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Bridging Intercultural Competence and Education for Sustainable Development Through Critical Thinking: An Exploratory Model in Online Intercultural Collaborative Learning



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Abstract

This qualitative study examines how critical thinking (CT) fosters the development of intercultural competence (IC) and how CT can be applied and further developed within learning themes related to Education for Sustainable Development (ESD). In 2023, an online intercultural collaborative learning program on microplastics was implemented with secondary school students in Japan and Taiwan. Interview data from 10 Japanese participants were analyzed using an integrated analytical framework applicable to both intercultural education and ESD. Analysis of 221 CT segments revealed that 47% reached the reframing and enactment stages. Findings indicate that CT mediates the progression of IC- and ESD-related reasoning from reflection to reframing, thereby facilitating enactment within ESD contexts. A detailed examination of individual cognitive trajectories illustrates how CT may cumulatively integrate, deepen, and expand reasoning across distinct learning themes. This study proposes an exploratory perspective in which IC can be understood not as a fixed trait but as a cognitive function that is reconstructed and extended across contexts. This insight offers a basis for ongoing discussions on transformative approaches to global citizenship education.

Keywords: Intercultural competence, critical thinking, education for sustainable development, online intercultural collaborative learning

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Introduction

Transformative learning empowers learners to rethink their relationship with the world by questioning and revising their existing perspectives, enabling deeper understanding and more responsible action toward global challenges (UNESCO, 2017, 2018). This orientation aligns closely with Education for Sustainable Development (ESD), which emphasizes analytical and critical thinking (CT) as essential for navigating cultural diversity and the interconnectedness of local and global contexts (UNESCO, 2023; Voogt & Roblin, 2012). Although 21st-century skills are understood as interrelated and mutually reinforcing (Brandt, 2024), empirical research examining how cognitive and metacognitive abilities develop alongside intercultural understanding remains limited (Esen, 2021; Huang, 2023; Ramstrand et al., 2026).

Traditional lecture-based instruction has been criticized for its limited capacity to cultivate CT, problem-solving, and transnational collaboration (Jansen van Vuuren et al., 2025). In response, educational practice has increasingly shifted toward collaborative and experiential learning. Intercultural education has gained prominence as societies seek to cultivate citizens capable of mutual understanding and co-operation in culturally diverse environments, positioning intercultural competence (IC) as an essential capacity (Fantini, 2020). At the same time, sustainability-related themes have been incorporated into national curricula worldwide, reflecting a shared recognition of their importance as global challenges that require collective action (UNESCO, 2022). Because sustainability challenges involve competing values and complex systems (UNESCO, 2018, 2020, p. 57), learners require IC to understand multiple perspectives and CT to critically examine them (UNESCO, 2014).

The rapid expansion of digital learning opportunities (OECD, 2018) has further accelerated the adoption of online intercultural collaborative learning programs that incorporate ESD. Such programs create conditions in which two distinct forms of CT may emerge: one, stimulated by cultural and linguistic differences in the intercultural education (ICE) context, and another, generated through engagement with broader sustainability challenges in the ESD context.

This study situates the collaborative exploration of environmental issues conducted by junior high school students in Japan and Taiwan within a hybrid learning context that combined regular English classes with an online intercultural collaboration module. Of the approximately 150 students enrolled in the regular English classes, ten participated in both components, allowing for an examination of how contrasts between the two settings shape the nature and significance of their learning. Intercultural collaboration is defined as the ability of individuals from different cultural backgrounds to work together toward a shared goal, a process that inherently requires IC (Guillén-Yparrea & Ramírez-Montoya, 2023). Evidence suggests that online intercultural collaboration fosters IC while also contributing to language proficiency, soft skills, and digital skills (Guillén-Yparrea & Ramírez-Montoya, 2023; O'Dowd, 2021). Building on this perspective, the present study examines how IC—cultivated through interaction with culturally different others—facilitates transformative learning within ESD. Specifically, CT is treated as a shared competency across IC and ESD frameworks, enabling analysis of how learners' reasoning processes contribute to the transformation of sustainability-related values and perspectives (see Figure 1).

Theoretical and Pedagogical Foundations

IC is defined as the knowledge and attitudes required for interacting with individuals from different cultural backgrounds (UNESCO, 2002), as well as the skills needed to communicate appropriately and effectively in intercultural situations (Deardorff, 2006). Although its origins lie in Western contexts (Spitzberg & Changnon, 2009), IC is not viewed as a naturally developing ability; rather, it requires continuous development and maintenance through educational interventions and practice (Council of

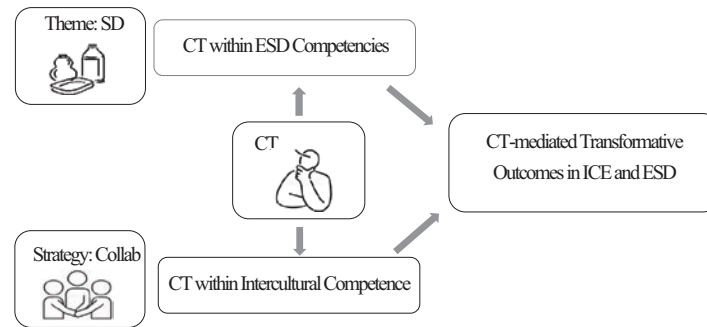


Figure 1 *Transformative Learning in this Study*

Europe, 2008). Because the terminology and interpretation of IC have not converged into a single definition, multiple frameworks have been proposed (Fantini, 2009, p. 457). Consequently, IC continues to evolve as scholars examine how it manifests across diverse regional and cultural contexts (Cubero, 2022; Dai & Feng, 2024; Fantini, 2020).

Among the most influential models in IC research are Byram's (1997) framework, which emerged from language education and conceptualizes the "intercultural speaker," and Deardorff's (2006) process-oriented model, focusing on the components and development of IC. Byram (1997) emphasizes that CT is indispensable for enabling learners to reflect on their cultural biases and unconscious assumptions, thereby facilitating decentering—a shift away from ethnocentrism toward an understanding of others' perspectives. Deardorff's (2006) model highlights the developmental progression from internal outcomes (e.g., attitudes, reflection) to external outcomes (e.g., behavior, interaction), grounded in attitudes, knowledge, and skills (see Figure 2). Both scholars identify CT as a core

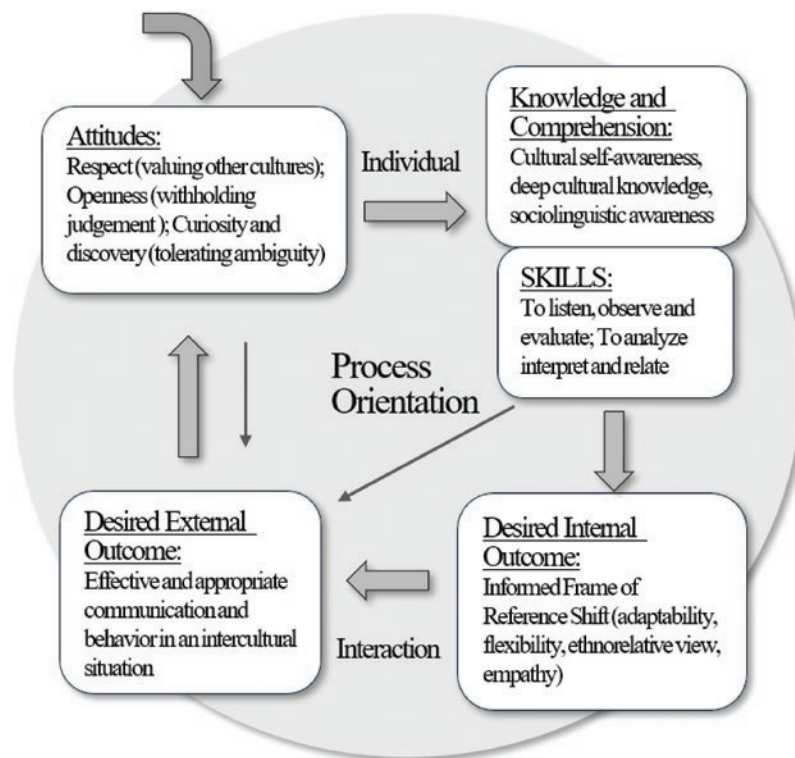


Figure 2 *Process Model of Intercultural Competence (Deardorff, 2006, p. 256)*

component of IC (Deardorff, 2009). However, the model does not explicitly delineate the extent to which subskills such as interpreting, analyzing, evaluating, and relating should be considered part of CT, leaving the conceptual boundaries of CT somewhat ambiguous; neither provides a detailed account of how CT interacts with other IC components during the developmental process.

A systematic review by Luo and Chan (2022), covering 34 studies published between 2007 and 2021, revealed that interviews were typically treated as supplementary rather than as primary sources of evidence (e.g., Demetry & Vaz, 2017; Jackson, 2015; Lee & Song, 2020; Liaw, 2007; Prieto-Flores et al., 2016; Tuncel & Paker, 2018). Moreover, several scholars have argued that Likert-scale-based assessments have inherent structural limitations, highlighting concerns about their ability to capture the complexity of IC (Genkova et al., 2021; Luo & Chan, 2022; Punti & Dingel, 2021). Conceptual studies (Martincová & Lukešová, 2015; Yershova et al., 2000) and empirical studies on IC support the usefulness of CT for IC development (Harrigan & Vincenti, 2004; Miller & Tucker, 2015; Schwarzenenthal, 2022; Yaprak & Özmen, 2021). However, these studies do not clarify the micro-level inference processes through which CT operates within intercultural interaction.

ESD aims to empower learners to make informed decisions and take responsible actions that contribute to environmental integrity, economic viability, and a just society for both present and future generations. ESD is conceptualized as a holistic and transformative form of education that encompasses learning content and outcomes, pedagogy, and the learning environment (UNESCO, 2020, p. 7). In this sense, ESD calls for transformative pedagogy (Mezirow, 2000), and transformative learning has been identified as one of its key pedagogical approaches (UNESCO, 2017).

Since the late 1990s, the discourse on educating sustainability-oriented citizens has shifted from an input-oriented focus on essential content toward an outcome-based competence approach (Adomßent & Hoffmann, 2013; Mochizuki & Fadeeva, 2010; Wiek et al., 2011). Consequently, an increasing number of researchers have examined the multiple and interconnected dimensions of ESD and their associated competencies (de Haan, 2010; Glasser & Hirsh, 2016; Rieckmann, 2012; UNESCO, 2018; Wiek et al., 2016). However, within these frameworks, the positioning of CT remains inconsistent. Some scholars treat CT as a basic or general competence rather than a core sustainability competence (Voogt & Roblin, 2012; Wiek et al., 2011), whereas others identify CT as one of the most essential competencies for sustainability (Cebrián et al., 2019; Rieckmann, 2012). This lack of consensus reflects a broader challenge: the conceptualization of sustainability competencies remains complex and context-dependent (Mochizuki & Fadeeva, 2010).

To address this fragmentation, UNESCO (2017) proposed eight key competencies for achieving the Sustainable Development Goals—systems thinking, anticipatory competence, normative competence, strategic competence, collaboration, CT, self-awareness, and integrated problem solving—providing a widely accepted international reference point (UNESCO, 2018, p. 44). Although UNESCO's key ESD documents (UNESCO, 2012, 2017, 2020) articulate the core components of ESD competencies and offer illustrative learning objectives, they do not present a developmental trajectory or stage-based model explaining how these competencies emerge, progress, or transform over time. Although some studies from science education suggest that ESD-based learning may enhance CT (Ekamilasari et al., 2021; Lutfianis et al., 2020), this line of research remains underdeveloped. This fragmentation is evident in the fact that research on ESD competencies has focused primarily on identifying component skills (Cebrián et al., 2019), while assessment practices remain dominated by summative approaches. Consequently, formative assessment and research on learning processes remain underdeveloped (Annelin & Boström, 2023; Cebrián et al., 2019, p. 36).

A more critical issue is the limited integration of cultural and sustainability perspectives. Although IC and ESD share several competencies—such as perspective taking, empathy, respect, and understanding

of others—few studies have attempted to connect these domains (UNESCO, 2009, p. 29). Research explicitly linking IC with the development of sustainability competencies remains scarce (Nikiforova & Skvortsova, 2021, p. 5; Parent et al., 2025, p. 42). Thus, ESD practices tend to remain locally bound, with limited engagement in intercultural dimensions.

In this study, CT is understood through the Paul–Elder framework, which defines CT as an intellectually disciplined process of analyzing and evaluating information derived from observation, experience, and reflection (Paul & Elder, 2003, 2020). The model conceptualizes CT as a lifelong practice in which individuals apply intellectual standards to the elements of thought to monitor and refine their reasoning. Because it is discipline-neutral and formally structured, the framework is widely applicable across educational contexts (Ralston & Bays, 2015).

The model consists of three interrelated components. First, eight Elements of Thought—purpose, questions, information, inferences/conclusions, assumptions, implications, point of view, and concepts—represent the basic structures of reasoning. In this study, I confirmed that the focal instructional practice can be conceptualized through the eight elements of thought, thereby demonstrating the applicability of CT within the learners’ reasoning processes, as outlined below. Building on this conceptualization, the activity addresses a sustainability-related problem (Purpose), prompting learners to examine how stakeholders’ interests interact (Question). They consider the issue from both their own and their partners’ perspectives (Point of View), using factual data and intercultural exchanges (Information). In doing so, they surface and reconsider implicit assumptions (Assumptions) and organize their reasoning through concepts such as sustainability, equity, and responsibility (Concepts). From this, they infer that problem manifestations and appropriate solutions differ across cultural and social contexts (Inferences/Conclusions), and reflect on the implications for identifying feasible, culturally sensitive actions (Implications). The second set of Universal Intellectual Standards—such as precision, fairness, and relevance—is outside the scope of this study, as they will be examined in a subsequent stage of the research. Third, the Intellectual Traits—intellectual humility, intellectual autonomy, intellectual integrity, intellectual courage, intellectual perseverance, confidence in reason, intellectual empathy, and fair-mindedness—are conceptualized in this study as developmental outcomes of IC and ESD competencies that are activated and strengthened through CT.

CT also plays a central role in transformative learning theory, where critical reflection enables learners to examine and revise their underlying assumptions (Kitchenham, 2008). This connection positions CT as a key mechanism linking cognitive processes with value-oriented transformation—an essential dimension of ESD. In this study, we draw on the Paul–Elder framework to analyze the micro-processes through which learners engage in CT during intercultural and sustainability-related interactions.

The following example illustrates how CT functions as a mediating process between IC and ESD in learners’ intercultural interactions. When students participate in intercultural collaboration, their thinking does not manifest as isolated capacities of IC, CT, or ESD. Rather, these domains develop in an interrelated and mutually reinforcing manner. Learners interpret differences in language, cultural practices, and environmental behaviors as cues to underlying values, prompting reflective meaning-making and comparative reasoning. Through this process, they may become aware of previously unexamined assumptions, fostering cultural relativism and enabling them to reconsider their own perspectives. Building on these insights, learners begin to recognize their personal responsibility in sustainability issues and gradually develop into agents capable of engaging with sustainable development from multiple perspectives.

Research Gap

Despite extensive work in both IC and ESD, three gaps remain. First, conceptualizations and frameworks of IC remain fragmented, with research tending to identify component skills rather than develop

coherent theoretical models. Second, there is a lack of micro-level empirical studies that examine how IC develops through authentic interactional processes. Third, although IC and ESD share several complementary competencies, theoretical and empirical integration between the two fields remains limited.

Together, these gaps underscore the need to investigate how learners' internal and external outcomes emerge during intercultural and sustainability-related interactions, and how CT functions as a linking mechanism between IC and ESD competencies. Based on these gaps, the present study addresses the following research questions.

Research Questions

- RQ1: What overall effects does the development of IC have on learners, both quantitatively and qualitatively?
- RQ2: In which segments of learners' discourse do IC-related and ESD-related competencies become integrated?
- RQ3: How does IC develop through the stages of CT, and how does this developmental process influence learners' engagement with ESD?

Significance of this Study

This study addresses the identified research gaps by examining junior high school students entering a developmental stage in which abstract reasoning—and thus the foundations of IC—begin to form (Luo, 2023; Piaget, 1999; Sui, 2023; Tulak et al., 2019). Understanding how adolescents engage in intercultural collaboration on sustainability themes is essential for preparing future generations to navigate complex global systems (UNESCO, 2023). The study advances theory by clarifying the role of CT within IC by integrating Paul and Elder's (2020) reasoning framework with Deardorff's (2006) model. Practically, it proposes an intercultural contact approach that extends ESD beyond community-based limitations, offering educators a viable pathway for cultivating global competencies in contexts with limited intercultural exposure.

Method

Research Design

This study investigates how Japanese junior high school students develop CT, IC, and ESD competencies through online intercultural collaboration with Taiwanese students, integrated with local experiential learning. CT is conceptualized as a reasoning process rather than a fixed ability, drawing on Paul and Elder's (2020) framework, which aligns with both ESD (UNESCO, 2020) and IC (Deardorff, 2006). The theoretical premise is that IC serves as the primary developmental axis and that CT mediates the transformation of learners' perspectives and actions within ESD. A qualitative, interpretivist approach was adopted to capture learners' meaning-making processes. Semi-structured interview data focusing on Japanese students were analyzed to identify CT segments embedded within ICE- and ESD-related reasoning. Transformative action—defined as the enactment of reconstructed understanding—was examined through individual case studies to trace micro-level cognitive shifts.

Curricular Component

Both the formal curricular and extracurricular components incorporated UNESCO's (2017, p. 55) key pedagogical methods, namely: (A) collaborative real-world projects, (B) analysis of complex systems, (C) critical and reflective thinking, and (D) vision-building exercises. In the English classes,

the following three activities were implemented as preparatory tasks aligned with pedagogical methods (A)–(D):

- One-week Home Plastic Waste Survey (B)(C)
- Documentary Movie: Microplastic Madness (Quirk & Cohen, 2019) (D)
- Online dialogue with the director of Microplastic Madness (D)

These activities provided cognitive scaffolding for subsequent intercultural dialogue (Refer to Appendix 2 for Learning objectives). The extracurricular component consisted of six online sessions with Taiwanese peers:

- Overview of the project
- Self-introductions by students from both countries
- Sharing reflections on the documentary film (C)
- Mid-project progress report (report on beach research) (C)
- Online Session 5: Final project report (C)(D)
- Cultural exchange and gift exchange

In addition, Japanese students conducted a local beach clean-up to connect global issues with local action, aligned with pedagogical methods (A) and (B). Taiwanese students completed parallel activities within their own context. No explicit instruction in CT or IC was provided. Students independently prepared materials for the online sessions, enabling observation of emergent reasoning processes rather than rehearsed responses. For the chronological details of the hybrid design, see Appendix 1.

Participants

The focal participants were 10 eighth-grade students (eight girls, two boys) from a public junior high school in Japan. All were native Japanese speakers with limited daily exposure to cultural diversity. Four of them initially expressed reluctance toward intercultural exchange. Only one had prior experience visiting Taiwan. Owing to earlier English education, Taiwanese students generally demonstrated higher English proficiency. Several of them had visited Japan and expressed a strong interest in Japanese culture. Data from Taiwanese students were used only for contextual triangulation, and the primary analysis focused on the Japanese participants. Not all 10 participants appear as direct quotations in the text, though all contributed to the coded data.

This study employed a purposive sampling strategy consistent with established qualitative research standards. Following Yin (2018), 10 theoretically meaningful cases were selected whose intercultural and ESD-related CT was clearly observable. In line with Stake's (1995) concept of "information-rich cases" and Merriam's (2009) emphasis on depth over representativeness, the aim was not to generalize to all 150 participants but to generate theoretical insight. The analysis followed Creswell's (2007) criteria for contextualized interpretation, enhancing the study's validity and trustworthiness.

Data Collection

Two rounds of semi-structured interviews were conducted: a brief pre-program interview (approximately 15 minutes) that explored students' initial expectations and attitudes, and a longer post-program interview (approximately 60 minutes) that examined cognitive, affective, and behavioral changes following the intercultural sustainability activities. Five research-oriented questions guided the interviews:

- How did your interactions with your Taiwanese partner influence your perspectives or attitudes?
- In what ways do you differ from students who did not participate in the exchange experience?

What specific behaviors or comments from your Taiwanese partner left a strong impression on you?
How do you interpret the significance of activities beyond online meetings, such as Padlet contributions or gift exchanges?
What do you consider the most important factor when interacting with people from another culture?

The questions focused on intercultural influence, comparison with non-participants, memorable interactions, the significance of non-synchronous activities, and key factors in intercultural communication.

Conceptual Structure

Because CT is conceptualized in this study as a reasoning process that mediates both IC and ESD, the analysis required explicit definitions and measurement criteria for CT, IC, and ESD competencies, as well as a clear account of how learners' interpretive and inferential processes were traced. To meet this requirement, we developed an analytical framework through a detailed, theory-driven integration of three established models:

Paul and Elder's Elements of Thought, which operationalize CT as a set of reasoning components;
Deardorff's developmental model of IC, which conceptualizes IC as a process of internal and external outcomes;
UNESCO's ESD transformative action framework, which positions learning as a progression toward value-based, outward-oriented action.

Development of the Framework

The analytical framework was developed through a multi-step process. First, we aligned the conception of reasoning operationalized through the Elements of Thought with the interpretive processes described in the IC and ESD literature. Second, we mapped these interpretive processes onto the stages of transformative action to establish a developmental trajectory (see Table 1). Finally, we synthesized these components into a three-axis structure that enables systematic identification of where, how, and to what extent CT emerges in learners' discourse (see Figure 3).

1. Developmental Stages

This study adopts a four-stage developmental framework—Analysis, Reflection, Reframing, and Enactment—as a common analytical lens for examining CT across both IC and ESD. Although Deardorff refers to “Reframing” as “Filter Shift,” the present study uses the term Reframing to emphasize cognitive reinterpretation.

From the IC perspective, development is conceptualized as a CT-driven process (Deardorff, 2009, pp. 478–481). In the Analysis stage, learners demonstrate CT by questioning assumptions, examining information from multiple perspectives, and applying attitudes of respect, openness, and curiosity to interpret cultural situations.

From the ESD perspective, the developmental stages draw on the OECD's PISA 2018 Global Competence Framework (OECD, 2019, pp. 171–184), which identifies knowledge, skills, attitudes, and values as core dimensions. UNESCO (2017, p. 56) positions these dimensions as foundational for conceptualizing global competence within ESD. In the Analysis stage, learners critically examine global

Table 1 *Developmental Trajectory of Critical Thinking: Stage-Specific Indicators and Interpretive Processes*

Stage 1 Analysis Deardorff (2006) Learners use attitudes such as respect, openness, and curiosity to question assumptions and critically interpret cultural information and events from multiple perspectives. OECD (2019) Learners critically examine global and intercultural issues by evaluating information, identifying biases, and recognizing how cultural, social, and environmental contexts shape interpretations, including how different stakeholders frame challenges such as inequality, migration, and environmental degradation. Stage 2 Reflection Deardorff (2006) Learners examine their own unconscious assumptions by relating their experiences and values to those of others, deepening their understanding of cultural perspectives. OECD (2019) Learners question their own assumptions and values by comparing them with diverse cultural perspectives and considering ethical implications for sustainability and collective well-being. They recognize personal biases or reconsider their everyday practices when confronted with alternative viewpoints on global or environmental issues. Stage 3 Reframing Deardorff (2006) Learners adopt alternative viewpoints to modify existing assumptions and reconstruct meaning, developing more flexible, empathetic, and ethnorelative internal orientations. OECD (2019) Learners reframe their understanding by integrating alternative cultural or sustainability-focused viewpoints, revising their prior assumptions, and constructing new ways of interpreting global or environmental issues. Stage 4 Enactment Deardorff (2006) Learners translate these transformed internal orientations into culturally appropriate and effective external behaviors, demonstrating intercultural competence in action. OECD (2019) Learners translate reconstructed understanding into responsible, culturally responsive, and sustainability-oriented action by adjusting communication, engaging in respectful dialogue, and making environmentally and socially conscious choices in their daily and social contexts.	Paul and Elder (2020) This table illustrates how learners engage in reasoning within a learning activity that incorporates all eight elements of thought— (1) purpose, (2) question, (3) information, (4) Inferences/Conclusions, (5) assumptions, (6) implications, (7) main concept(s), and (8) point of view —while progressing through the developmental phases of analysis, reflection, reframing, and enactment in pursuit of inquiry outcomes. The ultimate goal of this process is the cultivation of the Intellectual Traits, including (1) intellectual humility, (2) intellectual autonomy, (3) intellectual integrity, (4) intellectual courage, (5) intellectual perseverance, (6) confidence in reason, (7) intellectual empathy, and (8) fair-mindedness. A well-cultivated critical thinker communicates effectively with others in working out solutions to complex problems. This aligns with the outcomes of both IC and ESD.
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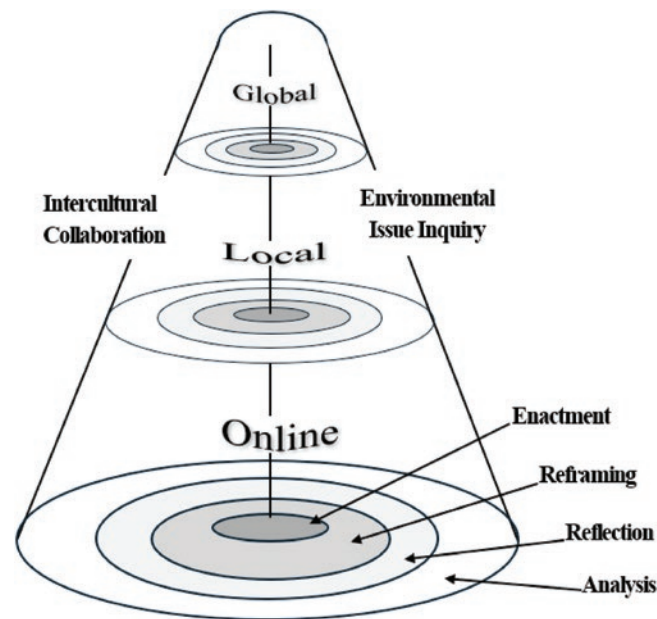


Figure 3 *Three Analytical Axes*

and intercultural issues by evaluating information, identifying biases, and recognizing how cultural, social, and environmental contexts shape interpretations, for example, by analyzing how different stakeholders frame challenges such as inequality, migration, or environmental degradation.

To clarify how each stage of transformative action was evaluated, learner utterances were coded according to explicit criteria distinguishing Analysis, Reflection, Reframing, and Enactment. These criteria included evidence of interpretive shifts, reconsideration of values, and the translation of revised understandings into action. The criteria for all four stages are summarized in Table 1.

2. Target Domain

To examine where learners directed their CT, this study categorized all relevant utterances into three target domains:

1. Online domain: Utterances referring to intercultural partners in the exchange or members of the learner's own group.
2. Local domain: Utterances concerning everyday contexts such as family, school, and the local community.
3. Global domain: Utterances addressing actors, communities, or stakeholders beyond national boundaries, including those involved in transnational environmental or social issues.

This three-level structure reflects widely recognized models of expanding responsibility and interconnectedness. Frameworks such as UNESCO's *Global Citizenship Education* (2015) and the OECD's *Global Competence Framework* (2019) describe a developmental progression from the self, to others, to the community, and ultimately to the wider world. Similarly, Wang (2025) conceptualizes responsibility as expanding concentrically from family to humanity. Although ESD does not explicitly present a tiered relational model, its emphasis on interconnectedness aligns with this perspective by encouraging learners to situate sustainability issues within local-to-global contexts.

Utterances were categorized into three domains based on whether they referred to immediate partners, everyday contexts, or cross-border actors and implications.

3. Theme

CT was analyzed within two thematic areas that represent the primary domains of learner engagement in this study:

1. Intercultural Collaboration: Utterances concerning interpersonal interaction and collaboration, including relationship building, mutual understanding, interpretation of cultural differences, and negotiation of collaborative methods.
2. Environmental Issue Inquiry: Utterances regarding the causes, impacts, and solutions of environmental issues, as well as related daily actions and social practices.

To ensure consistent classification, segments spanning both themes were assigned a single primary theme based on the focus of the utterance.

Data Analysis Procedures

The interviews with the Japanese students were transcribed using an AI-based tool Notta, and the accuracy of the transcription was verified by checking it against the original audio recordings. The finalized transcripts were imported into MAXQDA 2022 for qualitative analysis (Sato, 2008). The data were then segmented into 496 meaning units, from which 221 CT-related segments were identified (e.g., questioning, multiple perspectives, examining assumptions, reconstructing meaning). These segments were coded into a 24-cell matrix defined by four developmental stages, three domains, and two themes (see Appendix 3 for the operational definitions used in the coding process). Table 2 illustrates how each analytical method aligns with the research framework and contributes to addressing the research questions. A flowchart integrating the construction of the analytical framework with the procedures of the data analysis is provided in Appendix 4. In addition, examples of the content represented in the 24 analytical cells are presented in Appendix 5.

Table 2 *Alignment with Research Questions*

Research Questions	Data Used	Analytical Methods
RQ1 What overall effects does the development of IC have on learners, both quantitatively and qualitatively?	Segmenting full post-interview transcripts and extracting CT-containing segments.	Segment extraction Coding Quantification Competency identification
RQ2 In which segments of learners' discourse do IC-related and ESD-related competencies become integrated?	CT segments showing cross-domain connections among selected students, J-A, J-E, and J-H.	Visualizing cross-domain CT segments through mapping. Interpreting mapped segments qualitatively.
RQ3 How does IC develop through the stages of CT, and how does this developmental process influence learners' engagement with ESD?	Integrated CT flow diagrams and cross-domain mappings of the three focal students.	Synthesizing the three individual cases. Identifying common developmental patterns across domains. Constructing an overall developmental structure based on the synthesized patterns.

Analytical Reliability and Trustworthiness

To ensure the trustworthiness of the analysis, several strategies were employed. The author served as the main coder, conducting the initial coding of all 496 meaning units. To enhance reliability at this initial stage, the author conducted repeated coding cycles, maintained detailed coding memos to document decision rules, and created an audit trail recording how ambiguous cases were resolved. Coded segments were systematically compared with their original interview context to prevent over-interpretation, and these procedures were managed in an organized manner using MAXQDA's memo, retrieval, and coding-comparison functions.

Following this initial coding, a peer researcher with expertise in intercultural education and qualitative methodology independently reviewed the coded segments, providing investigator triangulation. When disagreements or ambiguous cases arose during this process, the coding rules were iteratively refined through discussion until consensus was reached, ensuring that no ambiguity remained in the final classification.

Upon completion of the coding process, peer debriefing sessions were conducted with several colleagues to examine the overall coherence of the coding framework, including the appropriateness of labels and categories. During these sessions, coded segments were again compared against the original interview context to verify that the assigned codes accurately reflected participants' intended meanings.

These procedures align with established criteria for qualitative trustworthiness (Merriam, 2009), enhancing the credibility and dependability of the findings. At the same time, we acknowledge that the analysis is limited to students' verbalized CT expressions; therefore, internal cognitive processes that do not surface in spoken discourse remain outside the scope of the study.

Ethical Considerations

This study forms part of the author's doctoral research. Ethical approval was obtained from the relevant institutional review board. Participation was voluntary, and parental consent was secured. Pseudonyms (J-A to J-J) were used to protect student identities.

Result

This section presents the findings for each research question.

- RQ1: Provides an overview of the distribution and characteristics of CT across the analytical axes.
- RQ2: Examines how CT manifestations interact with IC and ESD within individual developmental processes. RQ3 synthesizes these findings to clarify the overall developmental structure through which learners engaged in intercultural and sustainability-related inquiry.

RQ1: Manifestation Trends and Outcomes of CT

The findings for RQ1 provide an overview of the frequency and distribution of CT across the three analytical axes, highlighting the outcomes of reframing and enactment.

Of the 221 identified CT segments, the breakdown by developmental stage was as follows: Analysis ($n = 74$), Reflection ($n = 43$), Reframing ($n = 69$), and Enactment ($n = 35$). Notably, the combined total

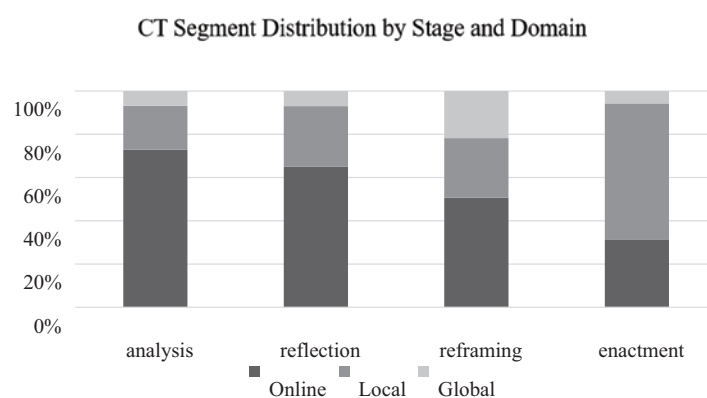
Table 3 *Distribution of CT Developmental Stages Across Target Domains*

	Analysis	Reflection	Reframing	Enactment	Total
Intercultural Collaboration					
Online	41	25	27	10	103
Local	3	8	5	6	22
Global	4	3	12	2	21
Total	48	36	44	18	146
Environmental Issue Inquiry					
Online	13	3	8	1	25
Local	12	4	14	16	46
Global	1	0	3	0	4
Total	26	7	25	17	75

for Reframing and Enactment reached 104 segments, constituting approximately 47% of the total 221 CT manifestations (Table 3). This indicates that nearly half of the identified CT instances led to a fundamental shift in the learners' frames of reference or translated into concrete action intentions.

Regarding thematic domains, 66% ($n = 146$) of all CT segments were related to intercultural collaboration. Among these, IC-related segments, 71% ($n = 103$) occurred in the online domain.

Figure 4 illustrates the proportion of each target domain across the CT developmental stages. As the target domain expands, more advanced forms of CT account for a larger share. Consistent with this pattern, the distribution of domains across the 221 CT segments varied by developmental stage: Analysis (73%, 20%, 7%), Reflection (65%, 28%, 7%), Reframing (51%, 28%, 22%), and Enactment (31%, 63%, 6%).

**Figure 4** *Proportion of CT Across Target Domains*

The following describes the qualitative outcomes of reframing and enactment across the three analytical axes. In the Intercultural Collaboration theme, shifts in frames of reference were observed in nine participants. These shifts included a transition from a fixed perception of “Taiwanese vs. Japanese” to a perspective emphasizing commonalities as “fellow students” (e.g., J-A, J-C, J-E, J-G, J-H, J-I, J-J), the correction of personal prejudices (J-D, J-E, J-J), and changes in self-awareness (J-G).

A notable example is participant J-E, who discovered shared commonalities through face-to-face dialogue. J-E expressed regret for having generalized that “Taiwanese people lack a sense of hygiene” based on a single observation during a past trip. Through the exchange, J-E actively challenged this prejudice. Behavioral enactment in this theme was observed in eight participants, manifesting as a transfer of the exchange experience into daily life, such as listening more attentively to friends (J-H) and taking proactive steps to show interest in others (e.g., J-A, J-C, J-E, J-G). In the Environmental Issue Inquiry theme, enactment was also observed in eight participants. Practical examples included consistently carrying reusable bottles (J-E, J-G), reducing single-use plastic use (e.g., J-A, J-C, J-D, J-G, J-H), and re-evaluating personal consumption habits (J-A, J-H).

In the context of the hybrid design, students described the added value of incorporating school-based learning connected to the collaborative activities with Taiwan as follows: J-A stated that “I felt that hearing many different opinions helped my own ideas develop. By watching how others presented their thoughts, I also learned things I didn’t know before. I think my knowledge expanded quite a lot through the experience.” J-B explained that “We also use Chinese characters, but there are characters that only Taiwan uses. I could really feel those kinds of differences firsthand.” Together, these reflections suggest that the hybrid design enriched students’ experience-based knowledge, enabling more meaningful comparisons and fostering deeper intercultural and ESD-related awareness.

RQ2: Interplay of CT Manifestations and Developmental Processes

We examined how CT interacted with IC and ESD within individual developmental trajectories. To do so, we constructed flow diagrams that linked only the segments in which learners explicitly identified their most significant learning through collaborative activities (shown in gray) to the segments related to those statements. These cases also served as the basis for RQ3. In the diagrams, solid boxes represent learning outcomes explicitly reported by the students, and solid arrows indicate inferential linkages based on causal relationships they described. Dotted boxes denote inferences grounded in causal cues within their narratives and coherence across segments from the same learner. Segments related to intercultural collaboration appear on the left, and those related to environmental issue inquiry appear on the right. Segment numbers reflect the chronological order of the interview, starting from 1. Three focal cases—J-A, J-E, and J-H—were selected for their clear reasoning pathways and diverse CT patterns (see Figures 5–7). Each case is structured in the following order: (1) an overview including the learner’s background, (2) a summary of the developmental trajectories, (3) the narrative segments, (4) the flow diagram, and (5) the final learning outcome.

Case J-A: Expanding Perspectives Through Environmental Engagement

1. Overview, Including the Learner’s Background

J-A contributed 26 CT segments, all of which were included in the analysis. Initially anxious about interacting with culturally different peers (JA-2), J-A later commented (JA-17) that he gradually developed curiosity toward the Taiwanese students as J-A discovered shared environmental interests. This curiosity then expanded from the students themselves to the cultural backgrounds underlying their environmental practices. For example, J-A expressed interest in why the Taiwanese students used reusable cups (JA-8), suggesting that he had begun to link environmental practices to the students and their cultural context.

2. Summary of the Developmental Trajectories

Categorized Summary of J-A’s Developmental Trajectory:

Recognizing anxiety and challenges (JA-2, JA-3, JA-19)
 Evaluating collaborative behavior (JA-1)
 Understanding intercultural relationships (JA-4, JA-7, JA-17, JA-20)
 Analyzing environmental issues and cultural mediation (JA-5, JA-8, JA-10, JA-14, JA-15, JA-11)
 Transforming awareness and enactment (JA-6, JA-12, JA-16, JA-23, JA-24, JA-9, JA-21, JA-22)

3. Narrative Segments

A key segment illustrating how J-A linked the two developmental domains appears in JA-5: “I found myself wondering how the presentation on microplastics would turn out, especially since it was done by someone who shared the same interest.” This suggests that shared interest helped the initially hesitant student develop curiosity toward the Taiwanese participant.

J-A also remarked: “In Japan, we don’t really introduce things like reusable or recycling cups, you know? So I became interested in understanding those kinds of cultural differences as well.” (JA-8) This suggests a possible shift from focusing solely on environmental issues to exploring the cultural contexts behind environmental actions.

4. Flow Diagram

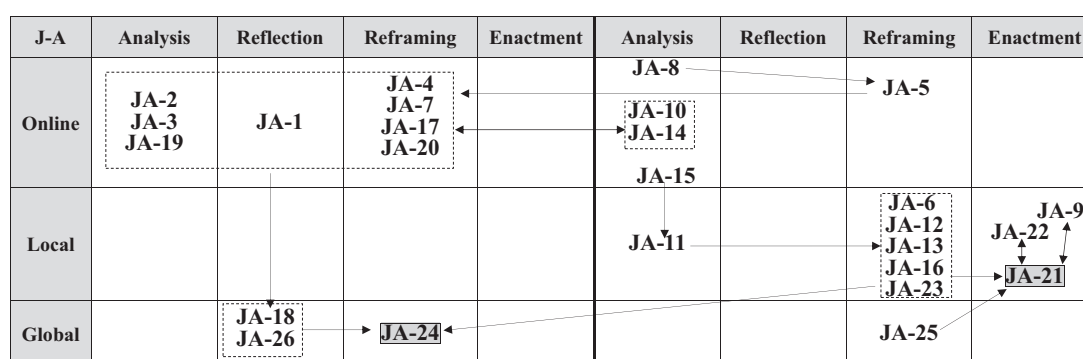


Figure 5 Flow Diagram of J-A

5. Final Learning Outcome

J-A identified two major outcomes:

A heightened sense of belonging to the global community enabled the student to view environmental issues as personally relevant, which the student described as leading to changes in consumption behavior (JA-21).

Recognition that respect and courtesy are essential for genuine expression in intercultural exchange, and that such authentic interaction constitutes the exchange itself (JA-24).

Ultimately, this suggests that J-A may have connected environmental issues to a broader sense of global citizenship, demonstrating integration of IC and ESD.

Case J-E: Reconstructing Preconceptions and Extending Understanding Globally

1. Overview, Including the Learner's Background

J-E contributed 23 CT segments, of which 15 were included in the analysis. J-E reflected (JE-12) on a prejudice formed during a previous trip to Taiwan, where litter on the streets had led to assumptions about Taiwanese hygiene standards.

2. Summary of the Developmental Trajectories

Categorized Summary of J-E's Developmental Trajectory:

Exploring ways of building relationships (JE-7, JE-8, JE-10)
 Reflecting on prejudice versus reality (JE-12, JE-18)
 Recognizing the need for individualized understanding (JE-11)
 Applying insights in daily contexts (JE-23, JE-15)
 Conceptualizing global perspectives (JE-1, JE-2, JE-4, JE-13, JE-19, JE-14)

3. Narrative Segments

A key segment illustrating how J-E linked the two developmental domains appears in JE-23: "When both sides are speaking in a language that isn't their first language, you naturally become more flexible in your thinking..." This comment suggests that JE's adaptive capacity was increasing.

In JE-4, the student noted: "Engagement with environmental issues depends on national policies and the level of interest among the people around you..." These reflections may suggest that J-E was also beginning to consider aspects that extend beyond the environmental domain. The student engaged in analysis, reflection, reframing, and enactment, which may have collectively contributed to overcoming initial prejudice toward Taiwanese peers. Together with JE-23, these excerpts may suggest a possible integration of intercultural engagement and environmental inquiry within the student's developmental process.

4. Flow Diagram

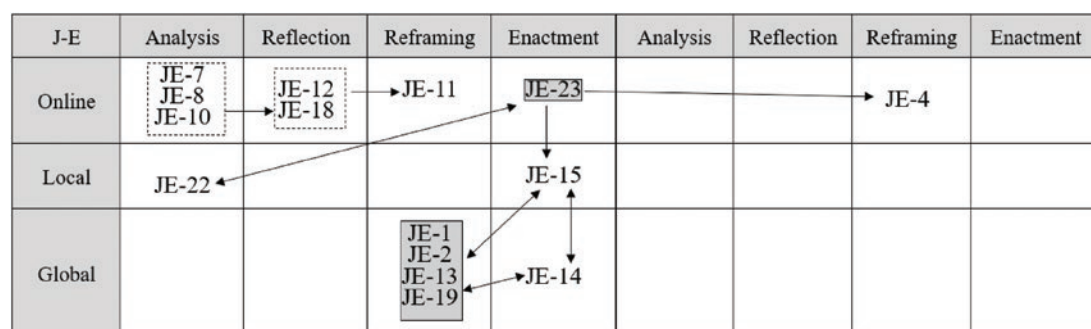


Figure 6 Flow Diagram of J-E

5. Final Learning Outcome

J-E identified two major outcomes:

Recognizing the possibility of mutual understanding despite disagreement (JE-1, JE-2, JE-13, JE-19).

Developing flexible meaning-making in English dialogue between non-native speakers (JE-23).

J-E's observations may suggest that the student was beginning to extend their thinking beyond interpersonal relationships to include environmental issues, which could be interpreted as a form of cross-thematic integration.

Case J-H: Developing Learning Strategies Grounded in IC and ESD

1. Overview, Including the Learner's Background

J-H produced 24 CT segments, with 12 included in the analysis. According to the pre-exchange interview, the student had prior exposure to foreigners from early childhood and entered the exchange hoping to build closer relationships with Taiwanese peers.

2. Summary of the Developmental Trajectories

Categorized Summary of J-H's Developmental Trajectory:

- Identifying elements necessary for collaboration (JH-6, JH-7, JH-22)
- Becoming aware of effective listening attitudes (JH-2)
- Evaluating one's own understanding of what others said (JH-9)
- Considering methods to deepen understanding (JH-8, JH-14, JH-20)
- Applying newly gained insights in daily life (JH-3)
- Connecting cultural understanding to environmental issues (JH-10)
- Transferring insights to broader learning strategies (JH-1)

3. Narrative Segments

Drawing on inferences derived from the key segments of JH-1 and JH-3, the following analysis illustrates how J-H's developmental processes interconnect two domains: understanding others through attentive listening and constructing meaning by linking ideas within environmental inquiry. JH-3 stated, "I learned how important it is to listen carefully and connect ideas as I think," indicating an emerging awareness of the need to integrate attentive listening with the cognitive process of linking ideas. Similarly, JH-1 reflected, "I think there are different levels of really listening to someone..." and elaborated on two such levels: "listening at a surface level by taking notes on what the teacher says" and "listening at a deeper level by structurally understanding the knowledge the teacher intends to convey." J-H further explained that "understanding what the other person is trying to say demonstrates interest in that person," noting that this insight was learned "through interactions with the Taiwanese students."

Taken together, these statements suggest that J-H became aware of the importance of integrating attentive listening with the process of connecting information to construct understanding—a form of cognitive learning that synthesizes listening and reasoning (CT). Collectively, these excerpts point to an emerging interplay between relationship-based understanding and systems-oriented thinking.

4. Flow Diagram

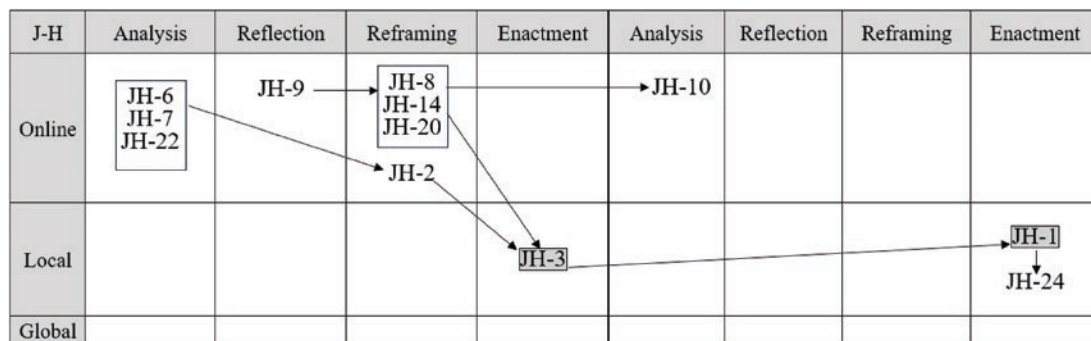


Figure 7 Flow Diagram of J-H

5. Final Learning Outcome

J-H identified two major outcomes:

Improved comprehension through enhanced listening (JH-1, JH-3).

Recognition of the importance of flexibility, tolerance, and persistence (JH-13).

These cases include narratives suggesting that the participants' environmental motivations likely continued to influence their daily lives even after the interviews. JA-5 stated, "Each time I visit a Starbucks in Japan, I recall the interviews that Taiwanese students conducted with Starbucks staff in Taiwan. Imagining the Taiwanese friends I interacted with continuing to take environmental action helps me strengthen my own motivation to engage with environmental issues." Similarly, JH-19 noted, "In the small meetings we organized, cross-national exchanges of ideas inspired one another, and by incorporating small improvements into our daily lives, we have continued to pursue better living practices." Taken together, these statements point to the possibility that the intercultural collaboration fostered forms of learning that continued to resonate in participants' daily lives over time.

RQ3: Developmental Structure of IC × CT × ESD

RQ3 presents the overall developmental structure by integrating the cases examined in RQ2. Cross-case comparison revealed a coherent developmental sequence that connects the Online, Local, and Global domains and links IC-related CT with ESD-related reasoning. Five shared developmental patterns emerged across the three learners.

1. Online CT as the Catalyst for Development

For all three learners, the Online domain served as the primary site for Analysis → Reflection → Reframing, as demonstrated in the results of RQ1, with intercultural dialogue triggering both the questioning of assumptions and the reconstruction of understanding. This indicates that the Online domain functioned as a cognitive incubator in which learners first encountered difference, negotiated meaning, and reconstructed their understanding of others.

2. Reframing Focused on Understanding Others

Across cases, reframing consistently centered on reconstructing learners' understanding of others—correcting stereotypes, recognizing individuality, and adopting culturally relativistic perspectives. This suggests that IC-related CT was not merely analytical but transformative, reshaping learners' interpretive frameworks.

3. Enactment Occurred in Local and Global Domains

Learners generally did not perceive themselves as having undergone behavioral change within the Online domain. Instead, they transferred reconstructed understanding into their lived contexts: (1) J-A enacted learning in both Local and Global domains. (2) J-E extended attitudes into Global perspectives. (3) J-H applied insights in Local interpersonal and academic contexts. These patterns demonstrate that enactment is context-dependent, emerging where learners have agency and opportunities for action.

4. Integration of IC and ESD

IC-related CT often seemed to precede and support ESD-related reasoning. Learners first reconstructed their understanding of others, then applied this broadened perspective to environmental issues. This indicates a developmental linkage in which intercultural reframing becomes the cognitive foundation for engaging with sustainability issues.

5. Individualized Developmental Configurations

Despite shared patterns—namely, a progression across domains and developmental stages—learners differed in: (1) the domain where development concentrated. (2) the domain where enactment occurred. (3) the focal points of reframing. (4) the extent of expansion into the Global domain. These variations reflect individualized configurations within a shared developmental architecture, suggesting that while the overall sequence is consistent, its expression is shaped by learners' prior experiences, interests, and interactional orientations.

Discussion

This study explored how junior high school students developed IC, CT, and sustainability-oriented values through a hybrid design that combined online intercultural collaboration with locally grounded experiential activities. By analyzing 221 CT segments and three focal cases, the study illuminates the micro-level reasoning processes through which learners interpreted cultural differences, reconstructed meaning, and extended their learning into broader contexts. These findings offer insights into theoretical, pedagogical, and developmental understandings of IC and ESD, particularly regarding the potential mediating role of CT.

Theorizing IC Through CT

To advance IC research grounded in general learning theories, it remains important to refine IC-specific theoretical foundations and clarify how its skills and attitudes may be learned and supported (Byram & Wagner, 2018). Although Byram (1997) and Deardorff (2006) position CT as central to IC, they do not specify how CT functions developmentally. Prior empirical studies point to CT's positive effects, yet the micro-processes through which it operates remain insufficiently understood. The present findings suggest that CT may help drive learners' progression from analysis to reflection, reframing, and

enactment within intercultural encounters. Learners interrogated assumptions, compared perspectives, and reconstructed meaning before attempting to translate these insights into interculturally appropriate action. These results indicate the possibility that IC can be approached as a CT-mediated developmental model. This study offers an exploratory perspective that draws on a “Cumulative Critical Thinking Process,” in which competence appears to be gradually shaped through intercultural encounters. This exploratory framing may provide a tentative direction for addressing conceptual gaps in existing IC models. CT may function as a cognitive resource that supports the transformation of attitudes, knowledge, and skills into intercultural understanding and behavior.

Shared Developmental Sequence and Individualized Pathways

From both the full set of participants and the focal cases, a similar developmental pattern appeared to emerge: (1) formation of intercultural understanding in the Online domain, (2) deepening of meaning through CT-driven reflection and reframing, and (3) enactment in Local or Global contexts. This sequence aligns with Deardorff’s (2006) internal–external outcomes and UNESCO’s (2020) transformative action model. The findings also suggest that enriching the analytical stage of learning may require exposing students to a wider range of perspectives early in the process. These patterns indicate that online intercultural collaboration can generate individualized forms of meaning-making shaped by learners’ interests (J-A’s interest in environmental issues), experiences (J-E’s prior visit to Taiwan), and J-H’s frequent contact with foreigners. Even within the same CT framework, learners pursued inquiries grounded in their personal interests and prior experiences. Ultimately, each learner appeared to reach goals that integrated IC and ESD within their respective target domains.

Developmental Interaction Among IC, CT, and ESD

When IC and ESD were addressed within the same learning context, learners appeared to achieve outcomes that extended beyond the boundaries of each domain. A majority of students (J-A, J-B, J-D, J-E, J-G, J-H, J-I) expressed that “even when cultures differ, attitudes toward addressing problems can be shared,” suggesting a shift toward understanding cultural diversity and the significance of international collaboration. These outcomes resonate with global competency frameworks such as UNESCO’s Global Citizenship Education (2015) and the OECD’s call for learners to take action for collective well-being and sustainable development (OECD, 2018). They also overlap with the core domains of 21st-century skills identified in ATC21S (Griffin et al., 2012) and DeSeCo (OECD, 2005), including CT, collaboration, global awareness, values and ethics, and metacognition.

The interaction among IC, CT, and ESD can thus be interpreted as an integrated developmental model. Intercultural understanding provides the relational foundation; CT supports the reinterpretation of perspectives; and ESD offers the value-oriented context through which reconstructed understanding may be translated into action. This triadic interaction suggests that $IC \times CT \times ESD$ appear to form a coherent competency architecture that supports holistic 21st-century learning. These findings offer preliminary insights into the educational relevance of integrating intercultural collaboration with sustainable development (SD) themes.

Transfer as a CT-Driven Mechanism

Transfer is widely recognized as context-dependent and difficult to achieve, particularly in intercultural and language education, where contextual diversity complicates generalization (Hang & Zhang, 2023). Cultural and educational differences further hinder knowledge transfer (Volet, 1999), and individuals often struggle to attend to temporally or spatially distant issues (Chatterjee, 2003). Although transfer is a central goal of schooling, it frequently fails to occur in desirable forms (Perkins & Salomon, 1992).

Intercultural education has been shown to promote understanding of cultural diversity, reduce prejudice (Adriana, 2023), and foster CT when learners engage deeply with cultural content (Bendraou, 2025). Some studies suggest that cognitive skills developed in intercultural contexts may be applied in other domains, representing a form of far transfer.

From a transfer perspective, this study points to two possibilities. First, CT activated in response to intercultural differences, appeared to function as a core mechanism supporting the transfer of learning and behavior across contextual boundaries. Learners extended insights gained in the online intercultural domain into local and global contexts, including interpersonal relationships and sustainability-related actions. CT may therefore provide the cognitive flexibility that enables learners to move beyond contextual constraints and apply intercultural insights to broader domains of action. Second, the study suggests that sustainability-oriented values may emerge not only from environmental inquiry but also from intercultural meaning-making, thereby extending prior work that has tended to treat IC and ESD as largely separate domains.

Conclusion

This study provides preliminary evidence that junior high school students may integrate IC, CT, and sustainability-oriented values through a learning design that combines online intercultural dialogue with locally grounded inquiry. Although exploratory in scope, the findings offer an empirically grounded illustration of how intercultural reframing may function as a developmental gateway to sustainability-related learning: learners appeared to reconstruct their understanding of others and then apply this broadened perspective to environmental issues. This pattern highlights the potential mediating role of CT in linking IC with transformative learning in ESD.

Pedagogically, the results suggest that programs aiming to foster global-mindedness might benefit from intentionally activating CT through structured opportunities for comparison, reflection, and meaning-making across multiple contexts. Integrating online exchanges with local experiential activities may help deepen cognitive transformation and support action that extends beyond the classroom.

This study has several limitations. The sample size was small, and the analysis focused exclusively on Japanese participants, without examining the developmental trajectories of the Taiwanese students involved in the exchange. In addition, the identification and coding of CT segments were interpretive in nature, and the developmental model proposed in this study should therefore be regarded as exploratory rather than definitive. Finally, there are inherent limitations in maintaining full objectivity, given that the researcher also served as the facilitator of the intercultural collaboration activities.

Future research should examine learners from more varied backgrounds, adopt longitudinal designs, and explore how explicit CT instruction (El-Dakhs et al., 2022; Schmidt et al., 2026) can strengthen students' capacity to engage with complex cultural and environmental challenges. Studies that analyze both sides of the intercultural partnership and triangulate multiple data sources would help validate and refine the developmental processes identified here.

Declaration of Generative AI Use and AI-assisted Tools

Copilot was used solely for English proofreading and reference formatting, while Notta was used for transcribing the Japanese interviews. The research content, analysis, and interpretations were entirely produced by the author.

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Notes

- In this study, intercultural competence is treated as an overarching construct, whereas ESD competencies are understood as a set of specific sub-competencies identified in UNESCO and OECD frameworks.
- Editorial ‘we’ is used throughout except where ‘I’ denotes the author’s individual responsibility.

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Appendix

Appendix 1. Outline of Curricular and After-school Online Intercultural Collaborative Activities

After-school Online Intercultural Collaborative Activities		English Class (Curricular)	
		Early Oct	Preliminary research on SDGs/ environmental initiatives
		Mid Oct	Watch the English version of the film Microplastic Madness (2 lessons) (D)
		Late Oct	Start a household waste audit/survey (about 1 week) (B)
			Create a reflection presentation on the film in English (C) (D)
10/27	Online Session 1 Overview of the project: A presentation of the project by teachers from both countries	Early to Late Nov	Individual research activities at home conduct household waste research at home for the presentation (B) (C)
11/13	Online Session 2 Self-introductions by students from both countries		
11/16	Online Session 3 Sharing reflections on the documentary film (C)	11/15	Online discussion with the film director (1 lesson) (D)
11/19	Field Investigation Microplastic, collection beach clean-up (A) (B)	Mid to Late Nov	Prepare presentation of household waste slide preparation (2 lessons) (C) (D)
11/29	Online Session 4 Mid-project progress report (report on beach research) (C)		
12/13	Online Session 5 Final project report (C) (D)	Early Dec	Presentation of all students' research results (2 lessons) (C) (D)
12/15	Online Session 6 Cultural exchange & gift exchange		

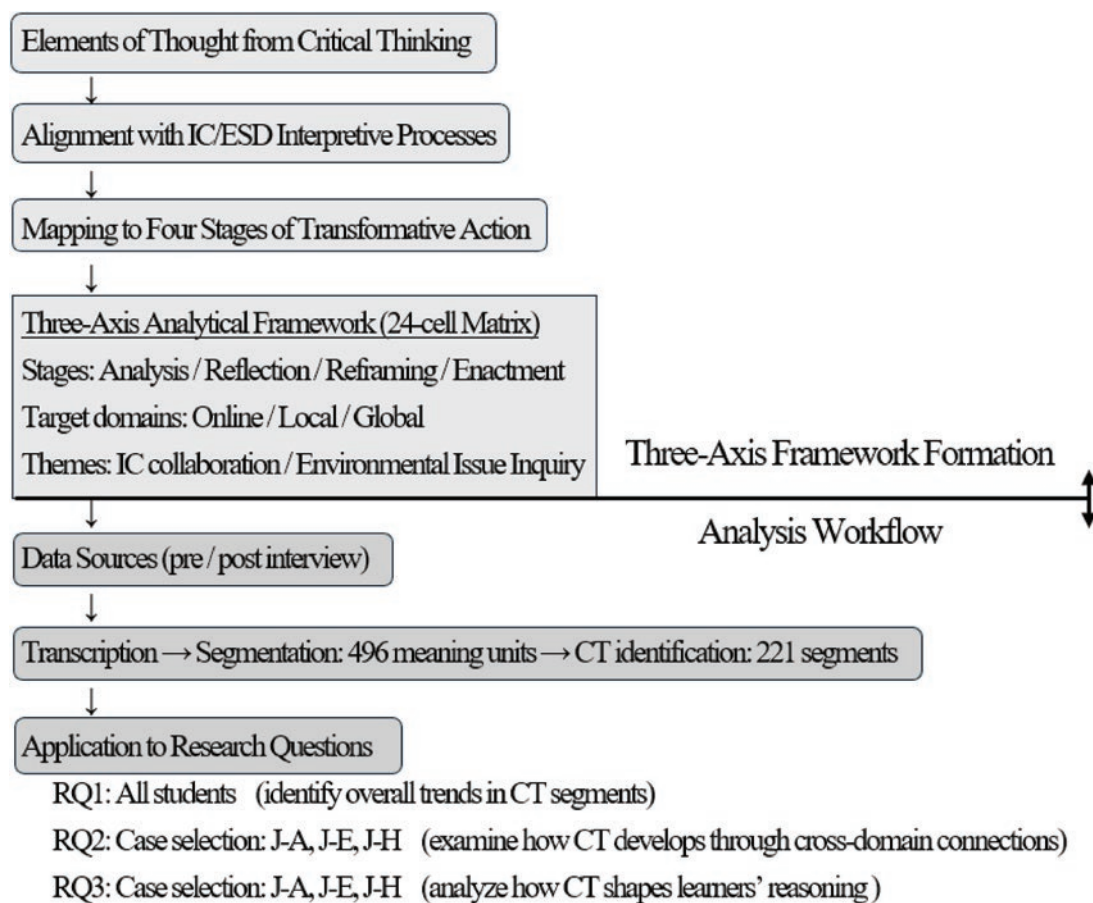
Appendix 2. *Content and Learning Objectives of the Six Collaborative Online Activities*

	Content	Learning Objectives
Session 1 (10/27)	Overview of the project	Make students understand the overall project structure and motivate them to engage proactively in the activities.
Session 2 (11/13)	Self-introductions by students from both countries	Increase students' interest in people from other cultures and promote active engagement in the exchange activities.
Session 3 (11/16)	Present impressions of the film	Use the shared learning resource (the film), to help students analyze diverse perspectives and foster an attitude of valuing different viewpoints.
Session 4 (11/29)	Mid-project progress report (report on beach research)	Through a shared social activity (beach clean-up and microplastic research), help students build a shared understanding of environmental issues.
Session 5 (12/13)	Final project report	Engage students in exchange and discussion from the perspectives of "culture," environmental issues, and the partner country students' attitudes toward addressing environmental issues, and foster CT.
Session 6 (12/15)	Cultural Exchange & Gift Exchange	Deepen understanding of people from other cultures and foster attitudes of mutual understanding and collaboration.

Appendix 3. *Code the Segment by the Primary Function of Reasoning*

Code	Stage	Operational Definition	Typical Markers (Examples)
A	Analysis	The learner examines comparisons, causal relations, or background factors to understand others/events/contexts, or to analyze sustainability-related realities and underlying causes.	Compared with... There are different standpoints... think the cause is... If we organize the information...
B	Reflection	The learner connects the issue to personal experience/values/assumptions/identity/everyday life, considering ethical/social implications (incl. decentering).	If it were me...I realized my own assumption... In my daily life... Thinking about fairness/responsibility...
C	Reframing (shift in frames of reference)	The learner updates prior assumptions and reconstructs meanings/values/intentions by adopting alternative perspectives.	At first, I thought..., but now... My view changed... I realized what matters is...
D	Enactment	The learner translates an updated frame into concrete action in daily life/relationships/future choices, or sustainability-oriented practices.	I started...I actually tried...I stopped...I changed the way I...

Appendix 4. Methodological Flowchart



Appendix 5. *Representative Examples of CT Segments Manifested Across the Three Analytical Dimensions*

Domain	Developmental Stage	Intercultural Collaboration	Environmental Issue Inquiry
Online	Analysis	I take part in the exchange while using gestures to compensate for my anxiety about the language barrier; however, I am still not sure whether we are truly able to communicate effectively. (JA-1)	The Taiwanese slides include images, which makes them feel more real, creates a sense of urgency, and amplifies the warning. (JB-13)
	Reflection	I had an image of people from overseas as strong-willed; however, comparing that assumption with the gentleness of the Taiwanese students, I realized it differed from the image I had held. (JJ-2)	Reflecting on this learning, because environmental issues are complex, it was my self-directed and dedicated attitude that prevented the process from ending incompletely. (JD-5)
	Reframing	I have come to think that, if we interact several times, we can build a relationship in which we understand each other to some extent, even with people from different cultures. (JB-9)	I came to think that, without seeing the reality of environmental destruction, learning remains only data-based and ends as someone else's problem. (JD-6)
	Enactment	When I noticed the Taiwanese students looking shy, I took the initiative to greet them cheerfully. (JC-11)	I was able to firmly articulate my own ideas, driven by the facts I confirmed through my own eyes during the field-based inquiry and my desire to communicate them to the Taiwanese students. (JC-1)
Local	Analysis	Since I can understand broken Japanese spoken by foreigners, I wonder whether, from the opposite perspective, someone could infer my intentions and understand me if I spoke imperfect English. (JE-22)	I think we need to raise awareness of environmental issues so more people will take an interest. (JH-15)
	Reflection	Just as showing interest in my partner led to a successful exchange, I suspect it is universal that people open their hearts when others show interest and ask them questions. (JC-16)	I realized that this improvement in knowledge can become the first step toward action. (JE-17)
	Reframing	Through this exchange experience, I have come to feel that my perspective on my future career has shifted. (JG-16)	I came to understand the significance of school-based community clean-up activities, and I learned that schools can also raise awareness in society. (JB-7)
	Enactment	The experience of challenging myself to build relationships with Taiwanese students is now being applied to my active effort to know others more deeply in daily conversations. (JC-14)	Through the exchange opportunity, my awareness of being part of the world grew, and I was able to view environmental issues as personally relevant. (JA-21)

(continue)

(continued)

Domain	Developmental Stage	Intercultural Collaboration	Environmental Issue Inquiry
Global	Analysis	While world cultures have both universal and specific elements, my understanding of Taiwanese culture, in particular, has deepened through this experience. (JD-11)	While the initiatives in Taiwan were unique to that region, I considered that if I expanded the scope to the entire world, even more diverse approaches would likely be taking place. (JC-30)
	Reflection	Putting myself in another person's position and behaving so as not to make them feel uncomfortable should be a sensibility shared across countries; yet even though we, on the Japanese side, simply did what felt natural, I still find myself wondering why we were evaluated as "polite." (JG-24)	NIL
	Reframing	I have begun to understand that clinging to a critical attitude can narrow one's world, in which cultural understanding gained through experience can broaden one's perspective. (JI-10)	I came to see that, even when cultures differ, attitudes toward problem-solving are shared, and that collaboration can further increase interest in other cultures. (JD-3)
	Enactment	Even with foreigners, I was able to interact without becoming overly guarded and to engage in relationships grounded in mutual respect. (JE-14)	NIL