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Biodiversity through the lens of social representation theory: A study with preservice Japanese elementary science teachers

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ABSTRACT

Biodiversity is a significant topic to understand systems that exist within, and education is one way to raise awareness or consciousness of this concept. This study investigates how pre-service Japanese elementary science teachers conceptualize biodiversity within the framework of Social Representations Theory (SRT), based on anchoring and objectification processes. A qualitative exploratory research design was conducted through an in-depth examination in Japan. With the participation of 127 pre-service elementary science teachers from four different universities, semi-structured narratives reflecting their experiences were obtained, considering educational, ethical, and practical dimensions. The data were analyzed using deductive and inductive coding approaches depending on the SRT framework. Findings revealed that pre-service teachers internalize environmental education issues by using the complementarity of the two concepts, anchoring and objectification. While anchoring is mostly contextualized with already present schemas in their social environment, objectification is seen as concrete classroom activities like posters. Additionally, teachers' identity, life experiences, cultural values, and scientific knowledge significantly impact the construction of the concepts of biodiversity and sustainability. Moreover, the ethical dimensions highlight awareness and their responsibility toward nature. The implications emphasize the contribution of Social Representations Theory (SRT) to environmental education and sustainability research.

Contribution/ Originality: This study contributes to the existing literature by raising awareness of biodiversity issues. It employs a new framework based on Social Representations Theory, focusing on anchoring and objectification processes. The paper conducts a qualitative analysis to examine pre-service teachers' reflections across educational, practical, and ethical dimensions.

1. INTRODUCTION

Biodiversity is a core global environmental issue, and as such, it has informed modern educational approaches. The scale, amount, and uncertainty of the impacts encountered in the themes of environmental issues are central difficulties, while processes are often observed abstractly and indirectly. The loss of biodiversity is not typically seen in daily life. The loss of diversity and degradation of ecosystems can occur over long time scales, making the risks abstract (Reich et al., 2012). It is not something people can see, hear, or touch; rather, it is a process that exists in the mind. Nevertheless, many people continue to lose control over biodiversity and sustainability. Despite this distance, links between media reports and politics have not led to easy changes in individuals' everyday lives, as they do not convey the clarity emerging from scientific findings on sustainability and biodiversity. The literature indicates that

people's judgments on biodiversity and sustainability are frequently influenced by value-laden perspectives, critiques, perceptions of risk, and the distribution of these risks among stakeholders (Klebl, Feindt, & Piorr, 2024). Indeed, research in the UK has shown that the environmental and political ideologies influence the beliefs about biodiversity and sustainability and, therefore, the level of skepticism (Kenny, 2021). Gao, Liu, and Bogonovich (2018) found that people's perceptions of biodiversity and sustainability are not directly connected to environmental problems but are the product of multiple social and cultural factors. As a result, the views of these ideas and what people mean by them, such as biodiversity or sustainability, are relevant areas of research. The translation of these ideas into sociopolitical action has been closely bound up with human framing, both political and theoretical.

Social Representations Theory (SRT) helps with this understanding. By providing an approach that gives an account of how widely held meanings shape people's perceptions, discussion, and reactions to their world, as well as their involvement and responses to social problems, it is a useful framework for interpreting the common understanding. Moscovici (1998) stated that social representations aim to facilitate understanding of the connections between human psychology and time- and place-specific social and cultural issues. From this perspective, Moscovici (1998) was concerned with the following questions: "What is the purpose of research within a social representation framework? Is it an endorsement or a critique of the social order? Is it to unify, or to change?" Therefore, in this study, Social Representation Theory aims to map how preservice teachers perceive a complex and evolving scientific phenomenon and explore how common-sense thinking about an unfamiliar issue develops. Science education is a core subject that equips students to address complex environmental problems scientifically, hence enhancing public engagement with these issues. Under the circumstances, how future educators, such as those in preservice elementary science teacher programs, would frame key concepts like sustainability and biodiversity is essential. Nevertheless, the literature has been scarce in specifically investigating the standard meanings, symbolic relationships, and collective perspectives of these concepts among preservice science teachers in Japan through an SRT lens. This study aims to address this gap in the literature. The primary research questions are: How do preservice elementary science teachers in Japan conceptualize biodiversity in their responses? What is their common sense about biodiversity? Therefore, the paper investigates how pre-service science teachers' concepts are formed by utilizing two basic mechanisms of SRT: anchoring and objectification.

2. LITERATURE REVIEW

This paper employs social representations theory to propose a novel lens for examining how student teachers engage with biodiversity issues. Moscovici's (1998) Social Representations Theory (SRT) is a seminal theory in the construction of social knowledge. Social representations theory aims to understand how people make sense of new information through enriching public studies and illustrating how unfamiliarity is turned into everyday common sense. The theory concentrates on social psychological processes involved in the construction of everyday knowledge of risk and common-sense thinking. The theory serves as a link between individual knowledge and collective consciousness, examining how scientific or technical knowledge of biodiversity is adopted by social groups and transformed within cultural, practical, and communicative contexts. Visual images, symbols, and metaphors can be incorporated into social and cultural lives in ways that help people apprehend unfamiliar issues. This happens through two primary psychosocial processes: Anchoring and objectification. Anchoring is a mental activity by which an innovative idea or concept is integrated within a previously existing approved category, social consensus, or experiential storage. This associates the new idea with existing schemas in collective memory, giving it character. For example, situating a problem within the context of "economic burden" or "ethical responsibility" constitutes formalization (Flick, 1998). Besides, objectification is the process of translating an abstract concept into a tangible, visual medium, metaphor, or figure, thereby rendering it more accessible and "visible." This process objectifies the new phenomenon into more concrete images, concepts, or symbols. This mechanism then allows the idea to solidify

around an image that represents its emotional and symbolic significance (Sammut et al., 2023). Therefore, Social Representation Theory can enable us to realize how pre-service teachers perceive biodiversity in this study.

Biodiversity encompasses all levels of life, from genes to species and ecosystems. Biodiversity is considered the most important ecological element that guarantees the functioning of natural systems (Reich et al., 2012). The resilience, functioning, and self-renewal of ecosystems depend largely on biodiversity. Biodiversity is not only part of nature but also the life-support system upon which human existence, economic activities, and development are built (Stevenson, Auld, Allan, Elliott, & Meadowcroft, 2021). However, such diversity is threatened by anthropogenic activities, including rapid habitat destruction, climate change, urbanization, and global agricultural expansion (Young et al., 2007). The ecological evidence is conceptually similar to that of Young et al. (2007) and Reich et al. (2012), who argued that this loss of biodiversity is associated with human activities and that damage occurs gradually, as reserves are depleted. Such activities included land use and human activities, habitat alteration, species extinction, reduction in ecosystem services, and threats to sustainability goals. Habitat integrity and species diversity were therefore key to long-term sustainability. Sustainability seeks, in its efforts to bring equilibrium to natural, economic, and social systems, to meet current needs, while not threatening the lives of future generations.

Sustainability is defined as the balance among ecological, economic, and social dimensions. But there are unavoidable tensions and competing priorities throughout these aspects. Kenny (2021) has argued that, in addition to attitudes on the environment, the economic trade-off has a strong connection with levels of economic rationality, in addition to value orientations, as well as the environmental awareness of individuals. This observation indicates that sustainability is not just a technical or economic matter, but a moral, cultural, and social one. Sustainability is not only about resource management; values such as justice, fairness, and balance are also reflected in the environment. Thus, biodiversity loss and environmental impoverishment should also be considered as an ethical and cultural emergency, not only as an ecological crisis.

EL and awareness are key factors in biodiversity conservation. The level of familiarity children, students, and teachers have with local species determines their emotional connection to nature and their attitudes toward the environment (Jaun-Holderegger, Lehnert, & Lindemann-Matthies, 2022). According to Özdemir's (2022) study, one possible cause of this differentiation is that concepts are structured and reinforced more as rules and obligations than as ethical responsibilities. Young et al. (2007) highlighted that people's perceptions of the risks associated with biodiversity loss are informed by scientific information, cultural values, and societal norms. Additionally, a European study by Buijs, Fischer, Rink, and Young (2008) demonstrated that people's representations of biodiversity are more closely tied to social and cultural issues than to environmental phenomena. This indicates that educational interventions should address not only cognitive but also emotional and value-based mechanisms.

Existing research conceptualizes sustainability and biodiversity in terms of knowledge and attitudes, but does not thoroughly consider Social Representations (SRs). Recently, Sengul and Doi (2025) investigated the environmental perspectives of preservice Japanese elementary science teachers through knowledge, values, and social skills. However, SRT plays an integral part in sense-making, as preservice teachers come to know not only environmentalist ideas but also represent them through their pedagogical endeavors. Yüce and Önel (2015) revealed how such representations can transform the lesson plans and classroom management of even preservice teachers into an eco-cognitively responsible form. It is no longer merely a biological phenomenon to be objectified as a professional ethical responsibility. Exploring how this duality is constructed in the responses of preservice Japanese elementary science teachers will help establish a transformative role of teachers in environmental education.

3. METHODS

The design was a qualitative and exploratory research, with the purpose of in-depth exploration of social representations of sustainability and biodiversity among preservice Japanese elementary science teachers. The study aimed to identify participants' conceptualizations of these topics and their interrelationships. Predefined hypotheses

or quantitative instruments were unable to capture these kinds of psychosocial realities. Therefore, for the type of study that was conducted, the research method followed a qualitative design grounded in Social Representations Theory (SRT). The qualitative exploratory strategy enables us to provide an account of students' intricate, multilayered, and spontaneous narratives within a specific context. Qualitative designs are thus most appropriate for rich descriptions of phenomena that support the in-depth examination of anchoring and objectification processes demanded by SRT, as outlined by Creswell and Poth (2018). Similarly, as Denzin and Lincoln (2011) have argued, knowing the experiences of subjects from an emic perspective is necessary if one is to access individual mechanisms through the social representations under construction. This methodological decision enables us to study both what students think and why and how they think.

The participants of the study were 127 preservice elementary science teachers from four different universities in Japan. Participants were selected by purposive sampling methodology. We selected these participants to obtain a variety of institutions of study in the diversity of the type of institution, including public and national universities and private universities, to ensure a multi-perspective of environmental and science education being taught. The use of the sampling design allows for an in-depth understanding, but may restrict the generalization of the findings since the identified participants were teacher candidates from one country (Japan) and a limited number of universities (four). Japan's environmental education curriculum is unique and informed by national, cultural, and policy contexts. Japan can provide a distinctive context to shape participants' conceptions of biodiversity and sustainability. For quality assessment, generalization is less important in qualitative research than transferability (Lincoln & Guba, 1988). Our study contributes to filling this gap by offering thick descriptions. Therefore, it provides detailed contextual descriptions of the participating universities and the teacher education system in Japan.

All Japanese students participating in the study were selected from teacher preparation programs affiliated with the Faculty of Education, where most participants were aspiring elementary science teachers. Students seeking elementary school teacher certification must complete at least eight credits in areas such as Japanese, social studies, mathematics, science, living environment studies, music, art, home economics, and physical education. They also have specific credit requirements in areas such as teaching theory, curriculum, and teaching methods, student guidance, and teaching practice.

The data used in this study were obtained from subject-specific courses, such as Science II and teaching methodology courses. Since the 1970s, environmental education has initially focused on promoting individual awareness and behavioral change, aiming to develop students' awareness of environmental protection. While legislative regulations such as the Environmental Education Law and the Education Basic Law aim to develop environmentally sensitive attitudes and behaviors, the emphasis remains largely on individual transformation. In the post-2015 period, the need for societal transformation within the Sustainable Development Goals (SDGs) framework has become increasingly prominent. At the university level, the content of environmental education largely depends on faculty members' discretion; national curriculum guidelines are binding only up to the secondary level. Therefore, teacher training programs in Japan offer a unique educational and sociocultural context for raising students' individual environmental awareness and integrating environmental and social dimensions into classroom teaching practices.

The resultant patterns of social representation are anticipated as a map for future teachers in future similar pedagogic and cultural landscapes. The sampling approach strikes a balance between contextual specificity and the interpretive depth that characterizes qualitative inquiry. Trustworthiness was strengthened through the inclusion of participants from four distinct universities, as evidenced by informed consent forms and an iterative analytic process involving multiple researchers. These strategies enhanced the dependability of the interpretations despite the absence of detailed demographic data.

Table 1. Questions on the data collection protocol.

Thematic area	Question
Sustainability and action	"After graduating and finding a job, what do you think you can personally do to protect biodiversity?"
Biodiversity and learning	"Write down your thoughts about the last lesson or experience, the courses you took, or the points that surprised you the most."
Pedagogical inferences	"As a science teacher, how do you plan to convey this knowledge to children?"

Table 2. Codebook, definitions, and examples.

Theme	Category	Objectification	Sample Quotation
Educational	Role of teaching	Having students prepare posters in lessons on living beings	Teach children the importance of living beings. Ask them to make posters.
	Contact with scientific knowledge	Visiting the zoo, nature observations	Children should have the opportunity to observe and experience nature.
		American crayfish, potatoes	I was surprised when I learned that potatoes are an invasive species.
Practical	Daily-life practices	Separating waste, using the air conditioner sparingly	Separate your trash! I don't use air conditioning, and I rarely use my car.
	Environmentally friendly behaviors	Energy saving, choosing pesticide-free products	We will work on what we can do to prevent global warming; for example, we will reduce car travel.
Ethical	Responsibility-ethics	Not abandoning pets, protecting living beings until the end	When buying a pet, take full responsibility for its care.
	Awareness, interest	Making an abstract concept visible or tangible through concrete examples	I was able to learn about the importance of biodiversity in a fun way through quizzes.

Data were collected through semi-structured narrative writing in which 127 preservice Japanese elementary science teachers reflected on their experiences in a science education course following a 90-minute lecture on biodiversity conservation. The narrative task included three open-ended prompts (Table 1) that encouraged participants to express their thoughts, feelings, and values regarding sustainability and biodiversity. Written responses were chosen as the primary data source because they allow participants to articulate spontaneous, individualized, and reflective meanings in their own words. The forms were completed following the class session. Using thematic content analysis informed by Social Representation Theory, we examined the narratives by the participants through the lens of anchoring and objectification. Table 2 presents the codebook for the analysis procedures. Based on theoretical constructs, an initial set of deductive codes was formed. On the other hand, inductive codes emerged during iterative reading of the data. The codebook and definitions appear in Table 2. All responses were read multiple times and independently coded by two researchers. Discrepancies were discussed until agreement was reached. An audit trail of coding choices was maintained to enhance the trustworthiness of the analysis, and representative excerpts were provided to illustrate these themes. These methodological decisions support the credibility and transferability of the results within the context of qualitative inquiry.

4. RESULTS

The research was conducted within the framework of Social Representations Theory (SRT) to explore how preservice elementary science teachers in Japan at four universities conceptualize biodiversity and sustainability across educational, ethical, and practical dimensions. The analysis identified two cognitive modes used to interpret complex and abstract ideas: anchoring and objectification. Anchoring involves linking new, abstract, or conceptual ideas to familiar experiences that are considered valuable or known. It functions as the basis for ideals expressed through images, metaphors, or practices. Students connected questions about biodiversity and sustainability to prior

teaching values, everyday life aspects such as shopping, waste disposal, and transportation, as well as childhood experiences and societal value systems. Participants also demonstrated abstract concepts through visual images like posters and course materials, everyday objects such as trains, disposal bins, and living organisms, and practical examples of animals like crayfish, potatoes, and mongooses. These examples and concrete images helped make biodiversity a visible and tangible concept by objectifying it. Such intuitions appeared to be mediated by tangible instances, ordinary objects, classroom rituals, metaphoric language, and practices.

In the educational dimension, participants consistently framed biodiversity and environmental problems in terms of what should be taught and how this teaching connected to their future professional roles. First, preservice teachers connected biodiversity with their careers to explain their role as teachers as transmitters or mediators of environmental knowledge. For these student teachers, the meanings of environmental problems centered not only on personal behaviors but also on how they would contribute to educating their children. One student teacher stated,

"Convey to the children the importance of preserving the creatures and landscapes unique to Japan."

This comment also focused on environmental education as something both local and curricular. They felt that teachers had to pass down place-based values. It indicated here that environmental education was not only cognitive, but it included the knowledge that environmental education needed and knowledge of species and habitats, as well as psychological and emotional aspects, as an appreciation of local landscapes, as well as a pedagogy that fostered both factual knowledge of a landscape and local protection. Environmental conservation was tied to cultural and national ideals, bridging worldwide ecological concepts to local identity. This abstract goal of environmental preservation was conveyed in actionable, concrete pictures as a symbol that was a point of emotional reference for not only national confidence but also ecological obligation. This teacher also sought to promote and increase interest and enthusiasm toward environmental consciousness. Another student said,

"Classes that don't just read what is in the textbook but think together with the child."

This statement underscored a dialogic, constructivist model of pedagogy and placed the teacher as a facilitator and not a disseminator of knowledge. This constructivist model drew upon the comparison to conventional textbook-based teaching. It made a contemporary teaching philosophy understandable, setting it straight against a widely held routine. This participant highlighted a commitment to co-constructing knowledge with students, such as the inquiry-based approach to topics on the environment. As for objectification, the educational ideal was framed as a dialogue in the classroom to foster active learning and shared exploration. The participant could use the environmental aspects he/she received at school to form a social representation of subjects related to these issues. Concerns such as invasive species, the effects of pesticides, and the balance of ecosystems were among the most popular issues listed. One individual remarked,

"I did not realize the potato is an invasive species."

This comment illustrated the re-conceptualization of familiar foods that preservice teachers initiated when confronted with ecological ideas. It was a result of cognitive restructuring in which everyday materials were recontextualized through ecology. This process could be considered as knowledge assimilation and a shift of perspective. The abstract problem of biological invasion was anchored in a direct moral and pedagogical rule. The issue had also materialized in a visible school setting, making environmental responsibility a concrete, everyday practice. Additionally, participants also addressed the educator's role in teaching about species, but emphasized that protecting ecosystems was the primary responsibility. This result also suggested that teachers should expand classroom subject matter beyond textbook basics to contemporary environmental concerns. Besides invasive species, the local ecosystem could serve as an anchor to understand the environment. One student said,

"It was interesting because it was familiar with the case of Lake Shinji."

This participant addressed abstract environmental issues in a well-known local case. Anchoring to local, familiar references appeared to make environmental problems cognitively and emotionally salient, facilitating learners' ability to relate abstract ecological processes to lived experience.

Participants also made objectification through classroom materials and activities. Objectification is the process of visualizing abstract ideas, ritual practices, and ordinary things in a visual medium. In the educational context, biodiversity was directly linked to teaching, with this connection materialized through educational activities. Biodiversity was manifested in students' thinking as real living organisms. Student teachers gave examples such as the American crayfish, the mongoose, or even the potato as an abstract notion. "If you see an invasive species at school, do not let it go," said a student teacher. This suggested that tangible examples were an effective means of representation in learning. In addition, students were able to make abstract concepts specific through educational resources such as walls, posters, field trips, and course materials. One student stated,

"Have students create posters showing what they can do to help biodiversity or teach about living things."

The quote illustrated how ideas and principles had become tangible classroom artifacts. Objectification achieved pedagogical goals by materializing ideas into visible products that prompted discussion, memory, and public involvement. It also indicated the importance of living organisms, such as plants, insects, and animals, as the core units through which students could make sense of broader ecological concepts. With these cases, pre-service teachers were ready to practice environmental elements in their pedagogy.

The moral dimension emphasizes moral relations between humans and other entities of life. Responsibility, avoidance of harming living things, and consciousness are prioritized. For example, one student said,

"As someone who in the future wants to be a teacher, I will not teach false information about living things."

This reflected an ethical commitment to epistemic obligations in the process of teaching. This explanation associated moral responsibility with the fidelity of information dissemination. The student contended that accurate and realistic environmental education, because it defined our attitudes and actions, was ethically necessary. Anchoring was rooted in the assumption that knowledge of truth has moral gravity: that it is what the world knows to be right. It underscored continuity, routine, and the making of moral sensitivity an embodied habit. Repeating care was an act of behavioral ethics as the objectification of compassion was an observable, repeated action. Another student stated,

"Think about how to prevent living things from taking away their habitat."

This indicated the recognition of indirect harms or habitat loss and of ethical awareness of human causation. It suggested a duty to spot human behaviors that lead to harm and the moral imperative that arises. This also broadened our thinking on habitat conservation to mirror the ethic of the minimal amount of waste and harm possible. This was symbolic of grounding in environmental ethics to engage in cognitive reflection and vision in which teachers are to think about their role in the indirect impact on other people. The participant connected the moral obligation of care with systemic awareness, transforming individual emotional concern into ecological responsibility.

Preservice teachers have given meaning to abstract concepts related to their childhood, family background, or self-reflection, thus anchoring them. For instance, one student reported,

"I hated insects as a child but came to realize they were also important."

This way of relating was grounded in perception, emotion, and instinct-based relations to nature, which stressed the need for in-nature contact. This quote captured an ethical viewpoint that acknowledged the value of nature itself. The transformation was cognitive as well as moral, as exposure to and consideration of those things could turn commonplace childhood fears into an ethical respect for creatures.

Additionally, on the ethical level, values such as non-injury, gratitude, and responsibility are also maximized. Vision has been the reciprocal of symbolic presentation; abstract notions are being presented as recognition. Some students also connected ethics in human-nature relationships with the value of appreciation and coexistence, which are deeply ingrained among the Japanese people. A student teacher said,

"Thank you when you eat a living thing like fish or meat."

Such terms showed that social representations have been constructed within cultural backgrounds, and that the pedagogy of sustainability should cater to local values. This remark connected cultural rituals with environmental ethics. Gratitude rituals were interpreted as a form of respect that moralized consumption and potentially reduced

thoughtless waste and detachment from the sources of food. Students also demonstrated ethical awareness through a sense of responsibility and a value for preserving the future. One student stated,

"As teachers, we must nurture children in a way that recognizes the value of each child."

Although mainly speaking of human ethics, the quote spoke to the human and the non-human as to value. It posited that an ethic of respect for students could be applied as an analogy to broader life forms, integrating human pedagogy and environmental ethics. This assertion cemented our common sense understanding of reciprocity between the human self and nature as the ethical concept of interdependence. The participants linked ecological ethics to cultural and moral concepts of feeling gratitude and coexistence. It showed a Japanese sensibility that is thoroughly rooted, where living in harmony with the ecosystem matters, demonstrating that conventional moral codes provide a gateway to new ecological learning.

The practical dimension comprises everyday practice and tangible action where one's environmental concern materializes. Practices of the participants relate to daily life or environmentally friendly choices, such as waste management, transportation choices, and consumption practices. At the beginning of class, student teachers connected abstract environmental concepts to everyday experiences. Topics such as garbage sorting, mode of transport choice, and energy conservation should be widely noted here. For instance, student teachers said,

"Dispose of your garbage properly and contribute to recycling."

"Reduce food waste, such as leftover food."

"Do not use too much detergent."

These statements revealed how sustainability had been manifesting in the everyday experience, folded into a personal practice. The practical manifestations of these ideas found an expression in the ideas of separating out waste, conserving energy, and practicing what you eat in real life. Common objects made daily troubles into objects. They reflected an illustration of this direct translational knowledge at play in an eco-conscious way. It showed an assumption of taking seriously the relatively simple, day-to-day task of sorting waste as a legitimate pedagogical object for teachers to use to instruct small communities in urban living. Recycling turned into a visual sign of social awareness; the proper disposal of waste was metaphorical as to how the most physical, most visible act that your everyday living style has taken on for yourself can symbolize the sort of sustainable practices now needed. Participants said reducing food waste was both an ethical and viable environmental way to reduce waste. These statements included that resource efficiency should be embedded into everyday habits, indicating that the reduction of consumption is a pragmatic target to address for learners and educators. The principle of sustainability was informed by the ethics of non-use, and leftover food was an evident example of waste and represented ethical behavior, along with caring for the physical environment. Participants further addressed the topic of household chemical pollution and its impacts, primarily using detergents. This is how an environmental approach was applied to household routines and what was presented as an opportunity for the curricula of household ecology and harm reduction. Environmental protection was woven into our daily hygiene habits, and we connected global pollution to personal hygiene practices. As for objectification, measuring detergent meant a material representation of the abstract idea of reducing chemical impact because, as pollution became tangible, there was no other way to reduce it. These practices, such as cutting energy use, reducing food waste, and selecting environmentally friendly products, linked an abstract environmental issue to personal action.

Transportation and eco-friendly behavior were also suggested by student teachers. Student teachers declared,

"Use eco-bags. Separate your garbage."

"Use the train as much as possible."

"I do not drive my car very much."

These comments suggested that reduced personal behavior had materialized in environmental awareness. These behaviors demonstrated an understanding of the effects of transport on the environment and indicated that preservice teachers were able to share practical solutions that could be advocated for as sustainable living. Sustainable

transportation was based on the conventional choice between cost-effective and practical means of transportation. The train became a symbol of sustainable mobility, giving people an abstract idea of reducing carbon emissions, a physical figure of transportation, and a real lifestyle change.

Not only eco-behaviors, but there were examples from everyday life that were reflected in these statements. Life practice can be the greatest enactment of knowledge around the concept and application. Classroom enactments and hands-on interventions were also discussed by student teachers. The participants stated,

"Volunteer to remove invasive species."

"Instruct them to take what they can eat at lunch time, and not to leave leftovers."

"Try to buy products made by pesticide-free farmers."

These remarks were examples of extending the reach of teaching objectives to direct, physical operations. Participating in volunteering for removal was also a form of civic engagement that was experiential learning; ecological action coincided with classroom goals. Safeguards for the environment were based on the moral and social benefits of giving of oneself. The removal of plants or species, physically, became the very physical embodiment of environmental protection for ecological care. They also proposed minimizing food waste to stimulate resource awareness. Environmental education became a site through which the lunch tray became an educational experience for sustainability education: an important source of moral education about moderation, respect, and gratitude towards resources to increase environmental responsibility. Buying from pesticide-free producers was an explicit promotion of bringing environmental values to the consumer's level of consumption and effecting change at the ecological scale. Consumer ethics established over time were integrated into an ecological consciousness that empowered people to make choices based on common sense and well-being. These pesticide-free products represented a physical manifestation of environmentally conscious behavior, tying global ecological well-being to a recognizable act of consumption.

5. DISCUSSION

Findings indicate that anchoring and objectification are complementary cognitive and pedagogical processes that preservice teachers employ to construct their social representations of environmental education. Anchoring is most evident in how respondents attach new scientific or ecological facts to familiar cultural images, local experiences, and personal events. Preservice teachers consistently contextualize abstract environmental ideas within contexts they are already familiar with, which include local ecological cases, community scenes, and everyday routines. For example, we see how preservice teachers contextualize global environmental challenges in ways that are both locally and emotionally meaningful, such as Lake Shinji, giving thanks before eating. Moreover, it is through this process that students translate unfamiliar ideas, for instance "biodiversity," into schemas already present in their social world, and in doing so, make learning personally meaningful and pedagogically accessible. Anchoring is the cognitive process of constructing new knowledge and integrating it into existing systems of meaning; thus, environmental education becomes an extension of culture and moral identity rather than merely a science-teaching and learning approach.

Objectification is where what we know about objects of a type gets to be concretized in contemporary physical form (Sammut et al., 2023). Educators spoke of the creative process involved in translating theoretical ideas about the environment into concrete classroom activities, in this case, for example, designing a poster that represents biodiversity or planning an excursion to the field, and using species such as crayfish, mongoose, and potatoes to embody larger ecosystem principles. Through such materializations, ideas of biodiversity and sustainability become operable in the learning environment and everyday life. Objectification, hence, is that which mediates the cognitive and practical aspects, encouraging preservice teachers to "see" and "do" the environment rather than talk about it. Furthermore, everyday ethical behaviors, such as separating garbage, releasing insects, and avoiding food waste, appear to be micro-level enactments of sustainability norms. These practices embody morality and ecology,

manifesting moral and ecological consciousness in practice that serves to solidify social representations through repeated acts of perception.

Taken together, anchoring and objectification account for the circulation of environmental knowledge between cognition, culture, and action in the construction of a teacher's identity. The anchoring makes the new meaningful by linking it to what is already known; the objectification makes visible the introduction of forms, putting into shape what we know. Pedagogy is presented as the dimension where both processes are combined: preservice teachers ground their ideas about the environment in personal and cultural experiences; at the same time, they make those ideas objective through teaching practices that render them effectively tangible for children. This twofold process brings abstract ecological discourse to contextually embedded, ethically sensitive, and potentially enacted teaching.

This article analyzed the social representations of biodiversity and sustainability among preservice elementary science teachers from four Japanese universities, using Social Representations Theory (SRT). The anchoring and objectification of general themes, i.e., educational, practical, and ethical dimensions, are discussed in detail. Teacher candidates often relate biodiversity and sustainability to their profession, particularly to the scientific knowledge they acquired in lecture halls. Some focused on the duty to impart accurate information to children, citing classroom examples such as invasive species and pesticide use. These findings align with previous studies that portray preservice teachers as a combination of scientific knowledge and pedagogical expectations (Lindemann-Matthies et al., 2011).

Sustainability was also encouraged at school by teachers through their everyday behaviors (e.g., recycling, low-carbon use, and environmentally friendly consumer choices). These are practices that we will discuss below as evidence of the materialization, at an individual level, of abstract sustainability constructs incorporated into daily life and habits (García-González, García Palencia, & Sánchez Ondoño, 2021). However, environmental objectives worked independently of sustainability dimensions, and the economic and social aspects of sustainability were underrepresented compared to the other two, suggesting a gap in achieving a comprehensive grasp (UNESCO, 2020). Thus, there is limited knowledge among preservice teachers, for example, whether fish belong to the animal kingdom (Lindemann-Matthies, Remmele, & Yli-Panula, 2017; Skarstein & Skarstein, 2020).

In addition, affirmation was deeply tied to cultural and ethical values. Teachers forged connections among biodiversity, gratitude, respect for life, and a shared sense of responsibility. Researchers studying environmental moral reasoning have made similar arguments, suggesting that values and epistemological concerns align with preservice teachers' meaning-making (Tuncay-Yüksel, Yılmaz-Tüzün, & Zeidler, 2023). According to the results of Tuncay-Yüksel et al. (2023), value-belief profiles are correlated with preservice teachers' environmental moral reasoning. Even if such sound moral foundations indicate significant cultural capital, misunderstandings can persist, such as the belief that all alien species are inherently "bad," which could propagate a stereotype or a factually incorrect worldview, as evident in other biodiversity education research (Kvammen, 2015).

One of the merits of this study is that it effectively employs SRT to understand how preservice teachers interact not only with biodiversity itself but also within experiential, cultural, and symbolic perspectives. Japan's cultural context contributes to the global discourse on education for sustainable development. Finally, Japanese society combines characteristic collectivist elements with a high level of population closeness to its natural environment and the power of symbolism. The participation of people in anchoring cultural values has shifted from a global to a local focus. However, there are also limitations, including the lack of species-level information for many of the species considered. There was a greater emphasis on environmental rather than economic/social aspects, and a risk that invasive species may be misinterpreted. These limitations are consistent with international research indicating that preservice teachers have limited knowledge of biodiversity and partial views of sustainability (García-González et al., 2021; Jaun-Holderegger et al., 2022).

By exploring the social representations of preservice elementary science teachers across three dimensions (educational, practical, and ethical), this paper suggests that teacher education should promote local species' knowledge. Professional development of teachers can foster awareness of the ecological, social, and economic

dimensions of sustainability and mobilize cultural values and emotions to foster a balanced view. This approach may contribute to constructing new, transformative ways of understanding biodiversity and sustainability for classroom precursors.

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