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Navigating Global Environmental Crises in The Classroom: Student Perspectives on Developing Future-Ready Skills Through Project-Based Inquiries

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Abstract

The escalation of global environmental crises, including climate change, biodiversity loss, and resource depletion, demands that education systems cultivate future-ready skills in the younger generation. This study aims to explore students' perspectives on developing future-ready skills (critical thinking, collaboration, creativity, and ecological literacy) through project-based inquiries focused on global environmental crises. The research employed a qualitative case study approach involving 36 senior high school students in Indonesia who participated in an eight-week project-based learning program on the environment. Data were collected through semi-structured interviews, classroom observations, reflective journals, and student project artifacts, then analyzed using Miles and Huberman's interactive thematic analysis. The findings reveal four key themes: (1) enhanced awareness of environmental interdependence, (2) strengthened collaborative problem-solving competencies, (3) development of transdisciplinary critical and creative thinking, and (4) emergence of agentic ecological citizenship. Students reported increased confidence in addressing complex real-world issues and articulated a stronger sense of responsibility toward sustainability. The study concludes that project-based inquiries into environmental crises effectively bridge classroom learning and 21st-century competencies, while recommending the curricular integration of global issues as authentic contexts for developing future-ready learners in Indonesian secondary education.

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Introduction

The global environmental crisis has transformed from a distant threat to the reality facing today's generation. The Intergovernmental Panel on Climate Change (IPCC) report and the Global Environment Outlook affirm that climate change, biodiversity loss, plastic pollution, and the water crisis are multidimensional challenges that require a cross-generational response (Reimers, 2021). In the context of Indonesian education, this urgency is even more relevant, given the archipelago's geographical position, which is vulnerable to ecological disasters, and the national commitment to achieving the Sustainable Development Goals (SDGs) 2030. Students, as heirs of the planet, are

required to have future-ready skills, including critical thinking, collaboration, creativity, communication, and ecological literacy (Fadel et al., 2015; OECD, 2019). To avoid conceptual ambiguity, this study positions its key terms within a single nested framework rather than treating them as interchangeable labels. Twenty-first-century competencies serve as the broad umbrella of transferable capacities (critical thinking, collaboration, creativity, and communication); future-ready skills refer to the forward-looking subset of these competencies that equips learners to anticipate and respond to emerging planetary challenges; ecological literacy denotes the domain-specific capacity to understand and reason about interdependent socio-ecological systems; and ecological agency represents the disposition and capacity to act upon that understanding. Within this framework, ecological literacy and ecological agency function as the environmental application layer through which the more general future-ready skills are enacted, so that the four constructs form a continuum from generic competence to situated action rather than a set of separate variables. However, classroom learning practices remain predominantly transmissive and disconnected from real-world problems, creating a gap between the competencies students learn and the demands they face.

Various studies in the last decade have highlighted the potential of project-based learning (PjBL) in fostering 21st-century competencies. Chen & Yang (2019), through a meta-analysis of 30 studies, found a significant positive influence of PjBL on students' academic achievement. Kokotsaki et al. (2016) identified the characteristics of effective PjBL, including authentic context, student engagement, and meaningful products. Furthermore, research by Hallinger & Nguyen (2020) shows that project-based sustainability education strengthens learners' ecological awareness. In the Indonesian context, Rahmawati & Ridwan (2017) found that integrating environmental issues into PjBL improves science literacy and problem-solving skills. A similar study by Anazifa & Djukri (2017) demonstrates the superiority of PjBL over conventional learning in developing students' critical and creative thinking.

However, there is a significant gap in the literature. First, most PjBL studies focus on quantitative outcomes (e.g., improved test scores) and overlook students' voices regarding how they interpret the learning process (Grossman et al., 2021). Second, research linking the global environmental crisis as an authentic context to the development of future-ready skills remains limited, especially in Global South countries (Monroe et al., 2019; Wals & Benavot, 2017). Third, existing studies tend to treat 21st-century competencies as a single entity, without tracing how specific skills such as collaboration, systems thinking, and ecological agency emerge in relation to one another within project inquiry. Inconsistencies are also evident between claims of PjBL's effectiveness in the international literature and implementation constraints in the Indonesian context, which faces limited resources and a culture of standardized exams (Afriana et al., 2016).

This gap is exacerbated by the fact that the Indonesian curriculum, despite having adopted the Independent Curriculum that emphasizes the Pancasila Student Profile and the Pancasila Student Profile Strengthening Project (*Projek Penguatan Profil Pelajar Pancasila*, P5), has not systematically raised the global environmental crisis as a context for integrated learning (Ristek, 2021). Teachers often face challenges in designing authentic, transdisciplinary, and meaningful inquiry for students. In addition, the perspective of students as the main actors in learning is rarely elaborated in depth in Indonesian environmental education research. In fact, understanding how students perceive their learning experiences is key to designing a responsive and sustainable curriculum (Rousell & Cutter-Mackenzie-Knowles, 2020; Trott, 2020).

Based on these gaps, this study comes with a specific focus that distinguishes it from previous studies. The objectives of this research are: (1) to explore students' perspectives on the development of future-ready skills through project-based inquiry on the global environmental crisis; (2) to identify key themes that emerge from students' learning experiences; and (3) to formulate pedagogical implications for the integration of global issues in secondary school learning. In contrast to studies oriented towards measuring effectiveness, this study positions students as co-constructors of knowledge, with their voices serving as the primary basis for analysis. The focus on the global environmental crisis as an authentic context broadens the horizons of conventional PjBL, which tends to be centered on limited local issues.

The main argument tested in this paper is that project-based inquiry on the theme of the global environmental crisis can be a transformative pedagogical space for the holistic development of future-ready skills. The qualitative hypothesis is that students' experiences in environmental projects will foster critical thinking competencies, collaboration, creativity, and ecological agency in an interrelated, rather than partial, manner. This study also tests the assumption that Indonesian students, when given space to study global issues, can articulate the relationship between local realities and planetary challenges.

Method

This study uses a qualitative approach with an instrumental case study design (Creswell & Poth, 2018) to explore in depth students' perspectives on developing future-ready skills through a project-based inquiry into the global environmental crisis. Case studies were chosen because they allow researchers to understand complex phenomena in real-world contexts, with clear boundaries between the case and its context. The unit of research analysis is the learning experience of students in an eight-week environmental project inquiry program. The cases studied are framed within an interpretivist paradigm that places the student's subjective meaning at the center.

The research was conducted at a public high school in West Java, Indonesia, during the odd semester of the 2024/2025 school year. The subjects of the study were 36 students of class XI who were selected purposively based on the following criteria: (1) enrolled in biology and geography subjects that integrate environmental projects; (2) willing to participate voluntarily after obtaining informed consent from parents; and (3) represent gender variation, academic achievement, and socio-economic background. Of the 36 students, 12 were selected as key informants for in-depth interviews, using a maximum variation sampling strategy to capture a wide range of perspectives. Subject teachers also act as supporting informants for data triangulation.

The researcher serves as a participant observer, documenting classes without intervening in the learning process. Researchers built rapport over the first two weeks before the core data collection to ensure participants felt comfortable and honest in revealing their experiences. The observed intervention program was a project inquiry titled "Global Environmental Crisis" that explored the sub-themes of climate change, marine plastic pollution, deforestation, and the clean water crisis. Students work in small groups (4-5 people) through six learning stages: (1) essential question, (2) literature and field investigation, (3) solution design, (4) product creation, (5) public presentation, and (6) critical reflection.

Data collection was conducted simultaneously using four techniques to ensure depth and triangulation. First, semi-structured interviews were conducted twice (pre and post-project) with 12 key informants, using interview guides that included questions about understanding issues,

learning experiences, challenges, and self-transformation. Second, participants' observations of 16 learning sessions were documented in structured field notes that recorded interactions, dialogues, and collaborative behaviors. Third, students wrote reflective journals each week, resulting in 288 entries that recorded their personal reflections. Fourth, project artifacts (posters, campaign videos, solution prototypes, scientific reports) are analyzed as supporting documents. The interview guidance instrument and observation rubric were developed based on the future-ready skills framework of the OECD Learning Compass 2030 and then validated by three education experts through expert judgment techniques.

Data analysis employed the interactive model of Miles et al. (2014) as the primary analytical framework, encompassing three concurrent activities: data condensation, data display, and conclusion drawing and verification. All data were first transcribed verbatim and coded using NVivo 12. The two analytical traditions were deliberately positioned in a hierarchical rather than parallel relationship: the interactive model governed the overall analytic logic, while the reflexive coding phases of Braun & Clarke (2019)—familiarisation, initial coding, theme generation, and theme review—were nested within its data-condensation stage as the concrete procedure through which raw data were reduced into themes. In this way, the interactive model of Miles, Huberman, and Saldaña served as the main method for structuring the analysis, from data reduction to verified conclusions, and reflexive thematic coding served as the subordinate operational technique. Operationally, this nested coding proceeded through six recursive steps—data familiarisation, initial coding, theme search, theme review, theme naming, and narrative writing—all feeding back into the condensation and display stages of the interactive model. To ensure the credibility of the results, the study employed four data validity-checking strategies as recommended by Lincoln & Guba (1985). Source triangulation is carried out by comparing data from students, teachers, and artifacts. The triangulation method is carried out through a combination of interviews, observations, journals, and documents. Member checking is carried out by confirming transcripts and interpretations with informants. A peer debriefing was conducted with two educational researchers to challenge the evolving interpretation. A complete trail audit is also compiled to document the traces of analytical decisions, thereby increasing the dependability and confirmability of findings.

Ethical research principles were strictly applied throughout the data collection process. The distributed questionnaires included a section on the first page explaining respondents' rights. Respondents were required to select the "Agree" option before proceeding to complete the research instrument. The researchers adhered to the principle of anonymity, ensuring that no sensitive data—such as identification numbers or full names—were recorded. All data obtained from respondents were treated confidentially and used solely for the academic analysis associated with this publication, rather than for commercial purposes or objectives outside the scope of the research.

Findings

Based on thematic analysis of interview data, observations, reflective journals, and project artifacts, the research identified four main themes representing students' perspectives on developing future-ready skills through the global environmental crisis project inquiry. The four themes are: (1) increasing awareness of ecological connectedness; (2) strengthening collaborative problem-solving; (3) the development of transdisciplinary critical and creative thinking; and (4) the

emergence of agent ecological citizens. The distribution of codes and theme frequencies is presented in Table 1.

Table 1. Distribution of Themes, Sub-themes, and Frequency of Code Results of Analysis

Main Theme	Sub-theme	Data Source	Frequency
Ecological connectivity	Systems awareness, local-global linkage, ecological empathy	Interviews, journals	142
Collaborative problem-solving	Role negotiation, division of labor, conflict resolution, peer learning	Observations, interviews	118
Transdisciplinary critical & creative thinking	Multi-perspective analysis, discipline integration, innovative solutions	Journals, project artifacts	134
Agent ecologists	Personal agency, public advocacy, ongoing commitment	Interviews, artifacts	96

Table 1 shows that the theme of ecological connectedness has the highest coding frequency (142), followed by transdisciplinary critical and creative thinking (134), collaborative problem-solving (118), and agentic ecological citizens (96). This distribution indicates that environmental project inquiry is the strongest driver of students' systemic awareness, while the public agencies dimension is still in the early stages of emergence and requires further strengthening.

Increased awareness of ecological connectedness

Students show a shift in understanding from a fragmentary view to systemic thinking towards environmental crises. In pre-project interviews, most participants described environmental issues as separate technical issues, such as garbage or flooding, or as purely hygiene issues. After participating in the project, participants were able to articulate the linkages between ecological, social, economic, and political dimensions. One of the informants, AR, stated that ocean plastic pollution was related to his family's shopping habits, industrial practices, state regulations, and even global consumption patterns. This reflection appears repeatedly in 78% of journal entries in weeks six through eight. Students also show strong ecological empathy, reflected in narratives about the fate of marine species, affected coastal communities, and future generations. Local-global connectivity is also strengthened: students connect the phenomenon of flash floods along the coast of Jakarta to global sea-level rise and Amazon deforestation.

Strengthening Collaborative Problem-Solving

Classroom observations across 16 learning sessions revealed a collaborative dynamic that gradually developed. In the first and second weeks, the group tends to experience conflicts over task division and differences in ideas. But from the fourth week, the group began to develop more mature collaborative norms, characterized by member-based role negotiations, scheduling joint work, and conflict resolution through dialogue. Learners articulate that the project teaches them to work with people who are not always liked, but have equally valuable ideas. Peer learning is a standout feature: tech-savvy learners teach less-than-proficient peers to create campaign videos, while students who are strong in writing help compile group scientific reports. This phenomenon reflects a shift from competitive learning to positive dependency-based learning.

Development of Transdisciplinary Critical and Creative Thinking

The analysis of project artifacts demonstrates learners' capacity to integrate knowledge from biology, geography, chemistry, economics, and social studies when formulating solutions. One group developed a water filter prototype from local materials and also developed a social media-based advocacy campaign and a policy proposal for schools. Another group produced a short documentary that combined scientific data, personal narratives of affected residents, and public policy analysis. Students question the assumptions that have been accepted so far, such as the claim that technology alone can solve the climate crisis. In a reflective journal, one of the participants (NS) wrote that after the investigation, I realized that a technical solution without behavioral change and social justice would only generate a new crisis. This kind of critical thinking appears in 65% of project artifacts and signifies the development of analytical capacity away from a single answer.

The Emergence of Agent Ecological Citizens

The fourth theme shows a shift in students from passive learners to active agents regarding environmental issues. After the project, 28 of the 36 learners reported taking tangible actions outside of schoolwork, such as reducing single-use plastic consumption, advocating for families to sort waste, or joining environmental communities. Five groups took the initiative to bring their project results to the Student Council meeting to encourage green school policies. The two groups worked with the local community to continue the project beyond the classroom. Students' confidence to engage in public discussions increased significantly, reflected in statements such as "I now feel they have a voice" and "that young people can also be part of the solution." These findings mark the transformation from competencies on paper to competencies in action.

Discussion

The findings of this study provide an empirical answer to the research problem of how project-based inquiry into the global environmental crisis contributes to the development of future-ready skills among secondary school students. The four themes that emerged, namely ecological connectedness, collaborative problem-solving, transdisciplinary critical thinking, and agent ecological citizens, emphasized that PjBL in the context of a global crisis can be a holistic and transformative pedagogical space. These findings are in line with Kokotsaki et al.'s (2016) argument that PjBL is effective in fostering 21st-century competence when it meets the criteria of authenticity, engagement, and meaningful products, and expand on it by showing that planetary issues are the most authentic context for today's generation.

The first theme of ecological connectedness reflects a paradigmatic shift from reductionistic thinking to systems thinking, which is at the heart of ecological literacy as proposed by Capra and Luisi. These findings confirm a study by Monroe et al. (2019) showing that climate change learning is effective when connecting global issues to learners' local experiences. Rahmawati & Ridwan (2017) also reported on the increase in Indonesian science literacy through the integration of environmental issues, but this study goes further by showing that students not only understand scientific facts but also develop ontological awareness that everything is interconnected. Within the framework of Bronfenbrenner's theory, modified for the Anthropocene era, learners begin to interpret themselves as part of a planetary ecosystem rather than as separate entities. This strengthens the thesis of Wals & Benavot (2017) regarding the importance of education that recognizes socio-ecological interdependence.

The second theme of collaborative problem-solving validates Vygotsky's theoretical framework of the zone of proximal development that is extended in the context of peer collaboration. The findings that groups experience initial conflicts before developing mature collaborative norms align with Tuckman's group development model (Forming-Storming-Norming-Performing) and enrich the study by Grossman et al. (2021) on the importance of instructional scaffolding in PjBL. Anazifa & Djukri's (2017) research in Indonesia demonstrates the superiority of PjBL over conventional learning, and the study's findings add a qualitative dimension to how collaboration develops. The social learning process is not just the end result. The prominent phenomenon of peer learning also confirms the findings of Hallinger & Nguyen (2020) that sustainability education requires a participatory pedagogy that empowers learners to serve as co-teachers for their peers.

The third theme, transdisciplinary critical and creative thinking, makes an important contribution to the 21st-century competency discourse, which has often been only partially defined. The finding that students integrate biology, geography, economics, and social studies in formulating solutions shows the emergence of what Morin calls complex thinking, that is, thinking skills that are able to embrace paradoxes and interconnections. These findings expand on the study by Chen & Yang (2019), who found positive effects of PjBL on academic achievement and added that PjBL also fosters epistemic qualities fundamentally different from those of traditional disciplinary learning. The ability of learners to question techno-fix assumptions indicates that learning reaches the level of critical pedagogy recommended by Freire, where learners not only study the world but also critique the structures that perpetuate problems. This is contrary to the concerns of Afriana et al. (2016) regarding the constraints of PjBL implementation in Indonesia, which shows that with the right design, Indonesian students are able to articulate systemic criticism.

The fourth theme regarding agent ecological citizens is the most significant contribution of this research. The finding that students take real actions outside the classroom context and take the initiative to influence school policies validates the concept of environmental agency developed by Trott (2020) and Rousell & Cutter-Mackenzie-Knowles (2020). Students not only develop knowledge and skills, but also experience an identity transformation into agents of change. This goes beyond the OECD's future-ready skills framework, which tends to focus on individual competencies, and aligns with Mezirow's transformative learning, in which learners experience a profound change in their frame of reference. The implication is that environmental education should not stop at knowledge and skills, but must open up space for students to become. The findings also challenge long-held theories that place young people as passive recipients of sustainability education, by suggesting that they are the co-architects of the future.

Despite this broad convergence with previous research, several findings contradicted expectations in the existing literature and are worth highlighting. First, whereas meta-analytic accounts such as Chen & Yang (2019) and the comparative study of Anazifa & Djukri (2017) imply relatively uniform gains from project-based learning, the present data show markedly uneven development across dimensions: agentic ecological citizenship emerged in fewer than a third of participants and remained the least frequently coded theme (Table 1). This suggests that ecological agency does not follow automatically from competency growth, complicating the linear progression assumed by some future-ready skills models. Second, whereas parts of the collaboration literature (e.g., Hussein, 2021) treat peer conflict primarily as a barrier to be minimized, students in this study experienced early conflict as a productive precondition for later collaborative maturity, which challenges deficit framings of group friction. Third, in tension with techno-optimist strands of sustainability education, participants actively resisted purely technological solutions, indicating that

critical scrutiny of techno-fix narratives may be an outcome of, rather than an obstacle to, project-based inquiry. Taken together, these divergences indicate that the relationship between project-based inquiry and future-ready skills is more conditional and non-linear than segments of the current literature suggest, and they caution against reading the four themes as a guaranteed developmental sequence.

Integratively, the four themes are intertwined to form an ecology of competencies that cannot be reduced to separate skills. Awareness of ecological connectedness forms the foundation for motivation to collaborate; collaboration creates a space for transdisciplinary critical thinking; and together, they result in ecological agency. This interrelational model updates the OECD Learning Compass 2030 framework by adding relational and transformative dimensions. For the Indonesian context, these findings support and enrich the implementation of the Independent Curriculum, especially the P5, which carries the theme of sustainable lifestyle. However, the results of the study also remind that the implementation of P5 is not sufficiently procedural, but requires a pedagogical design that dares to raise controversial issues and provide space for students' agency. Practical recommendations include: (1) teacher training in facilitating critical-creative inquiry; (2) strengthening school partnerships with environmental communities; (3) integration of global issues across subjects; and (4) evaluation policies that recognize transformative learning, not just cognitive achievement. The limitations of the study lie in its single-case context, which limits generalization; follow-up research is suggested using a multi-case approach across Indonesia and comparisons with Global South countries to strengthen the validity of the theories found.

Conclusion

This study concludes that project-based inquiry on the theme of the global environmental crisis is an effective pedagogical approach for fostering the holistic development of future-ready skills in secondary school students. Four themes that emerged from the perspective of students, namely awareness of ecological connectedness, collaborative problem-solving, transdisciplinary critical and creative thinking, and agent ecological citizens, show that 21st-century competencies develop in an intertwined way within authentic and meaningful learning spaces. These findings enrich the sustainability education literature by showing that Indonesian students, when given the opportunity to engage with planetary issues, can articulate systemic critique and become agents of change. The theoretical implications of the research are the need to renew the future-ready skills framework to be more relational and transformative, while the practical implications include revitalizing the Pancasila Student Profile Strengthening Project with a critical inquiry design that uses global issues as an authentic context. Further research directions are recommended through multi-case longitudinal studies to explore the sustainability of students' transformation after formal education and to develop substantive theories on the ecological agency of Indonesia's younger generation.

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