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Epistemological beliefs and values as predictors of preservice science teachers′ environmental moral reasoning

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Abstract

The purpose of this study was to test predictability of environmental moral reasoning patterns of preservice science teachers (PSTs) by their epistemological beliefs and values. Four environmental moral dilemma scenarios that reflect different environmental moral dilemma situations taking place in four outdoor recreation contexts (i.e., hiking, picnicking, fishing, camping) were used to trigger and examine environmental moral reasoning of PSTs. Centers of moral concerns (i.e., ecocentric, anthropocentric, egocentric) and underlying reasons of environmental moral considerations (e.g., aesthetical concerns, justice issues) were used to investigate PSTs′ environmental moral reasoning patterns. Data were collected from 1524 PSTs enrolled in six universities located in Central Anatolia region of Türkiye. A path model was proposed to test relationships of PSTs′ epistemological beliefs and values to their environmental moral reasoning for each environmental moral dilemma scenario. Results indicated good-fit between study data and the path model tested for each environmental moral reasoning scenario. Variances in environmental moral reasoning scores that were explained by the path models had

small to medium effect size values of 0.06 to 0.26. Statistical significance and direction of the tested relationships showed changes depending on the moral dilemma scenario context and focus of environmental moral reasoning. Nevertheless, path analyses consistently revealed positively significant relationships between environmental moral reasoning categories and epistemological beliefs in omniscient authority and self-transcendence and tradition values. Implications for science education policy and practice are discussed.

KEYWORDS
environmental moral reasoning, epistemological beliefs, path analysis, preservice science teachers, socioscientific issues, values

1 | INTRODUCTION

Researchers acknowledge that increasing environmental knowledge and awareness, or promoting positive environmental attitudes, are not enough for fostering long-term pro-environmental behaviors in society (York & Becker, 2012). The last few decades have been considered as a time of re-awakening about the importance of ethics and morality in environmental conservation and protection (The Organization for Economic Co-operation and Development [OECD], 2018; United Nations [UN], 2015). In line with this re-awakening, ethics and morality are given place in the recent international agendas about the future of life on Earth and precautions that should be taken in order to have a sustainable life on it. For instance, fostering "an ethic of global citizenship and shared responsibility" is declared as one of the goals in the United Nation's *2030 Agenda for Sustainable Development* (United Nations, 2015, item 36). Similarly, in OECD's (2018) report of *The Future of Education and Skills*: *Education 2030*, "moral and intellectual maturity" and "acting ethically" are explained among the "transformative competencies" that young people need to have in order to be prepared for the future (OECD, 2018, p. 6).

Some theories such as Schwartz's (1977) norm-activation theory and Stern et al.'s (1999) value-belief-norm theory provide theoretical and empirical support for the need of experiencing feelings of moral obligation (personal norm) for acting in more pro-environmental ways and/or supporting pro-environmental movements. The importance of ethics and morality and the need of cultivating an ethical perspective in educational efforts are emphasized in more recent research as well. For instance, Eilam and Trop (2010) refer to the role of ethical and value clarification in activation of cognitive and affective (emotional) processes and learning. York and Becker (2012) point toward the key role of ethics in resolving inconsistencies between people's beliefs (*telos*) and actions in practice (*praxis*) and discuss its implications for the need of cultivating an ethic of sustainability in educational institutions such as higher education.

Environmental moral reasoning, which is among the main constructs of the present study, can be thought of as a subset of environmental ethics. Environmental ethics, in its broadest sense, is a branch of environmental psychology that focuses on how individuals extend ethics to human–environment relationships (Palmer, 2012). In this context, environmental moral

reasoning is defined as a term that is utilized while explaining the variations in individuals' perceptions of morality and ethics with respect to human–environment relationships (Kortenkamp & Moore, 2009). In other words, the construct of environmental moral reasoning carries theoretical discussions of environmental ethicists to the "stage" of empirical research and is used to explain reasoning processes that individuals go through while evaluating moral aspects of environmental issues (Littledyke, 2004) and justifying decisions regarding them (Herman et al., 2020; Sadler & Zeidler, 2004; Zeidler & Sadler, 2008).

The overarching purpose of the present study, therefore, is to examine the extent, if any, environmental moral reasoning patterns of preservice science teachers (PSTs) are predicted by their epistemological beliefs and values. Two sub-research questions were tailored to address the overarching research question and key facets of the study: (1) How are epistemological beliefs of PSTs related to their environmental moral reasoning? (2) How are values of PSTs related to their environmental moral reasoning? A path model was proposed in order to examine the hypothesized relationships of epistemic beliefs about knowledge justification and values to the aspects of environmental moral reasoning. More specifically, epistemological beliefs and values were included in the proposed path model as predictors of environmental moral reasoning patterns since these two constructs are regarded among the basic components of cognitive and affective domains (Bendixen et al., 1998; Corraliza & Berenguer, 2000) and play important roles in individuals' perceptions and evaluations of issues, which are related to their reasoning about the morality of the environmental issues (Littledyke, 2008; Tuncay et al., 2011).

1.1 | Discerning environmental moral reasoning in science education: Theoretical and conceptual approaches

Many researchers have typically used two categorizations to describe moral reasoning patterns toward the environment. In the first categorization (Kahn Jr., 1997; Kahn Jr. & Lourenço, 2002; Kortenkamp & Moore, 2009; Severson & Kahn Jr., 2010), individuals' environmental moral reasoning is categorized into two orientations: human-centered (i.e., homocentric/anthropocentric) or nature-centered (i.e., ecocentric/biocentric). Other researchers have suggested that a more accurate categorization in understanding individuals' environmental moral reasoning takes on a tripartite distinction. Researchers suggesting this categorization (e.g., De Groot & Steg, 2007; Stern et al., 1998) propose that in addition to human-centered and nature-centered orientations, individuals' self-oriented (i.e., egocentric) considerations constitute a distinct type of environmental moral reasoning. In this respect, individuals who possess egocentric moral orientations tend to believe that people have an innate right to extract and use natural resources to enhance their own lives in response to environmental dilemmas.

We choose a tripartite categorization of ecocentric, anthropocentric, and egocentric moral reasoning to best capture and identify PSTs' locus of moral concerns in their environmental moral reasoning patterns. Our rationale for choosing a tripartite categorization over a binary categorization was twofold. First, a three-way vision of environmental moral reasoning provides a more robust picture of individuals' extension of ethics/morality to environmental issues (Stern et al., 1999). Second, tripartite categorization of environmental moral reasoning corresponds better with the theories and models proposed on moral development and moral reasoning than a binary categorization does. For instance, egocentric, anthropocentric, and ecocentric moral reasoning show parallelism with Kohlberg (1976, 1986) pre-conventional, conventional, and post-conventional/principled moral developmental levels, respectively (Tuncay-Yüksel, 2016).

It should be cautiously acknowledged that, similar to the most other studies in the literature, the categorization utilized for studying environmental moral reasoning in the present

study (i.e., egocentric, anthropocentric, ecocentric) typifies a "modern Western" perception about the environment and human–environment relationships where individuals are inclined to perceive a fundamental divide between humans and the environment. We recognize, for example, that in certain land-based and Indigenous cultures everyone and everything is perceived to be a part of a unified cosmos, including all living and nonliving beings, as well as the spiritual and metaphysical aspects that connect people to the land and the universe (Brayboy & Maughan, 2009). Nonetheless, previous research that utilized different methodologies and diverse samples such as Turkish 5–6 year old children (e.g., Altun, 2020), elementary school students (e.g., Onur et al., 2012), preservice teachers including PSTs (Sürmeli & Saka, 2013; Tuncay et al., 2011; Tuncay et al., 2012) indicate the validity of making such a categorization in environmental moral reasoning patterns based on moral concerns focused on the self, humans or the environment for Turkish culture, and arguably for most technocratic Western societies.

In addition to above-mentioned research studies, within modern Western philosophies and perceptions impacting environmental ethics (Payne, 2010; Quinn et al., 2016), differences at the center of environmental moral concerns (e.g., the self, humans, nature) tend to dominate discussions on environmental moral reasoning patterns (Kortenkamp & Moore, 2009). Likewise, points of references (i.e., self-centered, human-centered, nature-centered) are frequently used as frameworks for examining individuals' perceptions and conceptions of the environment and humans' place and role in it (Quinn et al., 2016; Yavetz et al., 2014). In related research, Yavetz et al. (2014) examined Israeli preservice teachers' writings for investigating their perceptions about the environment. Their analyses revealed that while many of the preservice teachers exhibited egocentric or anthropocentric utilitarian views by putting self-centered or human-centered needs as a reference point for allocating value to nature, only a few of them explicitly expressed ecocentric views. The researchers also found that, regardless of their teaching area (e.g., life sciences, social studies), preservice teachers did not perceive humans as a part of the environment and were unaware of the complex web of interrelations including social and cultural interactions of people, human-made systems, and natural ecosystems.

Further work conducted in Türkiye reveals a related pattern with regard to Turkish PSTs' environmental orientations. For instance, written responses of PSTs in Tuncay et al.'s (2012) and Tuncay-Yüksel et al.'s (2015) studies showed that the PSTs had higher levels of ecocentric concerns than anthropocentric concerns when confronted with local and non-local environmental moral dilemmas. Sürmeli and Saka (2013) and Karakaya and Çobanoğlu (2012) used Likert type scales to examine Turkish preservice teachers' environmental orientations. In both of the studies preservice teachers were found to have mostly biocentric and ecocentric approaches toward the environment regardless of their academic major.

It is clearly evident from the literature that amassing knowledge about the environment, its components, and the biophysical systems is not enough for the development of ecocentric approaches, which is required for higher levels of environmental (ecological) literacy (Quinn et al., 2016). Higher levels of environmental literacy requires integration and interpretation of knowledge to develop a comprehensive understanding about the interrelated and interconnected nature of the relationships among natural and human systems, which are equally part of the environment (Puk & Stibbards, 2012). Many dimensions of ecoliteracy that are critically important to environmental education such as ethics, morality, and spirituality, also factor into value-laden decisions and actions about the world we inhabit (Puk & Stibbards, 2012; Zeidler & Newton, 2017).

Some researchers such as Rachmatullah et al. (2020) conceptualize environmental literacy as a subcomponent of scientific literacy. These researchers propose that the development of

multidimensional perspectives with regard to the environment through addressing issues of ethics, culture, economy, politics and other sociocultural factors, will contribute not only to environmental literacy but also to scientific literacy of our community, which is considered as an overarching goal of global science education (Glaze, 2018). In fact, the main constructs of environmental education, such as socioecological literacy, ecojustice, and environmental literacy, are also regarded as key elements of science education movements that stress the importance of science-in-context (SinC) learning (Bencze et al., 2020; Zeidler, 2014).

Preservice teachers are of central importance to the success of most educational ecoliteracy efforts and would certainly be pivotal in helping to facilitate SinC environmental education efforts. Therefore, based on the importance of PSTs for science and environmental education, especially in the middle schools of Türkiye, participants of the present study were selected among Turkish PSTs. Our aim was to investigate environmental moral reasoning patterns of PSTs relative to the predictive impact of their epistemological beliefs and values.

1.2 | The use of environmental moral dilemma scenarios

In addition to the tripartite model of moral concerns (i.e., ecocentric, anthropocentric, egocentric), possible underlying justifications of environmental moral considerations (e.g., aesthetical concerns, ecojustice issues) were used to investigate PSTs' environmental moral reasoning patterns. This choice was based on our desire to examine the complex structure of environmental moral reasoning in a more robust and possibly effective way (Kronlid & Öhman, 2013; Wiseman & Bogner, 2003). Our presupposition acknowledges that empirical data would likely result in additional environmental moral reasoning categorizations beyond the ones proposed in the tripartite model. Accordingly, we acknowledge that environmental moral orientations are a combination of a variety of motivations, concerns, or moral considerations (Kronlid & Öhman, 2013). Therefore, we were open to the formation of environmental moral reasoning categories different from the theoretical classifications of the tripartite model of moral concerns and their respective justifications. In fact, novel moral reasoning patterns, such as various forms of empathy, righteous indignation and socio-moral compassion, have been reported during the resolution of place-based environmental socioscientific issues (SSIs) (Herman et al., 2020; Zeidler et al., 2019).

As in many other studies (e.g., Crumpei et al., 2014; Kortenkamp & Moore, 2009; Persing, 2006), environmental moral dilemma scenarios were used to trigger and examine environmental moral reasoning of the PSTs. In using this approach, researchers can include multiple variables in a moral dilemma scenario and even make changes to them. This advantage allows researchers to gain a more holistic view about the elements of moral psychology (e.g., moral reasoning, moral decision-making) of their subjects (Christensen & Gomila, 2012), and avoids the "trap" of identifying environmental moral reasoning as a linear unidimensional continuum (Kronlid & Öhman, 2013). Another advantage of using moral dilemmas is the opportunity it creates for readers to experience moral conflicts from many perspectives and contributes to the moral development of students when used in classrooms (Upright, 2002; Zeidler, 1984).

Since content and context of moral dilemmas are influential on one's moral reasoning (Garrison et al., 2015; Rest et al., 2000; Zeidler et al., 2005), it follows that hypothesized situational variables would also influence relationships of environmental moral reasoning, epistemological beliefs and values, as well as other potential variables. Accordingly, analyses of the path models proposed in this study were examined independently for each of the four environmental moral dilemma scenarios.

1.3 | Epistemological beliefs and environmental moral reasoning

Epistemological beliefs influence how individuals frame, construct, and justify knowledge and the meaning they make about the information they encounter (Hofer, 2001, 2002). In this vein, epistemological beliefs are reflections of individuals' conceptualization of issues and their justifications about their decisions regarding those issues (Zeidler et al., 2013). This framework implies relationships between epistemological beliefs and environmental moral reasoning in that critical analysis of available and relevant information embedded in issues is a prerequisite for informed moral reasoning and subsequent moral judgments. Moreover, as revealed in Zeidler et al.'s (2013) study, epistemological beliefs are also derived from, and work in concert with, the application of moral emotions such as care, empathy, sympathy, and concern. Research findings showing the influence of epistemological beliefs on individuals' tendencies for constructing their own moral standards (Bendixen et al., 1998; Walker et al., 1991) also add supporting evidence for the validity of hypothesizing relationships between epistemological beliefs and environmental moral reasoning. Nonetheless, to the best of the researchers' knowledge, there are no empirical studies that explicitly examined relationships between epistemological beliefs and moral reasoning about environmental issues.

In the present study, Schommer's (1990) epistemological beliefs model was utilized to examine PSTs' epistemological beliefs. In contrary to unidimensional approaches which propose stage like patterns to describe epistemological beliefs and explain their development (e.g., King & Kitchener, 1994; Perry, 1981), Schommer conceptualizes epistemological beliefs as a system which is multidimensional in nature and does not have strict stage like developmental levels (Hofer & Pintrich, 1997; Schommer, 1990, 1994). Five major dimensions are proposed in Schommer's (1990) epistemological beliefs model: simple knowledge (SK), certain knowledge (CK), omniscient authority (OA), quick learning (QL), and innate ability (IA). Details for these five epistemological belief dimensions as potential epistemological belief variables of the path analyses are presented in Table 1.

Variances in the sophistication of PSTs' beliefs in the epistemological belief dimensions were hypothesized to result in differences in their environmental moral reasoning patterns. For example, it was hypothesized that PSTs who had naïve beliefs in QL epistemological belief dimension would not devote enough time or concentrated effort while reasoning about the various moral aspects embedded in the scenarios (Bendixen et al., 1998). Conversely, they were anticipated to show a tendency to make decisions quickly by considering only the explicitly available information or more immediate, concrete, and foreseeable outcomes (Zeidler et al., 2013), which would prevent them from fully understanding the environmental moral dilemmas and result in narrower views related to environmental moral reasoning. Therefore, we might expect to see differences between environmental moral reasoning patterns of these PSTs and their counterparts, who had relatively more sophisticated epistemological beliefs in QL epistemological belief dimension.

1.4 | Values and environmental moral reasoning

The importance of values and their relativity (i.e., the order of importance) for individuals' decisions, judgments, and behaviors has been noted by several researchers (e.g., Dietz et al., 2005; Green, 1993; Schwartz & Bilsky, 1987). Findings of that scholarship provide necessary justifications for hypothesizing relationships between values and environmental moral

TABLE 1 Potential epistemological belief variables of the path analyses.

Variable name	Meaning of high score	Meaning of low score
SK	Naive beliefs that view structure of knowledge as being constituted of isolated bits of facts	More sophisticated beliefs that view knowledge as a composition of highly interrelated concepts
CK	Naive beliefs that view knowledge as certain and absolute	More sophisticated beliefs that view knowledge as tentative and evolving
OA	Naive beliefs that view knowledge as handed down by authority	More sophisticated beliefs that view knowledge as generated from self-reflection and reason
IA	Naive beliefs that view learning ability as fixed at birth	More sophisticated beliefs that view the capacity for learning as an entity that can be developed by hard work
QL	Naive beliefs that view learning as something that occurs swiftly or not at all	More sophisticated beliefs that view learning as a gradual process which may require concentrated effort

Note: Sophistication of the epistemological beliefs of the participants were measured by Bendixen et al.'s (1998) EBI, which is a 5-point Likert type scale ranging from "strongly disagree" (1) to "strongly agree" (5). High score of an individual refers to having mean score near 5; low scores of an individual refers to having mean score near 1.

Abbreviations: CK, certain knowledge; EBI, epistemological beliefs inventory; IA, innate ability; OA, omniscient authority; QL, quick learning; SK, simple knowledge.

reasoning. Lee et al. (2013), for example, have shown how PSTs became more sensitive to moral and ethical considerations, and expressed increased compassion during a SSI intervention, thereby promoting features of character and values congruent with conceptions about global citizenship. Thus, how individuals perceive and interpret information about environmental moral issues plays a vital role in individuals' reasoning about those issues and accompanying problems, as well as the analysis and construction of their related solutions (Simonneaux & Simonneaux, 2009). Studies have also revealed the influence of values on environmental moral norms (i.e., feelings of obligation to act more pro-environmentally) and moral analysis of environmental issues (Dietz et al., 2005), which suggests how values inform environmental ethics (Kronlid & Öhman, 2013; York & Becker, 2012), and provides a reasonable rationale for expecting value-environmental moral reasoning relationships.

Many researchers, including the researchers of the present study, utilize Schwartz's (1992, 1994) value theory to study value orientations of their participants since this theory is regarded as the most comprehensive and useful theoretical framework that is derived from data obtained from numerous countries and cultures (Corraliza & Berenguer, 2000; De Groot & Steg, 2007). In this work, values and the order of their importance are conceptualized as guiding principles of our lives (Schwartz, 1992, 1994; Schwartz & Bardi, 2001; Schwartz & Sagiv, 1995). According to Schwartz value theory, 10 value types (i.e., power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity, and security) are conceptualized in a way that they form a continuum having a circular shape (Figure 1; Struch et al., 2002, p. 19). In this circular shape, values sharing similar underlying motivational goals (e.g., universalism and benevolence) are closer in proximity to each other. On the other hand, values with competing motivational goals (e.g., universalism and power) form oppositional "slices" of the circle.
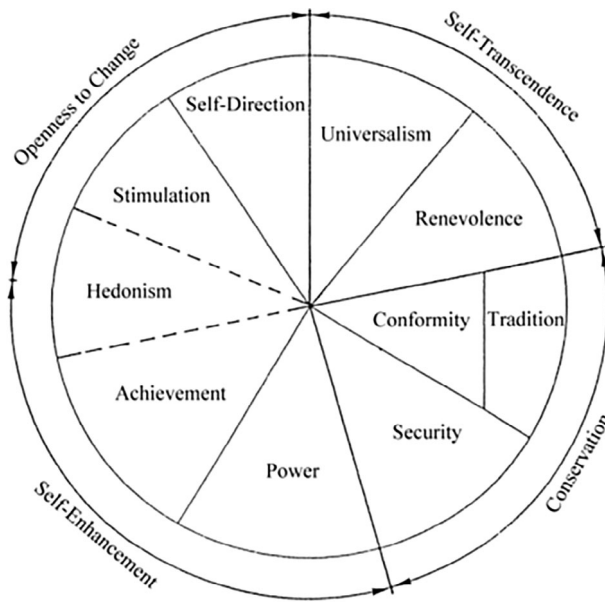
FIGURE 1 Relations among motivational types of the values and value categories proposed in Schwartz value theory.

The value categories identified by Schwartz value theory can be imagined along two dimensions each having two poles. One of the dimensions includes openness to change versus tradition (conservation) value categories and the other dimension includes self-transcendence versus self-enhancement value categories. Explanations of the four value categories identified in Schwartz's (1992, 1994) value theory as potential value variables of the path analyses are categorized in Table 2.

Together with research revealing the role of values on individuals' moral reasoning (Zeidler, 2014), relationships found between values and egocentrism, anthropocentrism, and ecocentrism/biocentrism scales (e.g., Herman et al., 2020; Schultz et al., 2005; Schultz & Zelezny, 1999) imply that values can be regarded among the most important factors that are related to individuals' moral reasoning about environmental issues. Therefore, similar to epistemological beliefs, values held by the participant PSTs were entered to the path equations of the present study as predictors of the variances in their environmental moral reasoning patterns.

Based on findings of previous research, some hypotheses were made about value-environmental moral reasoning relationships. For instance, values identified in universalism (example value items: a world of beauty, unity with nature, equality) and benevolence (example value items: helpful, loyal, responsible) value types and corresponding value category (i.e., self-transcendence) were hypothesized to be positively related to the PSTs' levels of moral considerations for all human beings (anthropocentric moral reasoning) and all nonhuman species and the biosphere (ecocentric moral reasoning). It would also be likely that these values, value types or the value category would be negatively related to environmental moral reasoning that focused on more self-centered (egocentric) considerations (Nordlund & Garvill, 2002; Thompson & Barton, 1994). In the literature, there is not enough evidence with regard to how environmental moral reasoning patterns may be related to values that fall into Schwartz's (1992, 1994) openness to change and tradition value categories. More specifically, existing literature

TABLE 2   Potential value variables of the path analyses.

Variable name	Definition of the variable	Meaning of high score	Meaning of low score
OC	Schwartz value category that reflects the extent to which individuals are motivated by the value types of self-direction, stimulation, and hedonism as guiding principles in their lives	Importance given to independence and readiness for new experiences	Giving less importance to values such as pleasure, freedom, and creativity
T	Schwartz value category that reflects the extent to which individuals are motivated by the value types of conformity, tradition, and security as guiding principles in their lives	Importance given to social expectations, norms, and preserving status quo.	Giving less importance to values such as honoring parents and elders, being humble, and family security.
SE	Schwartz value category that reflects the extent to which individuals are motivated by the value types of power and achievement	Importance given to personal interests as well as social superiority and esteem	Giving less importance to values such as having social authority, power, and wealth
ST	Schwartz value category that reflects the extent to which individuals are motivated by the value types of benevolence and universalism	Importance given to the welfare of others as well as justice and equity for all	Giving less importance to values such as being helpful and protecting the environment

Note: Value orientations of the participants were measured by the Schwartz Value Survey (Schultz & Zelezny, 1998, 1999), which is a 9-point Likert type scale ranging from "opposed to my values" (−1) to "of supreme importance" (7). High score of an individual refers to having mean score near 7; low scores of an individual refers to having mean score near −1.
Abbreviations: OC, openness to change; SE, self-enhancement; ST, self-transcendence; T, tradition.

does not provide enough empirical evidence to make hypotheses about the significance and direction of the relationships between individuals' environmental moral reasoning patterns and self-direction, stimulation, and hedonism values that align with openness to change value categories. Similarly, the nature of the relationships between environmental moral reasoning patterns and tradition, conformity, and security values, which reflect Schwartz's (1992, 1994) Tradition value category cannot be predicted based on the findings of previous research. Therefore, findings of the present study and their implications have the potential to impactfully contribute to the extant literature within and external to science education.

1.5 | Proposed path model

Investigation of the interrelationships of epistemological beliefs and values to environmental moral reasoning patterns in an explicit, holistic, and generalizable manner remains an open empirical pursuit. Findings of the path analyses tested throughout the present study can likely contribute to the gaps identified above in the existing literature. In addition to their hypothesized roles in explaining variances of PSTs' environmental moral reasoning patterns,

epistemological beliefs and values were selected as study variables because of their own importance for science teacher education. Conceptualizations of teaching and learning (Tezci et al., 2016), preferences for and applications of teaching practices (Chai et al., 2009), and richness of the repertoire of teaching strategies used for inducing conceptual change in students (Hashweh, 1996) are key variables linked to epistemological beliefs of (preservice) teachers. Collectively, these show the importance of epistemological beliefs for teaching in general and for science teaching in particular.

Similar to epistemological beliefs, values have a vital place in education owing to their roles in educational policy and practice. That is, values of curriculum developers are proposed to be influential on the content and educational goals emphasized in curricula, standards (e.g., the Next Generation Science Standards; NGSS Lead States, 2013), and their supporting documents (Hoeg & Bencze, 2017). Likewise, teachers' value orientations have been found to play significant roles in their educational decisions and preferences such as priority given to students' needs and interests, emphasis put on specific teaching goals, and degree of encouragement provided for students to actively engage in the learning processes (Gillespie, 2011). Furthermore, values, as reflections of character and virtue, are accepted as integral components of science education and scientific literacy, which guide individuals for making responsible decisions and taking appropriate actions on various issues (Choi et al., 2011; Lee et al., 2012; Zeidler, 2014; Zeidler et al., 2005).

Detailed information about the operational definitions of the study constructs are presented in the following sections. At this point, it should be noted that although related theories and models are utilized to operationalize environmental moral reasoning, epistemological beliefs, and values, variables of the path model were not predetermined. Instead, exploratory and confirmatory factor analyses were used to determine the factor structures of the study constructs, thus identifying variables of the path model.

2 | RESEARCH DESIGN AND METHODS

2.1 | Population and sample

The accessible population of the study was determined to be PSTs enrolled in public universities located in Central Anatolia region of Türkiye. In Türkiye, one needs to graduate from the "Science Teacher Education" program in order to teach science in middle schools (for grades 5 to 8). Of the 27 public universities in Central Anatolia, 13 of them had science teacher education programs (Council of Higher Education, n.d.). By using cluster random sampling, out of these 13 universities, six of them were selected. Data were collected from 1524 PSTs (N_{male} = 255, N_{female} = 1248, $N_{gender\ not\ identified}$ = 21) enrolled in freshman through senior years of the six universities. This sample size constituted 56% of the accessible population. Demographic characteristics of the sample are tabulated in online Table S1.

2.2 | Instrumentation

2.2.1 | Epistemic beliefs inventory

Epistemic beliefs inventory (EBI) (Bendixen et al., 1998, provided as online Supplementary Material) that utilized Schommer's (1990, 1994) epistemological beliefs model was used. It

measures individuals' beliefs regarding structure, certainty, and source of knowledge in addition to control and speed of knowledge acquisition/learning using a 32-item 5-point Likert type scale ranging from "strongly disagree" (1) to "strongly agree" (5). While lower scores obtained from the scale indicate more sophisticated epistemological beliefs, higher scores are indicators of naïve epistemological beliefs (see Table 1).

Although the EBI was previously translated into Turkish (Önen, 2007, 2009), it was subjected to a new translation and adaptation process in this study because there were some problems regarding semantic and/or conceptual meanings of the words/statements used in the items of the previously translated version. Language translation of the instrument was done by the researchers, then professional input was utilized from an English language expert who checked appropriateness of the language (e.g., grammar, sentence structure, presence of any types of ambiguity, etc.). An adaptation process (exploratory factor analysis [EFA]) was carried out by the researchers to improve the validity of the instrument. For this purpose, the instrument was pilot tested using 218 PSTs. The results of the EFA conducted on the pilot data (see online Table S2 for details) and the PSTs' written feedback on the instrument and oral feedback taken through short (5–10 min) informal interviews conducted after the data collection sessions were utilized for the instrument's adaptation. The adapted version of the instrument was then administered to the participants of the main study ($N = 1524$). Collected data were first subjected to EFA. Kaiser-Meyer-Oklin (0.81) and the Barlett's (1954) test of sphericity ($p = 0.00$) values showed that the data were suitable for EFA. Varimax rotation resulted in five factors with eigenvalues greater than one. These five factors explained 42.81% of the sample variation. Except for one item, which is not included in the subsequent data analyses, all items positively loaded on their factors with a minimum factor loading of 0.40. The item that was removed from the instrument ("People can't do too much about how smart they are") loaded on its factor with a factor loading of 0.35 and reflected Schommer's (1990, 1994) epistemological belief dimension of IA. Remaining items were grouped into five interpretable factors comprising QL, SK, IA, OA, and CK epistemological belief dimensions.

Replicability of the obtained factor structure across different samples of the population was checked through cross-validation, dividing the sample into two random subsamples. Confirmatory Factor Analyses (CFA) were conducted on the data of each subsample. Comparison of the demographic characteristics of the participants in these two subsamples showed that both were equivalent in terms of university enrolled, grade level, gender, and mean age. All of the indices obtained from the two CFA indicated that the data showed good model fit for both of the subsamples (see online Table S3). This finding provided supporting evidence for the construct validity of the adapted EBI and its five-factor structure.

Some of the subscales of the adapted EBI had very few items (e.g., OA subscale had only two items). Therefore, in addition to Cronbach's α, mean inter-item correlation value was used for interpreting reliability of EBI since mean inter-item correlation value is not affected by the number of items in instruments and is suggested as a measure of reliability for shorter scales (Briggs & Cheek, 1986; Pallant, 2007). The mean inter-item values calculated for the adapted EBI subscales were in the suggested range of 0.2 to 0.4 (Briggs & Cheek, 1986) indicating reliability of the instrument (see online Table S4).

2.2.2 | Value survey

The Schwartz value survey developed by Schultz and Zelezny (1998, 1999) was used for examining Turkish PSTs' value orientations. Value items of the survey were translated to Turkish by

Kusdil and Kagitcibasi (2000). The survey included 37-items and respondents were asked to rate the importance of the value items (e.g., social justice, creativity, pleasure, etc.) as "a guiding principle" in their lives. The design of the survey is based on a 9-point Likert type scale ranging from "opposed to my values" (-1) to "of supreme importance" (7) (see Table 2).

In the present study, Schwartz's (1992, 1994) four-value category (i.e., self-transcendence, self-enhancement, openness to change, tradition) and 10-value type (i.e., universalism, benevolence, power, achievement, self-direction, stimulation, hedonism, tradition, conformity, security) classifications were tested with CFA. Due to very strong associations among some of the value categories (i.e., self-transcendence and tradition) and value types (i.e., benevolence-tradition, tradition-conformity, and benevolence-conformity), CFA resulted in non-positive definite covariance matrix (i.e., collinearity). Therefore, an exploratory approach was adapted for examining factor structure of the value survey. Both Kaiser-Meyer-Oklin (0.93) and the Barlett's test of sphericity ($p = 0.00$) values confirmed factorability of the data via EFA. Items that loaded on more than one factor were removed from the instrument leaving a three-factor solution with the remaining 21 items (Factor 1: ST&T; Factor 2: OC; Factor 3: SE) explaining 39.24% of the sample variation. All items loaded on their factors with a minimum factor loading of 0.40. Since the correlation between the first and third factor was 0.30, the assumption of independent factors was not fully met; hence, results of direct oblimin rotation technique was used. Next, three-factor structure was cross-validated through CFA. Two different subsamples had acceptable model fit indices for subsamples A and B (see online Table S3).

Obtained model fit indices were regarded sufficient as indicators of the validity of the instrument used in the present study. Cronbach's α and mean inter-item correlation values used as measures of reliability were in the suggested ranges range of 0.2–0.4 (Briggs & Cheek, 1986) for all of the three subscales of the adapted value survey (see online Table S5).

2.2.3 | Environmental moral dilemma scenarios

PSTs' environmental moral reasoning was examined by means of four scenarios which were adapted from Persing's (2006) study. The scenarios depicted moral dilemmas taking place in four different outdoor recreation contexts (i.e., hiking, picnicking, fishing, and camping), and were mainly about performing specific acts that are potentially harmful to the environment (e.g., leaving garbage after picnicking, washing dishes in a lake). As suggested by Kortenkamp and Moore (2009), selection of the scenarios was mainly based on the likelihood of the respondents' familiarity with the dilemma contexts.

For each scenario, respondents were presented with nine statements and were asked to indicate to what extent each statement would be important for them in order not to perform the environmentally damaging action described in the scenario. Responses to the item statements were based on a 5-point Likert type scale that ranged from "not at all important" (1) to "very important" (5).

Translation and adaptation of the instrument was realized by two English-Turkish language experts and the researchers of this study. The same translation and adaptation procedure applied for EBI was used for the scenarios. In order to be more reflective of Turkish culture, the moral dilemma context of camping scenario was revised from washing leakage of a freezer pack to that of washing dishes with detergent in a lake. In this way, the main issues that were expected to evoke moral considerations in its respondents remained the same, but the context of the scenario better reflected Turkish culture. Data collected from the pilot study ($N = 218$)

and oral and written feedback obtained at the data collection sites were used to improve clarity and validity of the dilemma scenarios and statements following each scenario.

The instrument was administered to 1524 PSTs in the main study. Next, PSTs' responses to the environmental moral reasoning item statements were factor analyzed separately for the four environmental moral dilemma scenarios. Findings of EFA suggested two-factor solutions for the data of each scenario. Model fit indices obtained from CFA supported the obtained two-factor solutions (online Table S6). The factors obtained from the factor analysis of environmental moral reasoning data constituted the environmental moral reasoning variables which were then used in the path analyses. Information for the variables of environmental moral reasoning are tabulated in Table 3.

Information about the factors including item statements that loaded on the factors of the four environmental moral dilemma scenarios are tabulated in Table 4. In the table, ordering of

TABLE 3 Environmental moral reasoning variables of the path analyses.

Variable name	Meaning of high score	Meaning of low score
Utility of nature	Higher tendency for nature-centered moral considerations (i.e., desire for living in harmony with nature, rights of living creatures, intrinsic value of nature) evaluated together with human-centered aesthetical concerns and justice issues	Lower tendency for giving moral standing to nature in relation to its utility (as an agent of aesthetical pleasure) to humans
Threats to human-welfare	Higher levels of human-centered moral considerations that focus on losing benefits derived from the natural area explained in the scenario and potential harms that may result from damaging it	Lower levels of moral concerns about welfare issues regarding the self and other people
Ecojustice	Higher levels of nature-centered moral considerations (i.e., desire for living in harmony with nature, rights of living creatures, intrinsic value of nature) evaluated together with moral principles of rights and responsibilities	Lower levels of nature-centered moral concerns, which are positioned in a larger framework of justice issues
Humans	Higher levels of human-centered welfare considerations and aesthetical concerns (i.e., continuity of the aesthetical pleasure derived from the natural area explained in the scenario) for the self and other people	Lower levels of moral concerns centered on the self and other people[a]
Nature	Higher tendency for nature-centered moral considerations that focus on the rights of nature, its intrinsic value, and the necessity of living in balance/harmony with the environment	Lower tendency for giving a moral standing to nature regardless of its utility to humans

Note: Environmental moral reasoning of the participants was measured by their responses to item statements given for the four environmental moral dilemma scenarios (i.e., hiking, picnicking, fishing, camping) on a 5-point Likert type scale ranging from "not at all important" (1) to "very important" (5). High score of an individual refers to having mean score near 5; low scores of an individual refers to having mean score near 1.

[a]For the fishing scenario, participants' moral considerations that focused on human-centered justice issues loaded on the environmental moral reasoning variable of *ecojustice*.

the item statements under the corresponding factors are based on the magnitude of their factor loadings in EFA of the main study data, in the descending order. For instance, for the hiking scenario, item statement coded as "ecocentric-harmony" (EC-H in Table 4) loaded on its factor (factor 1: utility of nature) with a higher value of factor loading (0.83) than the item statement coded as "ecocentric- intrinsic value" (EC-IV in Table 4; factor loading = 0.78) and the following others. Item statement that had the lowest value of factor loading (0.43) on that factor was the one coded as "egocentric-aesthetic" (EG-A in Table 4).

2.3 | Data collection and analyses

SPSS was used for the preliminary analyses, descriptive analyses, and EFA while AMOS was used for CFAs and path analyses.

In line with the analytical framework used for examining environmental moral reasoning patterns of PSTs, not only were the centers of moral concerns (i.e., self, other people, nature/ecosystem/biosphere) used for coding PSTs' responses, we also examined their underlying reasons of the moral considerations (i.e., belief in the intrinsic value of nature, desire for living in

TABLE 4 Factor information for the environmental moral reasoning data.

		Scenario			
		Hiking	Picnicking	Fishing	Camping
Factor 1	Name of the factor	Utility of nature	Utility of nature	Ecojustice	Humans
	Item statements loaded	EC-H	EC-IV	EC-H	EG-PI
		EC-IV	EC-H	EC-IV	EG-A
		EC-J	EC-J	EC-J	AN-A
		EG-J	AN-J	AN-J	AN-J
		AN-A	EG-J	EG-J	EG-J
		AN-J	AN-A		AN-W
		EG-A	EG-A		
	Cronbach's α	0.83	0.85	0.78	0.85
	Mean inter-item correlation	0.42	0.46	0.42	0.48
Factor 2	Name of the factor	Threats to human welfare	Threats to human welfare	Humans	Nature
	Item statements loaded	AN-W	AN-W	EG-PI	EC-J
		EG-PI	EG-PI	AN-W	EC-IV
				AN-A	EC-H
				EG-A	
	Cronbach's α	0.44	0.39	0.76	0.76
	Mean inter-item correlation	0.29	0.25	0.44	0.52

Abbreviations: A, aesthetic; AN, anthropocentric; EC, ecocentric; EG, egocentric; H, harmony; IV, intrinsic value; J, justice; PI, personal interest; W, welfare.

harmony with it, personal interest, and issues of welfare, aesthetic, and justice) given in the environmental moral reasoning item statements as well. For instance, item statements referring to moral considerations related to the welfare of other people were coded as "AN-W" environmental moral reasoning because their center of moral concern are focused mainly on the issue of welfare of other people. Similarly, item statements which were coded as "EC-H" reflected moral concerns for the nature/ecosystem/biosphere and desires for living in harmony with it. This coding formed the base of the subsequent analyses of data obtained from environmental moral dilemma scenarios.

Path analyses were used for investigating relationships of PSTs′ epistemological beliefs and values to their environmental moral reasoning exhibited for the four environmental moral dilemma scenarios (i.e., hiking, picnicking, fishing, and camping). Schumacker and Lomax's (2010) approach was used for applying steps of path analysis. For model specification, AMOS graphics was used as the mode of model input. Owing to its advantages over other estimation methods (Byrne, 2010; Gallagher et al., 2008), maximum likelihood was used for model estimation.

Our selection of path analysis was based on its power of applying several multiple regression analyses with multiple endogenous and exogenous variables (Kline, 2011). In the study, a separate path analysis was conducted for each environmental moral dilemma scenario. Therefore, since multiple comparisons were not applied on the same data set, Bonferroni or other alternative corrections were not used (Green & Salkind, 2005; Hair et al., 2010; Tabachnick & Fidell, 2007). Mean values calculated for the dimensions/categories (factors obtained through factor analyses) of environmental moral reasoning, epistemological beliefs, and values, were used as the variables in the path equations. In line with the purpose of the study, environmental
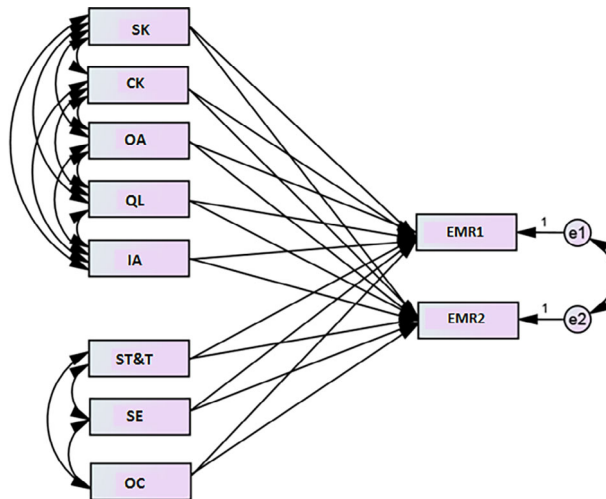
FIGURE 2 Representation of the path models analyzed for the four environmental moral dilemma scenarios (i.e., hiking, picnicking, fishing, camping). QL, quick learning; SK, simple knowledge; IA, innate ability; OA, omniscient authority; CK, certain knowledge; ST&T, self-transcendence and tradition; OC, openness to change; SE, self-enhancement. *Environmental moral reasoning 1 (EMR1): utility of nature for the hiking and picnicking scenarios; ecojustice for the fishing scenario; humans for the camping scenario. **Environmental moral reasoning 2 (EMR2): threats to human welfare for the hiking and picnicking scenarios; humans for the fishing scenario, nature for the camping scenario.

moral reasoning categories were entered into the analyses as endogenous (dependent) variables, while variables of epistemological beliefs and values were used as exogenous (independent) variables. Since factor analyses of environmental moral reasoning data resulted in two-factor solutions for each scenario (see Table 3 for details of the factor solutions), two endogenous variables were specified in each path equation. These variables are represented as environmental moral reasoning-1 (EMR1) and environmental moral reasoning-2 (EMR2) in Figure 2.

As typically done, a step-by-step procedure was followed for model specification. In the first steps, covariances were added between all pairs of exogenous variables (Kline, 2011). Modification index and expected parameter change values obtained from the tests of the path models indicated that allowing free estimation of the error covariances between endogenous variables (i.e., foci/categories of environmental moral reasoning) would substantially improve the model fits for all of the moral dilemma scenarios (i.e., hiking, picnicking, fishing, camping). Expecting relationships between environmental moral reasoning dimensions, especially when exhibited for the same moral dilemma scenario, was also theoretically plausible (Kortenkamp & Moore, 2009). Therefore, based on empirical and theoretical support, errors of the endogenous variables of the path models were allowed to covary freely (Byrne, 2010). Nevertheless, freeing these parameters (i.e., error covariances between the endogenous variables) resulted in just-identified models which were untestable as they had zero degrees of freedom (Byrne, 2010; Kline, 2011). Accordingly, covariances between epistemological belief-value pairs were removed from the path models. Figure 2 illustrates the resulting path models that were analyzed.

3 | FINDINGS

In this section, descriptive information about PSTs′ epistemological beliefs, values, and environmental moral reasoning is provided first to give an overall picture about the participants. Then, results of path analyses are presented to address the research questions of the study.

3.1 | Descriptive analyses

3.1.1 | Epistemological beliefs

Descriptive analyses of PSTs′ responses to EBI showed that their epistemological beliefs in OA ($M_{OA} = 3.79$, $SD_{OA} = 0.83$) were the most naïve when compared to the other epistemological belief dimensions (note that highest score indicates the most naïve epistemological beliefs). PSTs′ epistemological beliefs in SK ($M_{SK} = 3.26$, $SD_{SK} = 0.64$) and IA ($M_{IA} = 3.26$, $SD_{IA} = 0.71$) were comparatively more sophisticated. Descriptive findings for CK ($M_{CK} = 2.31$, $SD_{CK} = 0.71$) and QL ($M_{QL} = 2.04$, $SD_{QL} = 0.62$) suggested sophistication of PSTs′ beliefs in these two epistemological belief dimensions.

3.1.2 | Values

Descriptive analyses of PSTs′ scores in the three value categories of the value survey indicated relative importance of each value category for PSTs as guiding principles of their lives. Results showed that participants of the study gave the highest importance to ST&T value category

($M_{\text{ST\&T}} = 5.93$, $SD_{\text{ST\&T}} = 0.89$). Importance of OC value category for the PSTs was in between "important" (3) to "very important" (6) ($M_{\text{OC}} = 4.93$, $SD_{\text{OC}} = 1.18$). PSTs was found to give the least importance to SE value category ($M_{\text{SE}} = 4.06$, $SD_{\text{SE}} = 1.35$).

3.1.3 | Environmental moral reasoning

Results of the factor analyses suggested two environmental moral reasoning categories for each environmental moral dilemma scenario. Interestingly, one of these categories was anthropocentric oriented reasoning and the other one was ecocentric oriented reasoning for each scenario (see Tables 3 and 4). Descriptive analyses showed that mean values for ecocentric oriented moral reasoning categories were higher than mean values for anthropocentric moral reasoning categories (see Table 5).

3.2 | Path analyses

Examination of the model fit indices obtained from the path analyses (online Table S7) revealed that all of the fit indices, except for normed chi-square fit index (χ^2/df), χ^2 statistics and its significance test were within the suggested ranges. For large samples, such as the one in the present study, model-fit indices that utilize χ^2 statistics may not be dependable for evaluating goodness of the structural equation models (Byrne, 2010; Kline, 2011; Schumacker & Lomax, 2010). Therefore, values of Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), Root Mean Square Residual (RMR), and Standardized Root Mean Square Residual (SRMR) were found to be sufficient to decide on the goodness of fit of the path models to the related data.

Proportions of the explained variances of the endogenous variables (i.e., environmental moral reasoning categories) as denoted as SMC (R^2) values in AMOS output ranged from 0.04 to 0.21. These values correspond to a small to medium effect size (practical significance) in Cohen's (1988) standards (online Table S8).

Comparison of the absolute values of the standardized beta weights (online Figure S1, Figure S2, Figure S3, Figure S4) showed relative strength of the relationships between each

TABLE 5 Descriptive statistics for environmental moral reasoning categories.

Scenario	Environmental moral reasoning category	M	SD	Min.	Max.
Hiking	Utility of nature	4.27	0.56	1.57	5.00
	Threats to human-welfare	3.23	0.89	1.00	5.00
Picnicking	Utility of nature	4.40	0.51	1.86	5.00
	Threats to human-welfare	3.57	0.83	1.00	5.00
Fishing	Ecojustice	4.24	0.57	2.00	5.00
	Humans	3.66	0.80	1.00	5.00
Camping	Nature	4.40	0.57	1.67	5.00
	Humans	4.26	0.61	1.67	5.00

exogenous (epistemological belief dimension, value category) and endogenous (environmental moral reasoning category) variable. QL, OA, and ST&T variables made higher amounts of unique contribution to the prediction of PSTs′ environmental moral reasoning patterns.

There were some consistent patterns regarding relationships of epistemological beliefs and values to environmental moral reasoning. PSTs′ epistemological belief scores in OA was found to be positively related to their environmental moral reasoning regardless of the moral dilemma scenario context and focus of environmental moral reasoning exhibited for the scenarios. That is, the PSTs who tended to believe in the legitimacy of authority and view authority as a source of knowledge (see online Table S4 for items that loaded on OA epistemological belief dimension) exhibited higher levels of environmental moral considerations about the environmental moral dilemma scenarios. The same consistent (positively significant) relationships were observed between PSTs′ ST&T values and all of the environmental moral reasoning categories. The PSTs who tended to favor the preservation of the status quo and gave more importance to the welfare of others and trancendence of self-interests (see online Table S5 for value items that loaded on ST&T) were found to have higher levels of environmental moral considerations. PSTs′ beliefs in SK was not found to have statistically significant relationships with any of the environmental moral reasoning categories. In other words, PSTs′ epistemological beliefs about the structure of knowledge was not found to be related to the moral considerations they exhibited for the environmental moral dilemma scenarios.

Besides these consistent patterns, results of path analyses suggest that statistical significance of the hypothesized relationships are connected to moral dilemma scenario context and focus of environmental moral reasoning. For instance, epistemological beliefs in CK did not have any statistically significant relationship with environmental moral reasoning categories obtained for the hiking, picnicking, and fishing scenarios. The path coefficient between this variable (CK) and environmental moral reasoning category of *nature* was statistically significant for the camping scenario but insignificant for the environmental moral reasoning category of *humans* for the same scenario. Similarly, none of the path coefficients between epistemological beliefs in IA and environmental moral reasoning categories obtained for the picnicking and camping scenarios could reach statistical significance. On the other hand, relationships between IA and both of the two environmental moral reasoning categories obtained for the hiking scenario (i.e., *utility of nature*, *threats to human welfare*) and one of the environmental moral reasoning categories obtained for the fishing scenario (i.e., *humans*) were statistically significant.

Path coefficients between categories of environmental moral reasoning and values also provided supporting evidence for the importance of moral dilemma scenario context and focus of environmental moral reasoning for the significance of hypothesized relationships. That is to say, while OC and SE values had statistically significant path coefficients for some of the scenarios, their path coefficients were statistically insignificant for the others. Moreover, significance of the relationships changed depending on the endogenous variables (environmental moral reasoning categories) of the path models. For instance, for the picnicking scenario, path coefficients between environmental moral reasoning category of *utility of nature* and OC and SE values were statistically insignificant. On the other hand, for the same scenario, path coefficients of these two value categories (i.e., OC, SE) reached statistical significance when hypothesized relationships were analyzed for the environmental moral reasoning category of *threats to human welfare*.

Results of path analyses indicate that both the moral dilemma scenario context and the focus of environmental moral reasoning are important for not only the significance but also the direction of the relationships proposed in the path models. Path coefficients calculated for the epistemological belief dimension of QL exemplify this. For the hiking, picnicking, and fishing

Scenario	Epistemological Beliefs	Values

Hiking	• Significant for QL, IA (-), OA (+)
	• Direction changed for QL
	  ➤ (-) for "utility of nature", (+) for "threats to human welfare"
		• Significant for ST_T (+)
		• Significance changed for OC
		  ➤ signf. for "utility of nature", insignf. for "threats to human welfare"

Picnicking	• Significant for QL, OA (+)
	• Direction changed for QL
	  ➤ (-) for "utility of nature", (+) for "threats to human welfare"
		• Significant for ST_T (+)
		• Significance changed for OC, SE
		  ➤ insignf. for "utility of nature", signf. for "threats to human welfare"

Fishing	• Significant for QL, OA (+)
	• Direction changed for QL
	  ➤ (-) for "ecojustice", + for "humans"
	• Significance changed for IA
	  ➤ insignf. for "ecojustice", signf. for "humans"
		• Significant for ST_T (+)
		• Significance changed for SE
		  ➤ insignf. for "ecojustice", signf. for "humans"

Camping	• Significant for QL (-), OA (+) • Significance changed for CK ➤ insignf. for "humans", signf. for "nature"	• Significant for ST_T (+)

FIGURE 3 Summary of the relationships tested through the path analyses. QL, quick learning, IA, innate ability, OA, omniscient authority, CK, certain knowledge; ST&T, self-transcendence and tradition, OC, openness to change, SE, self-enhancement; (+), positive relationship, (−), negative relationship; signf., significant, insignf., insignificant.

scenarios, naïve beliefs in QL (demonstrated by higher scores in QL variable) had significantly negative relationships with environmental moral reasoning categories that included ecocentric (nature-centered) items. However, for the same scenarios, relationships between QL and environmental moral considerations that were more focused on egocentric (self-centered) and anthropocentric (human-centered) considerations were significantly positive. For the camping scenario, QL had significantly negative relationships with both of the environmental moral reasoning categories of *humans* and *nature*. Significance and direction of the relationships tested through path analyses are summarized in Figure 3.

4 | DISCUSSION

In this section, findings regarding the dimensions of the study variables are discussed first. Then, findings obtained from the analyses of the proposed path model are discussed by providing commonalities in preservice teachers' environmental moral reasoning and the relationships of epistemological beliefs and values to environmental moral reasoning, respectively. In order to help readers follow the section more easily, main findings of the study are represented in Figure 4.

4.1 | Dimensions of epistemological beliefs, values, and environmental moral reasoning

Five dimensions of epistemological beliefs as found in this study were in line with Schommer's (1990, 1994) epistemological beliefs model and provided empirical evidence for the
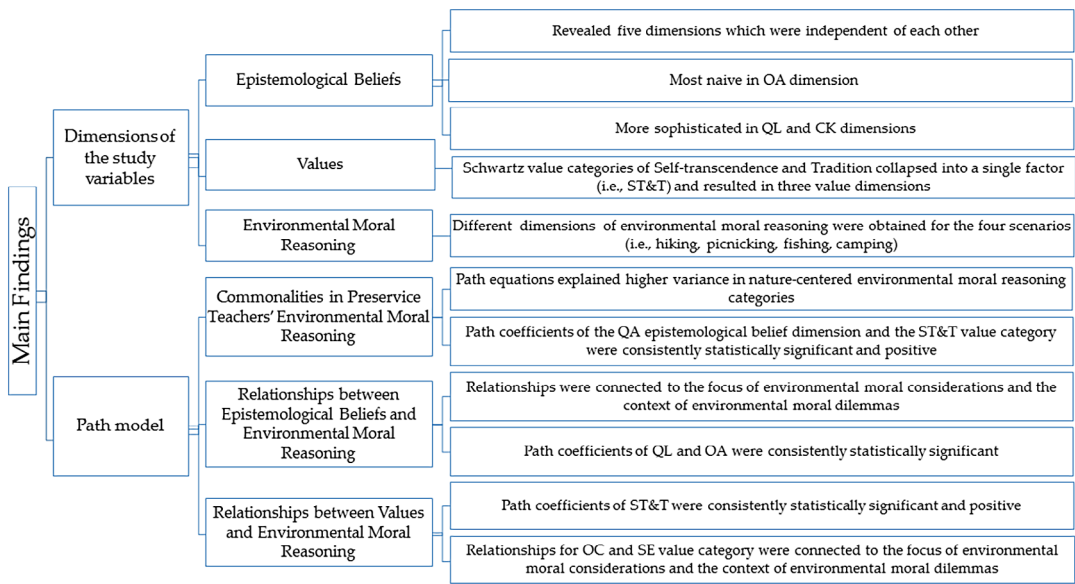
FIGURE 4 Main findings of the study. SK, simple knowledge; CK, certain knowledge; OA, omniscient authority; QL, quick learning; IA, innate ability; ST&T, self-transcendence and tradition; SE, self-enhancement; OC, openness to change.

multifaceted nature of epistemological beliefs (e.g., Bendixen et al., 1998; Schraw et al., 2002). Low correlation coefficients between the pairs of epistemological belief dimensions (all of the correlation coefficients were below 0.20 except for QL-CK relationship ($r_{QL-CK} = 0.46$)) were consistent with Schommer's contention that dimensions of epistemological beliefs are more or less independent of each other.

The findings for epistemological beliefs have implications concerning the propensity for a cultural basis related to epistemological reasoning (Hofer, 2008). In this study, the PSTs had the lowest level of sophistication for OA epistemological belief dimension. It is interesting to note that the Eastern culture of Türkiye tends to favor respect and obedience to authority (Raney & Çinarbas, 2005), which may be one of the reasons for this result. The educational system of Türkiye subsumes traces of this dominant culture with regard to the perceptions about and attitudes toward authority in educational settings, providing a further explanation for this observed result (Topçu & Yılmaz Tüzün, 2009; Yilmaz-Tuzun & Topcu, 2008; Youn, 2000). Hence, many of the PSTs who participated in the study were likely exposed to teacher-centered instructional strategies more often than student-centered teaching practices in their past educational experiences, at least before their university education (Yilmaz-Tuzun & Topcu, 2008). Therefore, the educational experiences of the PSTs in our study, when combined with their cultural tendency to perceive authority as something that is omniscient, may have led them to have naive beliefs regarding the OA epistemological belief dimension.

In the present study, PSTs' epistemological beliefs regarding the speed of learning (i.e., QL) and certainty of knowledge (i.e., CK) were found to be more sophisticated when compared to other epistemological belief dimensions. Sophistication of Turkish preservice teachers' epistemological beliefs about the speed of learning seems to be a common finding among previous studies and may be an indirect influence of the country's education system (e.g., Saylan Kirmizigul & Bektas, 2019; Topçu, 2011). Students in Türkiye constantly hear that the path for

learning and success is not easy, nor does it happens quickly, but requires continuous effort and hard work (Tanriverdi, 2012; Tezci et al., 2016). An alternative explanation, however, may suggest that the larger proportion of females in our sample may have influenced our results since findings of previous research suggest that females are generally more inclined to believe that learning is a gradually developing process, which implies more sophisticated beliefs in the QL epistemological belief dimension (Schommer, 1993; Topçu & Yılmaz Tüzün, 2009).

Earlier studies revealed inconsistent findings with regard to Turkish PSTs′ epistemological beliefs about the structure of knowledge (i.e., SK) (Ozturk & Yilmaz-Tuzun, 2017; Yilmaz-Tüzün & Topçu, 2013) and ability of learning (i.e., IA) (Saylan Kirmizigul & Bektas, 2019; Yilmaz-Tuzun & Topcu, 2008). These inconsistencies can be explained by the selected instruments. It is reasonable that some meaning loss can be seen as potential drawbacks of these instruments. Thus, replication of similar studies would be helpful in supporting the validity of these translated epistemological belief instruments in Türkiye.

Regarding values, the results of factor analyses revealed that values which belong to self-transcendence and tradition (conservation) value categories in Schwartz (1992, 1994) value theory collapsed into a single factor (i.e., *ST&T*). The remaining two value dimensions were representative of the value items that are identified in OC and SE value categories in Schwartz's value theory. The nature of structural relationships among the value types in Schwartz's value theory (see Figure 1) justifies this three-factor solution. Previous research suggests that values which share similar motivational goals may combine and form fewer numbers of value dimensions than the 10 value types or the four value categories grouped by Schwartz (Davidov et al., 2008; Schwartz & Rubel, 2005). Combining self-transcendence (ST) and tradition (T) value categories in a single value dimension (i.e., ST&T) in the present study seems to exemplify this situation, with PSTs construing values belonging to self-transcendence and tradition value categories as being very similar to each other in terms of the motivational goals they express. Considering the disproportional gender distribution of the sample (i.e., 81.9% female, 16.7% male), the combination of self-transcendence and tradition values may be attributed to the influence of gender having an interaction effect on cultural values as well. When social roles attributed to females in traditional Turkish society, including family roles as mothers and housewives who are expected to be more understanding, devoted to the wellbeing of their family members, humble, respectful to traditions, and so forth (Gümüş & Dönmez, 2009; Parlaktuna, 2010) are considered, the contribution of gender and culture interaction on the study findings becomes more plausible.

Regarding the four environmental moral reasoning scenarios contextualized in this study, PSTs′ responses to the environmental moral reasoning items clustered into different factor structures (see Table 3). For example, contrary to the hiking, picnicking, and fishing scenarios, for the camping scenario, PSTs′ moral concerns about nature itself (ecocentric moral reasoning) were completely distinct from their human-centered moral considerations (egocentric and anthropocentric moral reasoning) forming a separate environmental moral reasoning structure (i.e., *nature*). This finding implies that the degree of distinguishing between nature-centered and human-centered moral considerations are sensitive to the context of the moral dilemmas that people reason about, providing supporting evidence for the importance of dilemma context relative to individuals′ moral reasoning (Kortenkamp & Moore, 2009; Rest et al., 2000; York & Becker, 2012; Zeidler & Keefer, 2003).

In addition to specific characteristics of each environmental moral dilemma scenario, differences in environmental moral reasoning patterns observed across the scenarios may be attributed to PSTs′ perceptions about the naturalness of the environments described in the scenarios

(Kortenkamp & Moore, 2009; Persing, 2006; Tuncay-Yüksel et al., 2015). For instance, in the context of Türkiye, camping is an outdoor recreation activity that is undertaken in more pristine environments such as forests. However, hiking and picnicking are outdoor recreational activities that can also take place in more "developed" environments, which can be described as those that are more likely to have higher numbers of visitors and/or contain physical structures and facilities within them (Persing, 2006). In fact, research shows that many Turkish people generally associate hiking with walking, which is frequently done in urban parks as a way of losing weight and relaxing (Peters et al., 2010). Similarly, picnicking is a very traditional and cultural outdoor recreation activity which is often associated with having a barbecue (Özgüner, 2011) and coming together to have food and drinks (Te Kloeze, 2001). Therefore, it is reasonable to infer that the participants of the present study might have associated the dilemma contexts of the hiking and picnicking scenarios with more "developed" rather than pristine environments. This might, in turn, have caused their nature-centered considerations (i.e., ecocentric) to merge with the more human-centered (i.e., egocentric and anthropocentric) ones. In a similar vein, associating camping with more pristine environments and may have led them to separate ecocentric moral concerns from all other considerations, which resulted in the emergence of a purely nature-centered moral reasoning factor that had almost no correlation with the other moral reasoning dimension obtained for this scenario.

4.2 | Path model

4.2.1 | Commonalities in preservice teachers' environmental moral reasoning

In this study, the path analyses revealed two common findings. The first common finding was related to the explained variances in environmental moral reasoning categories. Except for the camping scenario, percentages of the explained variances indicated that path equations explained higher variance in nature-centered environmental moral reasoning categories (i.e., *utility of nature* for the hiking and picnicking scenarios, *ecojustice* for the fishing scenario, *nature* for the camping scenario). Thus, we concluded that epistemological beliefs and values were more predictive of nature-centered moral considerations when compared to human-centered ones.

From a "modern Western" perception, this finding may be attributed to the relatively consistent feature of ecocentric moral considerations. That is to say, ecocentrism is proposed as an ecological worldview that is conceptually similar to the construct New Environmental Paradigm, which is regarded as a measure of generalized beliefs about human–environment relationships (Dunlap et al., 2000; Schultz & Zelezny, 1999). Hence, it may be possible to explain greater amounts of variance within this worldview (i.e., ecocentrism) with a fewer number of other deeply rooted sociopsychological variables such as epistemological beliefs and values. However, human-centered moral considerations (including the self and other people) are proposed to be more heterogeneous and involve a mixture of various concerns (Nordlund & Garvill, 2002). For instance, owing to their socialization as caregivers and family nurturers, females are generally expected to have higher levels of moral considerations about the consequences of environmental problems on humans, especially when environmental problems are more local to them (Mohai, 1992).

We also offer caution that our findings may not be generalizable to other populations from different societies and cultures. Henrich et al.'s (2010) study revealed differences in the range of

moral principles (e.g., justice, rights, care, etc.) that societies and cultures enact while reasoning about moral issues. While justice and care/harm are the two moral principles of an ethos of autonomy that westerners typically consider in their moral judgments, non-westerners may consider a wider range of moral principles including an ethic of community (e.g., fulfillment of interpersonal obligations) and divinity (e.g., responsibilities for one's own body which is accepted as a part of holiness). Comparison of the findings of the present study with previous research provides supporting evidence for this contention. Epistemological and ontological orientations and values of different populations are shown to be varied and substantially influenced by how individuals come to understand nature, which is termed "folkbiological reasoning" (Serrelli, 2011, p. 158).

Finally, Türkiye is a non-western country possessing mainly a collectivistic cultural orientation (Henrich et al., 2010; Ozkan Kuyel, 2002). Nonetheless, it is under a rapid transformation from a traditional and agricultural society to that of a modern, urbanized and industrial one (Kumru et al., 2012). Urbanization of the country also reveals itself as a kind of cultural transformation in which Turkish society transitions from a more collectivist and traditional country to a more individualistic and "western" one (Kahraman, 2008). Educated Turkish youth, such as university students, are among the ones that are highly influenced by this cultural transformation (Kuyel, 2002). Therefore, epistemological and ontological orientations of the PSTs who participated in the present study are likely to differ from epistemological and ontological orientations of some other non-western cultures such as land-based or indigenous cultures. In land-based and Indigenous Knowledge Systems, knowledge cannot be thought as separate from the setting in which it resides; that is, knowledge is "contextual and contextualized" (Brayboy & Maughan, 2009, p. 11). Therefore, aspects of the natural world and its ecosystems will be more influential on nature-related moral considerations and environmental moral reasoning patterns for individuals who belong to those cultures.

The second common finding across the path analyses was connected to the relationships of exogenous variables (epistemological belief dimensions and value categories) to environmental moral reasoning. Epistemological belief dimensions of QL and OA and the value category of ST&T had statistically significant path coefficients with all of the environmental moral reasoning categories of the four scenarios. When these epistemological dimensions and the value category were examined, it was observed that they shared common patterns in their item structures (see online Tables S4 and S5 for items of the epistemological belief and value variables, respectively). For instance, one of the two item statements that were factorized under OA and two of the items in ST&T emphasize the importance of family and obeying laws for security reasons respectively, which appears to be a unifying link between the nature of the PSTs′ epistemological beliefs in OA and ST&T values. Similarly, some of the item statements that were factorized under the QL dimension also reflect respondents′ tendency for obedience to authority and reveals parallelism with OA and ST&T items. Therefore, we infer that the PSTs perceived both laws and parents as agents for protecting humans as well as the environment. These perceptions were found to be highly correlated with environmental moral reasoning.

4.2.2 | Relationships between epistemological beliefs and environmental moral reasoning

Results of the path analyses indicated that, except for the OA epistemological belief dimension, relationships between epistemological beliefs and environmental moral reasoning are

connected to the focus of environmental moral considerations and the context of environmental moral dilemmas (see Figure 3 for the summary of the relationships tested through path analyses). For instance, participants who had naïve beliefs in QL, thus perceived learning as something that occurs swiftly or not at all (see Table 1), were found to be less concerned about ecocentric aspects of the environmental moral dilemma scenarios (except for the camping scenario). However, they showed a propensity to have higher levels of moral concerns about egocentric and anthropocentric aspects of the scenarios. Research shows that naïve believers of QL epistemological belief dimension are more inclined to spend less time critically analyzing and evaluating information (Braten & Strømsø, 2006). In this vein, our study confirms that PSTs with naïve beliefs in the QL epistemological belief dimension may not have concentrated on the scenarios due to lack of prior knowledge. As a result, they may have disregarded ecocentric aspects of the dilemmas that were generally more abstract (e.g., intrinsic value of nature), and needed a considerable amount of time and prior knowledge to form interpretations (e.g., reactions of ecosystems to pollution and other kinds of environmental damages) consistent with the findings of Khachatryan et al. (2013). This finding is also in line with work of Zeidler et al. (2013) and Zeidler (2016) arguing that the ability of extending moral considerations on SSI from foreseeable and immediate concerns to more abstract and distal ones are related to increased sophistication of epistemological beliefs and socioscientific reasoning.

Path coefficients of QL which were calculated for its relationships to environmental moral reasoning revealed a different pattern for the camping scenario than the patterns observed for the other three scenarios. For this scenario, naïve beliefs in QL had negative correlations with both of the two environmental moral reasoning scores (i.e., *humans*, *nature*). Research shows that individuals' perceptions about the severity of environmental problems are related to their environmental moral reasoning and awareness about and sensitivity to the potential harms of environmentally damaging actions (Dietz et al., 2005; Kortenkamp & Moore, 2009). In this regard, it may have been more difficult for the PSTs who had naïve beliefs in QL to comprehend the long-term outcomes of the action described in the camping scenario (i.e., washing dishes in a lake), not only in relation to the environment/nature itself, but also as it affects themselves and other people. Therefore, these respondents may have underestimated the severity of the outcomes for the potentially environmentally damaging action, and failed to recognize the moral considerations that were implicit within the scenario.

Path coefficients reflecting relationships of OA to environmental moral reasoning scores were statistically significant for all of the path equations. Signs of the coefficients showed that correlations between beliefs in OA and levels of moral considerations were positive for all scenarios. Thus, the PSTs who were more concerned about the potential harms of the environmentally damaging actions and problems described in the scenarios, may have exhibited a tendency to legitimate those in authority (e.g., managers of the national parks where the scenarios took place) who might be in a position of preventing those actions and/or solving the stated problems. This indicates a positive relationship between environmental concern levels and perceptions about the necessity and legitimacy of authority for environmental protection, similar to the findings of Kahyaoğlu (2011).

4.2.3 | Relationships between values and environmental moral reasoning

Path coefficients for the relationships of ST&T values to environmental moral reasoning dimensions were statistically significant and positive regardless of the dilemma scenario and focus of

environmental moral reasoning. Findings of research in the extant literature also provide supporting evidence for the positive relationships between ST&T values and all of the environmental moral reasoning dimensions obtained in the present study. For example, De Groot and Steg ([2007]) found that self-transcendence values were a combination of altruistic (anthropocentric) and biospheric (ecocentric) value orientations, which were positively correlated with feelings of moral obligation to act in pro-environmental ways (i.e., pro-environmental personal norms). Similarly, Stern et al. ([1995]) revealed that self-transcendence values were positively related to individuals' awareness about the consequences of environmental issues for the self, other people, and nonhuman species. Furthermore, a path model proposed by Nordlund and Garvill ([2002]) also supported that self-transcendence values were positively related to individuals' awareness about environmental problems, which enacted their personal norms and resulted in higher dispositions for pro-environmental behaviors.

Findings of previous research on the relationships between tradition (conservation/conservatism) values and egoistic, altruistic, and biospheric considerations (e.g., Schultz et al., [2005]) show that significance and direction of the relationships of tradition values to environmental moral reasoning depend on samples' characteristics. These findings are reasonable and even predictable since "tradition" is a contextual construct that cannot exist independent of cultures that individuals belong to (Schultz et al., [2005]). Merging of tradition (T) values with self-transcendence (ST) values into a single ST&T value dimension in the present study is consistent with this conceptualization. Related research on examining the effect sizes of 12 SSI studies found that similar SSI initiatives had statistically large effects on content learning, competence, decision-making, and reasoning on middle and high school students, and medium effect sizes on college level students (Badeo & Duque, [2022]). Our findings revealing significant relationships between environmental moral reasoning and epistemic beliefs about moral concerns (e.g., social justice issues) aligns well with that research.

In the present study, the PSTs who had higher SE scores by attributing more importance to personal interests as well as social superiority and esteem (see Table [2] and online Table [S5]) were found to be less likely to exhibit ecocentric moral considerations in response to environmental moral dilemmas. Instead, they were found to be more concerned about environmental dilemmas' egocentric and anthropocentric moral aspects. Examination of the value items that loaded on the SE value category (i.e., authority, influential, wealth, ambitious, social power) support the interpretation that students tend to have a myopic focus on egocentric/anthropocentric viewpoints to the near exclusion of ecocentric concerns. Certain science educators (e.g., Herman et al., [2020]; Herman et al., [2021]) express cautionary caveats relative to the pedagogical need to factor *both* perspectives into classroom discourse and exploration.

For instance, Herman et al. ([2021]) stated that some values such as individual comfort, success, and self-esteem are elevated at the expense of some others (e.g., humility, tolerance, empathy) in formal and informal learning environments. The researchers propose that this situation ought to be alarming to the aims of functional scientific literacy. In their study, the researchers showed the efficiency of implementing well-designed (e.g., scaffolding of experiences and questions requiring socioscientific perspective taking) pedagogical approaches for moving students from more egocentric and anthropocentric viewpoints to more ecocentric ones, which represented higher awareness about the reciprocal interconnected relationships in nature and elements of sustainable development. Postsecondary students who participated in Herman et al.'s ([2021]) and Herman et al.'s ([2020]) studies experienced questioning, modeling, deconstructing perspectives of others, and reflected upon their own perspectives and experiences in a place-based SSI instructional context during a 6-week environmental topics course. Herman et al. ([2021]) found

that some of the students referred to the necessity of avoiding certain SE values for supporting their ecocentric epistemological orientations with regard to the resolution of the issue (i.e., reintroduction of wolves in Greater Yellowstone Area). Likewise, findings in Herman et al.'s (2020) study revealed how those students downgraded certain SE values and concerns (e.g., desire for massive amounts of materialistic items that cause harm to nature) in favor of utilitarian values that balance the needs of people within nature. Accordingly, the researchers, having found success with their SSI interventions, propose group inquiry investigations, such as Town Hall debates, direct immersive experiences in place-based settings, and interactions with stakeholders that are directly involved in environmental issues, to help foster more insight into how varied values and perspectives influence functional scientific literacy in general, and environmental literacy in particular.

4.3 | Limitations of the study

There are possible limitations of this study which may temper the generalizability of its findings. The instruments used in this study and the models utilized to examine the PSTs' epistemological beliefs, values, and environmental moral reasoning are based on modern Western perceptions of these constructs. Therefore, despite the efforts that we factored in to compensate for this limitation (e.g., procedures applied for improving the clarity of the instruments and making them more reflective of Turkish contexts, statistical techniques used for cross-validating the factor structures, etc.), the collected data and its analyses may not fully reflect how Turkish PSTs reason about moral aspects of environmental issues and the relationships of their epistemological beliefs and values to these environmental moral reasoning patterns.

Another possible limitation is that the conclusions drawn from the study findings are related to the particular sample selection method and gender distribution of the participants. Participants of the study were a convenience sample, large as it may be, of PSTs enrolled in public universities of the Central Anatolia region of Türkiye, which may not be representative of all PSTs in the country. For example, gender distribution of the sample was highly disproportional (82% female, 18% male).

4.4 | Implications for science education policy and practice

Clearly conceptualizing a construct is a very important antecedent step for making modifications on it for further empirical study (Kahn & Zeidler, 2017). Therefore, in order to promote environmental moral reasoning, educators should first carefully examine the processes that their students go through while trying to resolve moral issues related to the environment. In light of the findings of the present study, we propose that epistemological beliefs and values held by students are among the factors that are related to, if not directly influencing, patterns of moral reasoning about environmental issues. Therefore, we advocate that science educators give more explicit emphasis to epistemological beliefs and values in their science education programs, particularly in the context of facilitating SSI-related discourse and exploration. This would be consistent with the most recent research highlighting the central role of cultivating epistemic sense-making practices and argumentation as it impacts the advancement of scientific models, concepts and explanations in SSI (Zeidler & Sadler, 2023).

Similarly, the contextual-based nature of environmental moral reasoning patterns as well as the observed relationships among environmental moral reasoning, epistemological beliefs and values, imply the need for presenting a variety of contexts in students' coursework in order to examine and develop learners' environmental moral reasoning. It is important to note that the contextual nature of engaging learners in environmental themes that are explored through SSI-related approaches is precisely what is advocated by UNESCO, EuroScitizen, Evoke (Evolutionary Knowledge for Everyone) and the European Cooperation in Science & Technology initiatives (Sá-Pinto et al., 2022). The use of different dilemma case scenarios, such as the ones adapted and utilized in the present study, is a promising instructional approach to enacting these synergistic themes. Coupling these, when feasible, with place-based experiences, taps the relevance that locality places on issues (e.g., community, national, global), and affects the forms of moral reasoning and level of moral concerns about environmental problems (Herman et al., 2020; Tuncay et al., 2012).

Finally, to the extent that research shows that "most people lack the vocabulary to articulate their ethical views except in terms of how they feel" (Poole et al., 2013, p. 350), the necessity of integrating ethics literacy in our educational programs becomes a more pressing issue. In this regard, explicit emphasis should be given to the development of epistemological beliefs and values in science education programs, which would contribute to the moral reasoning and ethical literacy of our students. We consider this issue critical because ethical literacy cannot be thought of as independent from scientific literacy, for that is what it means to be functionally scientific literate.

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