



Can Young Children Learn Bioethics and Geoethics? Evidence from a Mediated Non-Formal Science Experience

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Abstract

This study explores the educational potential of introducing bioethical and geoethical issues to young children through mediated non-formal science education experiences. The research focuses on primary students (ages 6–12; n = 24) as audiences and interlocutors rather than direct participants in structured instructional interventions. The context involved an intergenerational science theatre project, in which adolescents created and performed a play addressing ethical dilemmas related to life sciences and human–Earth interactions. Following the performance, younger children participated in a brief ludic activity using emoji-based response cards and engaged in semi-structured group interviews. Additional interviews with institutional educators provided complementary perspectives on engagement, comprehension and pedagogical feasibility. Data were analysed qualitatively and through descriptive quantitative analysis of responses to ten statements addressing bioethical, geoethical and combined ethical themes. Results from the ludic activity indicate a high proportion of correct responses in bioethical topics (95.8%), alongside consistent levels of correct responses in geoethical (80.2%) and mixed bioethical–geoethical categories (81.2%). These patterns suggest that children were able to recognise ethical dimensions, differentiate between types of socioscientific issues and articulate positions aligned with the narratives presented. Interview data further revealed emotional engagement, concern for living beings and the environment, and the ability to relate ethical questions to everyday experiences. Overall, the findings indicate that mediated, narrative-based and intergenerational approaches can lower conceptual barriers and support inclusive engagement with complex ethical dimensions of science in primary education. The study contributes to science education by highlighting non-formal, narrative-based approaches as effective entry points for early ethics learning, and by proposing mediated ethical understanding as a framework to explain how young learners engage with ethical dimensions of science.

Keywords: Primary education; Bioethics; Geoethics; Socioscientific issues; Non-formal education

1. Introduction

The increasing relevance of socioscientific issues (SSI), particularly those related to sustainability, technological development, and human–Earth system interactions, has reinforced the need to reorganise science education to integrate scientific understanding, ethical reflection, and responsible citizenship [1]. However, ethical dimensions remain underrepresented in formal science education [1,2], particularly in the early years, often due to assumptions about children’s cognitive readiness to engage with abstract ethical concepts and the complexity of ethical deliberation required in socioscientific contexts [3,4].

Traditional approaches to science education tend to privilege conceptual knowledge over ethical deliberation, frequently relying on transmissive pedagogies that limit student engagement and the application of knowledge to real-world contexts [5]. In contrast, non-formal educational environments provide opportunities for more flexible, participatory and context-based learning experiences, where ethical dimensions can be explored through narrative, emotion and interaction.

The literature suggests that drama-based and embodied approaches can facilitate the understanding of complex scientific and ethical issues by lowering conceptual barriers and promoting empathy, perspective-taking and engagement [6,7,8]. Nevertheless, empirical evidence on younger children’s ability to meaningfully engage with bioethical and geoethical issues remains limited.

This study addresses this gap by exploring whether primary school children, as audience members of a mediated non-formal educational intervention, can recognise, interpret and apply ethical dimensions related to science. The research question that guided this study was: To what extent can young children



identify and engage with bioethical and geoethical issues through mediated, narrative-based non-formal science education experiences?

2. Theoretical Framework

2.1 Bioethics and Geoethics in Science Education

Bioethics and geoethics have emerged as key frameworks for addressing ethical challenges associated with scientific and technological development and human interactions with the Earth system. While bioethics focuses on life sciences, health and human dignity, geoethics extends ethical reflection to environmental responsibility, sustainability and intergenerational justice [9,10].

The integration of ethical dimensions into science education is increasingly recognised as essential for preparing students to engage with complex socioscientific issues (SSI) and to act as informed and responsible citizens [4,5,11]. SSI are characterised by uncertainty, conflicting values and the need to evaluate risks, making them particularly relevant for developing students' capacity to reason about real-world problems [12]. Research shows that SSI-based approaches promote critical thinking, argumentation and ethical reasoning, although their implementation remains uneven [13].

Evidence also indicates that SSI can be meaningfully integrated into primary education when connected to real-world contexts and supported by appropriate strategies [14]. In this context, bioethics and geoethics contribute to the development of moral reasoning and awareness of the ethical implications of scientific and environmental issues.

Despite these advances, their integration into early science education remains limited [15,16,17,18]. Although research suggests that children can engage with ethical reasoning and perspective-taking [19,20], these domains are often considered too abstract for younger learners. As a result, ethical discussions are frequently postponed, limiting opportunities for early development of ethical awareness.

2.2 Non-Formal and Mediated Learning Approaches

Non-formal education offers a complementary space to formal schooling, enabling participatory, contextualised and experiential learning. Such environments provide the flexibility to explore complex, interdisciplinary topics, including the ethical dimensions of science, in ways that are accessible and meaningful, particularly in contexts of social inclusion [21,22].

Mediated learning approaches are particularly relevant for addressing abstract concepts such as bioethical and geoethical issues. These approaches rely on narratives, interaction and guided interpretation, aligning with socio-constructivist perspectives that emphasise the role of dialogue and cultural tools in learning [23,24]. Intergenerational contexts further enhance relevance and engagement among younger learners.

Drama-based learning represents a powerful strategy within this framework. By combining storytelling, role-play, and emotional engagement, this approach allows learners to explore socioscientific issues in meaningful, situated contexts, supporting ethical reasoning and consideration of different perspectives [6,7]. Research shows that such approaches integrate cognitive, affective and social dimensions of learning and promote empathy and moral reflection [25,26].

Narrative and symbolic representations function as mediating tools that translate complex concepts into accessible experiences. The use of metaphors and analogies supports ethical reasoning and decision-making, particularly among younger learners [27,28,29]. These processes can be understood through sensemaking and mental models, which allow individuals to interpret complex situations without relying on fully articulated conceptual knowledge [30,31].

Taken together, non-formal, mediated and narrative-based approaches create conditions for the emergence of mediated ethical understanding, in which learners can recognise and respond to ethical dimensions of science without necessarily mastering formal concepts. The conceptual model guiding this study is presented in Figure 1.



Fig. 1. Conceptual model of mediated ethical understanding in non-formal science education.

3. Methodology



3.1 Research Design

This study adopts a mixed-methods approach within an exploratory case study design to examine how young children engage with bioethical and geoethical issues when exposed to a mediated, narrative-based non-formal educational intervention.

The study focuses on a convenience sample of 24 children (ages 6–12) attending the first and second cycles of basic education. They participated as audience members rather than as direct contributors to the intervention design. This distinction is relevant, as it allows for the examination of how ethical understanding may emerge through indirect, mediated experiences.

This design is consistent with established approaches in educational research that combine qualitative and quantitative data to provide a more comprehensive understanding of complex learning processes [32,33].

3.2 Educational Context and Intervention

The study was conducted in a non-formal educational context at a social support institution in an urban area characterised by socio-economic disadvantage. Such contexts are particularly relevant for exploring inclusive educational approaches, as they provide opportunities to engage learners who may have limited access to formal enrichment activities. Research highlights the importance of promoting social inclusion and supporting the development of moral reasoning from early stages, particularly by addressing children's epistemic beliefs and their capacity to engage with ethical issues [34,35].

The intervention was embedded in an intergenerational science education project, in which adolescents designed and performed a theatre play addressing bioethical and geoethical dilemmas. The play explored themes such as animal experimentation, environmental sustainability and human responsibility towards the Earth system.

Following the performance, younger children participated in two complementary activities: (i) a ludic evaluation task using emoji-based response cards to assess their responses to ethical statements, immediately after the theatre and (ii) semi-structured focus group interviews. Data collection from the interviews took place approximately 8 days after the performance, allowing for some reflection while maintaining proximity to the experience.

3.3 Data Collection and Analysis

Data were collected from multiple sources to enable triangulation. Quantitative data were obtained from participants' responses to an emoji-card activity comprising 10 items addressing bioethical, geoethical, and combined issues. Items were presented orally by a narrator and included both statements and questions. Participants responded individually using coloured cards: green (smiling emoji) to indicate agreement or an affirmative response, yellow (confused emoji) to indicate uncertainty, and red (angry emoji) to indicate disagreement or a negative response.

Examples of items included "A scientist should conduct experiments on animals without considering their well-being or level of suffering", "If a company discharges toxic waste into a river, causing harm to ecosystems and drinking water, is this an ethical practice?", and "Learning about the impacts of electronic waste on human health and the environment contributes to more ethical behaviour".

Participants' responses were recorded using an observation grid by two researchers positioned at different points in the room, allowing full visibility of all participants' responses. This procedure supported accurate data recording and reduced the risk of observational bias.

Qualitative data included transcriptions of two semi-structured focus group interviews with 18 participants. The groups were organised according to age and educational level: one group included 12 children attending the first cycle of basic education (ages 6–10), and the other included 6 children attending the second cycle (ages 10–12). Group formation accounted for age-related differences in cognitive and social development. The number of participants was determined by availability on the scheduled day of data collection. Additional interviews were conducted with institutional educators to provide complementary perspectives.

Quantitative data were analysed descriptively to identify patterns across bioethical, geoethical and combined categories. Qualitative data were examined through thematic content analysis, focusing on three dimensions: (i) recognition of ethical concepts, (ii) application of ethical reasoning in context, and (iii) emotional engagement and interpretation.



This combined approach enabled a comprehensive understanding of how participants engaged with ethical dimensions of science, integrating response patterns with interpretative insights.

4. Results and Discussion

The findings of this study indicate that young children can engage with bioethical and geoethical issues when presented through mediated, narrative-based approaches. Following the mixed-methods design, the baseline capacity for ethical identification is established quantitatively, followed by an in-depth qualitative analysis of the children's reasoning and retention.

4.1 Quantitative Findings: Immediate Identification of Ethical Dimensions

The results of the immediate emoji-card activity provide substantial evidence of the participants' capacity for ethical decision-making, as detailed in Table 1.

Table 1. Results of the emoji-card activity.

Category	Correct answer (%)	Uncertain (%)	Incorrect (%)
Bioethical topic	95.8	4.2	0.0
Geoethical topic	80.2	19.8	0.0
Combined topics	81.2	18.8	0.0

High levels of correct responses were observed across all categories, particularly in bioethical statements (95.8%), with slightly lower but consistent results in geoethical (80.2%) and combined categories (81.2%). The slightly lower results observed in geoethical and combined categories may reflect the greater level of abstraction and systems thinking required to interpret environmental and human–Earth interactions, compared to more immediate and relational bioethical issues. Notably, no incorrect responses were recorded, with remaining answers reflecting uncertainty rather than misunderstanding.

These results suggest that children in early stages of education are capable of recognising simple bioethical and geoethical principles when supported by appropriate pedagogical frameworks. This finding is consistent with previous research indicating the feasibility of ethics education in primary contexts [37,38], as well as recent reviews highlighting the development of argumentative and value-based reasoning from early school years [39]. In addition, studies show that younger learners construct meaning in scientific contexts through a combination of linguistic and non-linguistic resources, reinforcing the importance of multimodal and inclusive approaches [40], such as the emoji activity implemented here.

4.2 Qualitative Findings: Engagement, Applied Reasoning, and Educational Perspectives

To ascertain whether this high level of immediate identification translated into sustained reasoning and deeper ethical internalization, the focus groups conducted 8 days later were analyzed. Overall, participants demonstrated high levels of lingering engagement with the theatre-based intervention, expressing interest and valuing the opportunity to actively participate in the final decision-making process. Interactive elements, such as the voting component, were frequently highlighted as meaningful, suggesting that participation played a key role in sustaining attention and involvement over time. As one participant recalled, “[the voting component] brought more fun to the theatre” (Participant 6), while another argued that “... it was great” (Participant 14).

Despite the high identification success shown in the emoji activity, the qualitative data revealed that most participants had no prior familiarity with the concepts of *bioethics* and *geoethics*. None were able to provide formal definitions; however, when reflecting on the play a week later, many demonstrated an incipient applied understanding by using core values such as “care” (Participant 6), “protection” (Participant 5) or “responsibility” (Participant 12).

This distinction between formal conceptual knowledge and applied understanding is particularly significant. While conceptual mastery was absent, participants were nevertheless able to recognise ethical dimensions and interpret their meaning in context. This finding aligns with research on socioscientific decision-making, which conceptualises decision processes as multidimensional, involving the integration of knowledge, values, personal experiences and contextual factors [31]. From this perspective, ethical reasoning does not depend solely on formal conceptual understanding but can



emerge through processes of interpretation and judgement. Similarly, studies on sensemaking and mental models suggest that individuals rely on simplified representations to interpret complex situations and guide action [30].

Participants also demonstrated the ability to apply ethical reasoning to everyday situations, reflecting on issues such as animal welfare, environmental responsibility and social behaviour. However, difficulties were observed in generating explicit examples outside the scope of the play, indicating that while recognition and interpretation were present, the ability to independently articulate abstract ethical issues remained limited. This pattern suggests that early ethical understanding may be grounded in contextual and experience-based reasoning, rather than abstract conceptualisation.

Furthermore, the use of theatre appears to have facilitated access to complex issues by combining storytelling, emotion and interaction, allowing participants to engage with dilemmas in a situated and meaningful way. This is consistent with research indicating that narrative, metaphor and analogy can support ethical reasoning and decision-making by structuring how learners interpret and respond to complex situations [27,28,29]. In the context of socioscientific issues, science itself functions as a key epistemic resource for ethical reasoning [35]. In addition, participants demonstrated elements of perspective-taking, considering different viewpoints and reflecting on the consequences of actions. These findings are consistent with recent research showing that children can engage in perspective-taking and socioscientific decision-making when supported by contextualised learning environments [34], as well as earlier work highlighting the emergence of moral and environmental reasoning in primary education [36].

The intergenerational nature of the intervention appears to have further contributed to its effectiveness. Younger participants engaged with content produced by older peers, enhancing identification, motivation and relevance. This dynamic reflects socially mediated learning processes, in which meaning is co-constructed through interaction and shared experience.

Furthermore, the perspectives from institutional educators reinforce these findings. In individual interviews, all professionals (n=3) reported clear benefits of the intervention for younger participants, particularly in terms of long-term engagement, ethical awareness and the development of critical thinking. As one educator noted, "it is a much more engaging way for them to understand what is being discussed... these are not easy topics" (Educator 1). Another educator emphasised that the experience "left something that could awaken them to what they should or should not do". The same participant added that it is important "to start introducing them to these topics from a very young age, as I think they are very relevant" (Educator 2).

On the other hand, educators expressed differing views on the most appropriate age to introduce bioethical and geoethical concepts. While one suggested that these topics can be introduced in the later years of primary education (1st cycle of basic education), provided they are approached gradually and in accessible ways (Educator 2), another mentioned the 2nd cycle of basic education (Educator 3), and another argued that greater cognitive maturity is required for deeper understanding, suggesting that these topics should only be addressed at secondary school level (Educator 1).

This reflects a tension also identified in the literature. On the one hand, research in early childhood education highlights that children are capable of engaging in ethical reasoning, perspective-taking and socio-emotional reflection [20,21]. On the other hand, the depth and complexity of ethical understanding are heavily influenced by cognitive development and maturity [3].

4.3 Synthesis and Conceptual Contribution

Taken together, the quantitative metrics and qualitative indicators suggest that young learners can develop early forms of ethical understanding when exposed to mediated, narrative-based and contextually meaningful learning environments. This supports the notion of *mediated ethical understanding*, in which learners can recognise and meaningfully respond to the ethical dimensions of science without necessarily mastering formal conceptual definitions. Additionally, our findings suggest that early exposure to ethically rich, narrative-based experiences may play a role in bridging the gap between scientific understanding and responsible action in young learners.

These results challenge traditional assumptions that ethical learning depends primarily on conceptual knowledge. Instead, they highlight the central role of engagement, interpretation and contextualisation in early science education.

Several limitations should be acknowledged. The study was conducted with a relatively small sample in a specific non-formal context, which may limit the generalisability of the findings. In addition, the short time frame between the intervention and data collection does not allow for the assessment of long-term learning effects.



5. Conclusions and Implications

This investigation examined how young children engage with bioethical and geoethical issues when exposed to a mediated, narrative-based non-formal educational intervention. Although participants did not demonstrate formal conceptual understanding, they showed a clear ability to identify ethical dimensions, apply contextual reasoning, and make value-based decisions.

These results support the notion that ethical learning in early stages does not depend primarily on conceptual mastery, but can emerge through engagement with meaningful, contextualised and emotionally resonant experiences. In this study, the use of theatre as a pedagogical tool, combined with interactive and intergenerational dynamics, appears to have played a central role in facilitating access to complex socioscientific issues.

From an educational perspective, the findings suggest that bioethical and geoethical dimensions can be meaningfully introduced in primary education, provided that age-appropriate and mediated approaches are used. Narrative-based strategies, such as drama, storytelling or visual representations, offer effective pathways to foster ethical engagement, particularly by promoting empathy, perspective-taking and reflective thinking.

At the same time, the results highlight the importance of recognising developmental differences. While younger learners can interpret and respond to ethical situations, the depth of understanding and the capacity for abstract conceptualisation remain limited. This suggests that ethical education should be introduced progressively, balancing accessibility with increasing conceptual complexity.

This study contributes to the field by providing empirical evidence for integrating ethical dimensions into early science education through non-formal and mediated approaches. It also introduces the concept of mediated ethical understanding as a useful framework to describe how learners engage with ethical issues in the absence of formal conceptual knowledge.

Future research should explore how these approaches can be adapted to formal educational settings and diverse learner populations, and examine their long-term impact on ethical reasoning, scientific literacy, and responsible citizenship. Further studies could also investigate how the progressive integration of conceptual knowledge may build upon early forms of mediated ethical understanding.

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REFERENCES

- [1] McCrory A., Reiss M. J., "The place of ethics in science education: Implications for practice", London, Bloomsbury Publishing, 2023.
- [2] Zeidler D. L., Sadler T. D., Simmons M. L., Howes E. V., "Beyond STS: A research-based framework for socioscientific issues education", *Science Education*, 89, 2005, pp. 357–377.
- [3] Lymbouridou C., "Science for ethics in socioscientific issues discussions", *Cultural Studies of Science Education*, 20, 2025, pp. 389–429.
- [4] Garrecht C., Czinczel B., Kretschmann M., Reiss M., "Should we be doing it, should we not be doing it, who could be harmed?", *Science & Education*, 32, 2022, pp. 1761–1793.
- [5] Sadler T. D., "Informal reasoning regarding socioscientific issues: A critical review of research", *Journal of Research in Science Teaching*, 41, 2004, pp. 513–536.
- [6] Braund M., "Drama and learning science: An interdisciplinary approach", *International Journal of Science Education*, 37, 2015, pp. 1–22.
- [7] Ødegaard M., "Dramatic science: A critical review of drama in science education", *Studies in Science Education*, 39, 2003, pp. 101–127.
- [8] Varelas M., Kotler R. T., Natividad H. D., Phillips N. C., Tsachor R. P., Woodard R., Gutierrez M., Melchor M. A., Rosario M., "Science theatre makes you good at science: Affordances of embodied performances in urban elementary science classrooms", *Journal of Research in Science Teaching*, 59, 2022, pp. 493–528.



- [9] Bobrowsky P., Cronin V., Di Capua G., Kieffer S., Peppoloni S., “The emerging field of geoethics”, in *Scientific Integrity and Ethics with Applications to the Geosciences*, 2017, pp. 175–212.
- [10] Lee L., “A bridge back to the future: Public health ethics, bioethics, and environmental ethics”, *The American Journal of Bioethics*, 17, 2017, pp. 12–15.
- [11] Vesterinen V.-M., Tolppanen S., Aksela M., “Toward citizenship science education: What students do to make the world a better place?”, *International Journal of Science Education*, 38, 2016, pp. 30–50.
- [12] Schenk L., Hamza K., Arvanitis L., Lundegård I., Wojcik A., Haglund K., “Socioscientific issues in science education: An opportunity to incorporate education about risk and risk analysis?”, *Risk Analysis*, 41, 2021, pp. 1–11.
- [13] Högström P., Gericke N., Wallin J., Bergman E., “Teaching socioscientific issues: A systematic review”, *Science & Education*, 34, 2024, pp. 3079–3122.
- [14] Pessoa P., de Lima J., Piacentini V., Realdon G., Jeffries A., Ometto L., Lopes J. B., Zeidler D. L., Fonseca M. J., Sousa B., Pinto A., “A framework to identify opportunities to address socioscientific issues in the elementary school curricula: A case study from England, Italy, and Portugal”, *PLoS ONE*, 20, 2025, pp. e0308901.
- [15] Moorthy R., Selvadurai S., Gill S. S., Gurunathan A., “Sustainable societal peace through the integration of bioethics principles and value-based education”, *Sustainability*, 13, 2021, pp. 3266.
- [16] Paz M., Vasconcelos C., “Beyond the classroom: Empowering learners in Bio and Geoethics with engaging non-formal resources”, in Sparitis O. (Ed.), *Proceedings of 11th SWS International Scientific Conference on Social Sciences - ISCSS 2024*, 2024, pp. 159–166.
- [17] Koupatsiaris A. A., Drinia H., “Expanding geoethics: interrelations with geoenvironmental education and sense of place”, *Sustainability*, 16, 2024, pp. 1819.
- [18] Ribeiro T., Vasconcelos C., “Earth system science and education: From foundational thoughts to geoethical engagement in the Anthropocene”, *Geosciences*, 15, 2025, pp. 224.
- [19] Burroughs M., Tuncdemir T., “Philosophical ethics in early childhood: A pilot study”, *Journal of Philosophy in Schools*, 4, 2017.
- [20] Tuncdemir T., Burroughs M., Moore G., “Effects of philosophical ethics in early childhood on preschool children’s social–emotional competence and theory of mind”, *International Journal of Child Care and Education Policy*, 16, 2022.
- [21] Allaste A., Beilmann M., Pirk R., “Non-formal and informal learning as citizenship education: The views of young people and youth policymakers”, *Journal of Applied Youth Studies*, 5, 2021, pp. 19–35.
- [22] Paraskeva-Hadjichambi D., Goldman D., Hadjichambis A., Parra G., Lapin K., Knippels M., Dam F., “Educating for environmental citizenship in non-formal frameworks for secondary level youth”, *Environmental Discourses in Science Education*, Springer, 2020, pp. 213–235.
- [23] Vygotsky L. S., “*Mind in society: The development of higher psychological processes*”, Cambridge, Harvard University Press, 1978.
- [24] Bruner J., “*The culture of education*”, Cambridge, Harvard University Press, 1996.
- [25] Dorion K. R., “Science through drama: A multiple case exploration of the characteristics of drama activities used in secondary science lessons”, *International Journal of Science Education*, 31, 2009, pp. 2247–2270.
- [26] Verhoeff R., “The use of drama in socio-scientific inquiry-based learning”, in Hahl K., Juuti K., Lampiselkä J., Uitto A., Lavonen J. (Eds.), *Cognitive and Affective Aspects in Science Education Research*, Cham, Springer, 2017, pp. 117–126.
- [27] Tramowsky N., Messig D., Groß J., “Students’ conceptions about animal ethics: The benefit of moral metaphors for fostering decision-making competence”, *International Journal of Science Education*, 44, 2022, pp. 355–378.
- [28] Kim J., Loewenstein J., “Analogical encoding fosters ethical decision making because improved knowledge of ethical principles increases moral awareness”, *Journal of Business Ethics*, 172, 2020, pp. 307–324.
- [29] Abrori F., Lavicza Z., Anđić B., “Enhancing socio-scientific reasoning of elementary school students through educational comics”, *Education 3–13*, 53, 2023, pp. 1299–1320.
- [30] Bagdasarov Z., Johnson J., MacDougall A., Steele L., Connelly S., Mumford M., “Mental models and ethical decision making: The mediating role of sensemaking”, *Journal of Business Ethics*, 138, 2016, pp. 133–144.



- [31] Fang S., Hsu Y., Lin S., “Conceptualizing socioscientific decision making from a review of research in science education”, *International Journal of Science and Mathematics Education*, 17, 2019, pp. 427–448.
- [32] Creswell J. W., “*Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*”, Boston, Pearson, 2015.
- [33] Cohen L., Manion L., Morrison K., “*Research Methods in Education*”, London, Routledge, 2018.
- [34] Kim M., Ahmed N., Akdemir K., Wong S., Bulut O., “Children’s perspective-taking and decision-making on forests and land use”, *Disciplinary and Interdisciplinary Science Education Research*, 7, 2025.
- [35] Scholes L., Brownlee L., Walker S., Johansson E., Lawson V., Mascadri J., “Promoting social inclusion in the early years of elementary school: A focus on children’s epistemic beliefs for moral reasoning”, *International Journal of Inclusive Education*, 21, 2017, pp. 507–520.
- [36] Littledyke M., “Primary children’s views on science and environmental issues: Examples of environmental cognitive and moral development”, *Environmental Education Research*, 10, 2004, pp. 217–235.
- [37] Balatsou M., Theologou K., “Promoting bioethical literacy in primary education: The European reality and the case of Greece”, *International Journal of Childhood Education*, 2, 2021, pp. 42–51.
- [38] Fischer M. L., Cunha T. R. D., Roth M. E., Martins G. Z., “Path of dialogue: A bioethics experience in primary school”, *Revista Bioética*, 25, 2017, pp. 89–100.
- [39] Roy G., Sikder S., Danaia L., “Adopting scientific literacy in early years from empirical studies on formal education: A systematic review of the literature”, *International Journal of STEM Education*, 12, 2025, pp. 26.
- [40] Siry C., Gorges A., “Young students’ diverse resources for meaning making in science: Learning from multilingual contexts”, *International Journal of Science Education*, 42, 2020, pp. 2364–2386.