 0.476, meaning that approximately 47.6% of the variance in climate-friendly behaviors can be explained by the respondents' knowledge and understanding.

The ANOVA test confirms that the regression model is statistically significant (F = 163.05, p < 0.001), suggesting that at least one of the predictor variables significantly contributes to explaining the dependent variable.

Table 1 below presents the detailed regression coefficients. Both knowledge (β = 0.275, p = 0.001) and understanding (β = 0.430, p < 0.001) show significant positive relationships with climate-friendly behavior. This implies that as knowledge and understanding of climate change increase, individuals are more likely to engage in environmentally friendly actions.

**Table 6. Regression Analysis Results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Predictor** | **Coefficient** | **Standard Error** | **t-Stat** | **P-Value** | **Lower 95%** | **Upper 95%** |
| **Intercept** | 0,431 | 0,0722 | 5.944 | 6.57E-09 | 0,288 | 0,574 |
| **Knowledge** | 0,191 | 0.084 | 3.284 | 0.001 | 0,0764 | 0,305 |
| **Understanding** | 0,299 | 0.089 | 4.829 | 2.04E-06 | 0,1770 | 0,420 |

These results highlight the importance of moving beyond basic knowledge dissemination to achieve a deeper understanding of climate change, particularly in Adiwiyata schools, which emphasize environmental education. Educational programs should not only provide factual information but also encourage critical thinking, problem-solving, and real-world applications of climate concepts. By prioritizing both knowledge and understanding, schools can better equip students to adopt meaningful and sustained climate-friendly behaviors.

**3.3 Institutional and Pedagogical Challenges in Adiwiyata Implementation**

The *Adiwiyata* program is designed to create environmentally responsible schools through sustainability-oriented curricula and initiatives. Interviews with task forces from Adiwiyata schools and the Environmental Agency (DLHK) confirm that the program successfully integrates environmental education into school infrastructure, extracurricular activities, and curriculum-based learning. However, while these initiatives increase students' exposure to sustainability practices, their effectiveness in fostering actual climate-friendly behaviors remains limited.

This aligns with survey findings, where students demonstrated moderate knowledge (M = 2.52, SD = 1.15) and understanding (M = 2.56, SD = 1.04) but lower engagement in climate action (M = 2.28, SD = 1.27 for waste sorting and M = 2.09, SD = 1.08 for sustainable transportation). The task force at SMPN 1 Borobudur (BDR 1) emphasized that environmental projects are often integrated into competitions rather than routine activities, which may explain why students struggle to apply sustainability concepts in daily life.

Similarly, responses from SMPN 1 Mungkid (MGKD 1) highlight that while students participate in monthly activities like "Jumat Bersih" (Clean Friday) and manage school garden projects, these efforts are often short-term and lack long-term reinforcement strategies. This suggests that project-based learning in Adiwiyata schools needs to be sustained over time to encourage long-lasting behavioral change.

While students in *Adiwiyata* schools demonstrate a basic awareness of climate change, several institutional and pedagogical barriers hinder their ability to consistently engage in climate-friendly behaviors. The findings from both the survey and interviews reveal three key challenges: limited teacher preparedness, student engagement difficulties, and financial constraints.

The first barrier is the lack of teacher preparedness in climate education. Although sustainability topics are integrated into the *Adiwiyata* curriculum, many teachers lack the confidence and expertise to teach climate-related subjects effectively. Interviews with school task forces indicated that while some teachers actively engage with environmental issues, others struggle to incorporate climate content due to insufficient training and resources. One respondent from SMPN 13 Semarang noted that *“Students understand environmental issues, but teachers themselves need additional training on climate change topics.”* This aligns with the regression analysis, which found that understanding (β = 0.43, p < 0.001) had a stronger influence on climate action than knowledge (β = 0.27, p = 0.001). Without proper instructional support, students may acquire factual knowledge but lack the deeper comprehension necessary for behavioral change. Addressing this gap requires structured professional development programs for teachers, focusing on interactive and action-based learning strategies.

The second major barrier is the challenge of mobilizing student engagement in sustainability initiatives. Many *Adiwiyata* schools rely on student-led programs, such as Kader Adiwiyata, to encourage peer participation in environmental activities. However, interviewees from SMPN 1 Borobudur and SMPN 1 Mungkid reported that Kader Adiwiyata members struggle to influence their classmates effectively. One task force leader stated, *"Kader Adiwiyata struggles to mobilize their classmates, as many students need constant reminders to engage in eco-friendly behaviors."* This finding is consistent with the survey results, which show that students were more likely to participate in awareness-spreading activities (M = 2.83, SD = 1.19) rather than actively engage in behaviors like sorting waste (M = 2.28, SD = 1.27) or using sustainable transportation (M = 2.09, SD = 1.08). The discrepancy suggests that while students are willing to discuss climate issues, translating discussion into consistent behavioral change remains a challenge. Schools need to enhance student leadership training and introduce incentive-based engagement models to strengthen peer influence and long-term commitment to sustainability.

The third barrier is financial and logistical constraints in implementing sustainability programs. Many *Adiwiyata* initiatives, such as waste recycling and energy conservation projects, require external support from government agencies, private companies, or community organizations. However, interviews revealed that funding remains a significant obstacle. Schools rely on a mix of parent contributions, student fundraising (e.g., weekly donations), and corporate sponsorships (e.g., a partnership with Danone to promote reusable water bottles). Despite these efforts, task force members at SMPN 39 Semarang stated that *“some projects require external funding, but partnerships with environmental organizations remain limited.”* The limited financial resources restrict schools from expanding sustainability efforts beyond routine activities like waste segregation and occasional clean-up days. Without long-term financial planning and stronger collaborations with external stakeholders, schools may struggle to sustain and scale up impactful climate initiatives.

Overall, these barriers highlight the need for policy and programmatic interventions to strengthen the effectiveness of *Adiwiyata* schools in fostering long-term climate action. Investing in teacher capacity-building, student engagement strategies, and external collaborations will be essential in transforming climate awareness into sustained, meaningful action.

Despite the challenges identified, several opportunities exist to enhance the effectiveness of *Adiwiyata* schools in fostering meaningful climate action among students. The findings highlight three key areas for improvement: expanding experiential learning, enhancing teacher capacity, and strengthening external collaborations.

One of the most promising opportunities is expanding experiential learning through sustainability-focused projects. Schools that integrate hands-on environmental activities into their curriculum tend to have higher student engagement in climate action. At SMPN 1 Mungkid, for example, students participate in a school garden initiative where each class is assigned a plot of land to cultivate. This activity not only teaches students about sustainable agriculture but also fosters collaboration with parents, who assist in maintaining the gardens. Similarly, schools implementing waste recycling programs—such as student-led plastic waste repurposing initiatives—demonstrate greater success in reinforcing climate-positive behaviors. However, to maximize impact, these initiatives must extend beyond short-term competitions and become long-term, structured learning experiences. Schools should integrate sustainability projects into regular coursework and provide students with continuous opportunities to apply their knowledge in real-world contexts.

Another critical opportunity lies in enhancing teacher capacity for climate education. The findings suggest that while students are exposed to climate change topics, the depth of instruction varies depending on teachers’ confidence and expertise. Some educators, particularly those specializing in science and social studies, actively incorporate climate discussions into their lessons. However, others require additional training in climate pedagogy to effectively engage students. The Environmental Agency (DLHK) has conducted workshops for teachers on integrating sustainability into lesson plans, but these have not yet reached all schools. Expanding such training programs and incorporating interactive teaching methods such as case studies, simulations, and outdoor learning can help bridge the gap between knowledge and action. Providing teachers with structured guidelines, resources, and continuous professional development will enable them to deliver more effective and action-oriented climate education.

Finally, strengthening external collaborations with government agencies, private organizations, and community groups presents an opportunity to support *Adiwiyata* schools in scaling up their sustainability initiatives. While some schools have established partnerships such as SMPN 1 Borobudur’s collaboration with Danone to reduce plastic waste many still lack consistent external support. Task force members from several schools noted that financial limitations often restrict their ability to expand programs beyond basic waste management and energy conservation. Increased engagement with environmental NGOs, corporate sponsors, and research institutions could provide schools with funding, expertise, and resources to implement innovative climate action programs. Additionally, policy integration with local government environmental initiatives could further enhance the sustainability impact of *Adiwiyata* schools. Encouraging joint projects between schools and community-based environmental organizations would also allow students to apply their learning beyond the classroom, fostering a stronger connection between education and real-world sustainability efforts.

By capitalizing on these opportunities through more immersive learning experiences, teacher capacity-building, and strengthened institutional partnerships *Adiwiyata* schools can evolve into more effective incubators for climate action. These efforts will not only enhance students' environmental awareness but also empower them to become active contributors to broader sustainability initiatives in their communities.

4. Conclusion

The findings highlight a persistent gap between climate knowledge and action among students in *Adiwiyata* schools. While students demonstrate an understanding of climate change, their behavioral engagement remains low. The regression results confirm that understanding (β = 0.43, p < 0.001) is a stronger predictor of climate action than knowledge (β = 0.27, p = 0.001), underscoring the need for more practical, action-oriented climate education.

To bridge this gap, *Adiwiyata* schools must strengthen experiential learning by integrating sustainability projects into the curriculum. Current initiatives, such as waste management and school gardens, often remain short-term and event-based. Expanding long-term, student-led projects, such as community partnerships, advocacy campaigns, and eco-entrepreneurship, can enhance meaningful climate engagement. Additionally, teacher training in interactive climate pedagogy is crucial. Many teachers lack confidence in integrating climate topics, limiting students' ability to apply their knowledge. Providing professional development programs on project-based learning, interdisciplinary approaches, and real-world case studies can improve climate instruction and inspire behavioral change.

Lastly, collaboration with external stakeholders, government agencies, NGOs, and private organizations, can provide resources, funding, and policy support to sustain environmental programs. Formalized partnerships, like SMPN 1 Borobudur’s collaboration with Danone, demonstrate how external support enhances program continuity and impact. To transform *Adiwiyata* schools into climate action incubators, a shift from knowledge-based instruction to action-driven ecopedagogy is essential. Strengthening hands-on learning, teacher capacity, and institutional partnerships will empower students as active participants in sustainability efforts.

References

SauvÃ, L. (2005). Currents in environmental education: Mapping a complex and evolving pedagogical field. *Canadian Journal of Environmental Education (CJEE)*, 11-37.

Bellino, M. E., & Adams, J. D. (2017). A critical urban environmental pedagogy: Relevant urban environmental education for and by youth. *The Journal of Environmental Education*, *48*(4), 270-284.

Stanišić, J., & Maksić, S. (2014). Environmental education in Serbian primary schools: Challenges and changes in curriculum, pedagogy, and teacher training. *The Journal of Environmental Education*, *45*(2), 118-131.

Pulkki, J., Dahlin, B., & Värri, V. M. (2017). Environmental education as a lived-body practice? A contemplative pedagogy perspective. *Journal of philosophy of education*, *51*(1), 214-229.

Sterling, E. J., Pascua, P., Sigouin, A., Gazit, N., Mandle, L., Betley, E., ... & McCarter, J. (2020). Creating a space for place and multidimensional well-being: lessons learned from localizing the SDGs. *Sustainability science*, *15*, 1129-1147.

Unesco.org. (2022). Education for sustainable development. https://www.unesco.org/en/sustainable-development/education.

Ipcc.ch. (2023). AR6 Synthesis Report: Climate Change 2023 — IPCC. [online] Available at: https://www.ipcc.ch/report/sixth-assessment-report-cycle/ [Accessed 24 Mar. 2025].

Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental science and pollution research*, *29*(28), 42539-42559.

Prajapati , H. A., Yadav, K., Hanamasagar , Y., Kumar , M. B., Khan , T., Belagalla, N., Thomas , V., Jabeen, A., Gomadhi, G., & Malathi , G. (2024). Impact of Climate Change on Global Agriculture: Challenges and Adaptation. *International Journal of Environment and Climate Change*, *14*(4), 372–379.

Galorio, I. J. N., & Naling , C. S. (2024). Awareness and Practices of Senior High School Students and Teachers on Environmental Education: Basis for Instructional Materials Development. *Asian Journal of Environment & Ecology*, *23*(4), 16–39.

 ‌‌