



GC Insights: Integrating Art and Geoscience through STEAM: Public Perceptions and Learning at a Cultural Festival

5 Santiago Jose Navas Jaramillo¹, John Egverto Soto Luzuriaga¹, Renato Efen Gonzalez Zuñiga¹, Marlon Antonio Chamba Toledo², Alicia Mercedes Arciniegas Naula², Hellen Ariel Jimenez Masache¹ and Cristian Raphael Falconi Infante¹

¹Departamento de Ingeniería Civil, Arquitectura y Geociencias, Universidad Técnica Particular de Loja (UTPL), San Cayetano Alto, Paris and Praga, Loja 110107, Ecuador

²Departamento de Comunicación y Artes, Universidad Técnica Particular de Loja (UTPL), San Cayetano Alto, Paris and Praga, Loja 110107, Ecuador

10 *Correspondence to:* Santiago Navas (sjnavas1@utpl.edu.ec)

Abstract. GeoArte, an art-integrated geoscience initiative developed within the STEAM framework, was presented at the International Festival of Living Arts (FIAVL, Loja, Ecuador, 2025) and evaluated through a post-experience survey of 30 non-specialist visitors using a convergent parallel mixed-methods design. Physical geological specimens were the single most cited attraction (86.7 %), yet a comparable majority (83.3 %) rated artistic mediation as strongly facilitating their understanding of geological concepts, with high agreement also recorded for heritage learning and art–geology recognition. Given the exploratory design and absence of pre-test measures, these results are interpreted as preliminary evidence that authentic specimens and artistic representation operate as complementary rather than competing channels of engagement, supporting the applicability of STEAM methodologies in community-based geoscience outreach and geoconservation.

1 Introduction

20 Informal learning contexts such as festivals, museums, and exhibitions have become important spaces for science communication, allowing diverse audiences to engage with knowledge voluntarily, free of curricula and assessment (Asghar, 2012; Falk and Dierking, 2018; Braund and Reiss, 2019). Geosciences, however, face a particular engagement challenge: although geology underpins our understanding of Earth processes, hazards, and heritage, non-specialist audiences often perceive it as abstract or disconnected from everyday experience (Gray, 2013; Vasconcelos and Ribeiro, 2025) (even in regions of high geodiversity such as southern Ecuador).

25 Interdisciplinary approaches that integrate science with artistic practice have been proposed to address this. The STEAM framework couples scientific inquiry with creativity and aesthetic expression, and appears especially effective in informal settings, where art can translate complex ideas into accessible experiences (Martín-Páez et al., 2019; Perignat and Katz-Buonincontro, 2019; Matias et al., 2020; Wright et al., 2023). Art-based learning is particularly relevant to geoscience, which inherently involves visual patterns, textures, and spatial relationships (McNeal and Petcovic, 2020; Lesen et al., 2016). Yet its



educational role remains contested: some argue art mainly raises motivation, while others contend it supports genuine conceptual understanding through meaning-making and reflection (Wynn and Harris, 2012).

Despite a decade of STEAM literature, empirical evidence on art-mediated geoscience communication at large-scale public cultural events remains sparse (a gap that is especially consequential in Latin American contexts), which combine exceptional geodiversity with strong cultural-territorial identities yet are underrepresented in the literature. Critically, existing studies tend to conflate motivational engagement with conceptual learning. The present study treats these as interconnected but distinct dimensions, examining how festival visitors perceive learning outcomes, recognize art–geology relationships, and value geological heritage within a single informal STEAM encounter. We address three questions: (RQ1) what learning outcomes do participants self-report; (RQ2) to what extent do they recognize the art–geology relationship; and (RQ3) how do they value local geological heritage and their overall experience?

2 Methods, data and ethics

GeoArte was an art-integrated geoscience exhibition presented during the International Festival of Living Arts of Loja (FIAVL), a ten-day public cultural event in southern Ecuador (November 2025). It combined geological specimens, artwork inspired by geological heritage, and hands-on workshops, including the participatory mural *Ecos del mar en la montaña*, developed following STEAM principles (Hughes et al., 2022; Perignat and Katz-Buonincontro, 2019).

We used a convergent parallel mixed-methods design, collecting quantitative and qualitative data simultaneously and integrating them at the interpretive stage. Voluntary festival visitors who engaged with at least one GeoArte activity were surveyed on-site immediately afterwards, using convenience sampling appropriate to an open-access event ($n = 30$). The structured instrument combined five-point Likert items on perceived learning, art–geology relationships, and heritage valuation; a verbal satisfaction scale; a recommendation item; and two open-ended questions. It was designed to capture immediate visitor perceptions rather than as a validated measurement tool (a limitation addressed in Section 4).

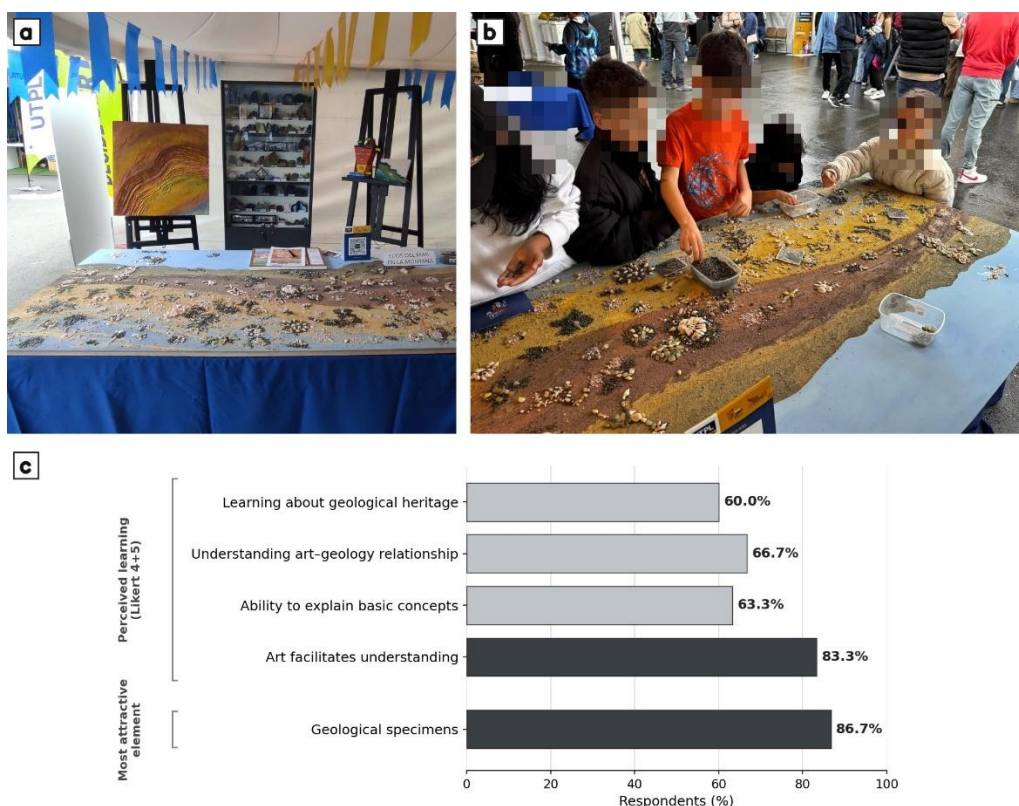
Given the ordinal scale and small sample, analysis was descriptive: responses were summarized as frequency and percentage distributions, with higher Likert values (levels 4 and 5) grouped to indicate strong agreement. No inferential statistics were applied. Open-ended responses were examined through descriptive content analysis adapted from thematic categorization principles (Braun and Clarke, 2006); as most entries were brief, findings are reported as preliminary semantic categories rather than saturated themes. Figures were produced in R (R Core Team, 2024).

The study was approved by the Research Ethics Committee for Human Beings (CEISH) of UTPL (protocol 2025-08-INT-EO-SR-005). Participation was voluntary and anonymous, with no incentive; for participants under 18 (the largest age cohort), verbal assent and parental consent were obtained.



60 3 Results

Across the four perceived-learning items, responses concentrated toward the upper end of the scale (Fig. 1). High agreement (Likert levels 4 and 5 combined) reached 60.0 % for learning about the geological heritage of southern Ecuador, 66.7 % for understanding the relationship between artistic works and geological concepts, and 63.3 % for self-assessed ability to explain basic geological concepts such as minerals and fossils. The strongest convergence was for art as a facilitator of geological understanding, where 83.3 % of participants selected the two highest levels (63.3 % the maximum). This pattern indicates that, among these self-selected visitors, artistic mediation was widely perceived as supporting (not merely accompanying) their engagement with geological content.



70 Figure 1. GeoArte at FIAVL, Loja, Ecuador (2025); visitor survey (n = 30). (a) Stand with specimens, geological artwork, and the mural *Ecos del mar en la montaña*. (b) Visitors building the mural; faces pixelated for privacy. (c) Percentage of respondents at the two highest Likert levels (4 + 5) for the four learning items, and the percentage citing specimens as most attractive (distinct measure). Dark bars: art facilitating understanding (83.3 %) and specimens as main attractor (86.7 %).

75 When asked which exhibition element they found most attractive, however, participants pointed overwhelmingly to the physical geological specimens (rocks, fossils, and minerals), cited by 86.7 % of respondents, far ahead of artistic works (6.7 %) and interactive workshops (6.7 %) (Fig. 1c). The two dominant signals therefore point in apparently different directions:



authentic specimens were the primary attractor, yet artistic mediation was the dimension most strongly credited with facilitating understanding.

80 This quantitative juxtaposition was echoed in the open-ended responses (Fig. 1a, b). The most consistently mentioned aspect was the direct encounter with geological specimens (one participant was drawn to "the real fossil samples", another to "the quantity of minerals, rocks and fossils ... and all the history they hold") converging with the 86.7 % who identified specimens as most attractive. A smaller subset valued instead how the content was communicated, describing "the didactic way in which they teach", while several unprompted reflections extended toward heritage and outreach, including suggestions to bring the exhibition into schools.

85 **4 Discussion**

These results engage a persistent tension in STEAM scholarship: whether artistic integration mainly lowers affective barriers to scientific content, or whether it supports the understanding of abstract concepts (Corrigan et al., 2025; Mejias et al., 2021). Our data cannot resolve this debate (the absence of pre-test measures and objective knowledge assessments precludes any causal claim) but they offer a more nuanced reading than a purely motivational account. Perceived understanding was strongest
90 precisely where material authenticity met artistic reinterpretation: geological specimens were the dominant attractor (86.7 %), yet it was artistic mediation that participants most strongly credited with facilitating their understanding (83.3 %). We interpret this convergence as preliminary evidence that physical specimens and artistic representation may operate as complementary rather than competing channels of engagement (de Kluis et al., 2024; Lesen et al., 2016).

This interpretation remains speculative given the cross-sectional design and the absence of item-level cross-tabulation, but it
95 carries a practical implication: in informal STEAM initiatives built around geoscience content, reducing specimen collections to decorative elements subordinate to artistic activities may undermine the very engagement dynamic these data suggest is most productive. The reading is also context-dependent. Geology is minimally represented in Ecuador's secondary curriculum, so large public events such as FIAVL may be among the few occasions on which non-specialist audiences meet geological content in an engaging, non-evaluative setting (consistent with the 70.0 % of participants reporting limited or no prior
100 geological knowledge).

These findings should be read against clear constraints: post-experience self-report only, convenience sampling, a small single-site sample ($n = 30$), and uniformly high satisfaction subject to ceiling effects. They characterize the perceptual profile of engaged, self-selected visitors rather than the general festival audience, and cannot separate exhibition-induced change from pre-existing knowledge. Even so, within an underrepresented Latin American context, the GeoArte experience indicates that
105 culturally embedded, art-mediated geoscience communication can open access to geological knowledge for non-specialist audiences (most productively, these data suggest, when authentic specimens and artistic mediation are designed to reinforce one another rather than compete).

Data availability. The data supporting the findings of this study are available on request from the corresponding author. Access may be subject to limitations imposed by ethical and confidentiality considerations aimed at protecting the privacy of participants.

110

Author contributions. Conceptualization, S.N., R.G. and J.S.; Methodology, S.N., R.G., A.A., M.C. and J.S.; Software, S.N. and R.G.; Formal analysis, S.N., R.G. and J.S.; Investigation, S.N., J.S. and R.G.; Resources, R.G., J.S. and S.N.; Data curation, S.N.; Writing original draft, S.N., J.S. and R.G.; Writing, review and editing, S.N., A.A., J.S., M.C., R.G., H.J. and C.F.; Visualization, S.N.; Supervision, S.N. and R.G.; Project administration, S.N. All authors have read and agreed to the published version of the manuscript.

115

Competing interests. The authors declare no conflicts of interest.

Financial support. This research was supported by the Universidad Técnica Particular de Loja (UTPL) through the institutional programme "Ciencia a través del Arte" (2025).

Acknowledgements. The authors thank the organizers of the International Festival of Living Arts of Loja (FIAVL) for hosting the GeoArte initiative, the colleagues and volunteers who supported the design and assembly of the exhibition and the participatory mural, and all festival visitors who kindly took part in the survey.

120

References

Asghar, A.: Informal science contexts: Implications for formal science learning, *LEARNing Landscapes*, 5, 55–72, <https://doi.org/10.36510/learnand.v5i2.551>, 2012.

125 Braun, V. and Clarke, V.: Using thematic analysis in psychology, *Qual. Res. Psychol.*, 3, 77–101, <https://doi.org/10.1191/1478088706qp063oa>, 2006.

Braund, M. and Reiss, M. J.: The 'great divide': How the arts contribute to science and science education, *Can. J. Sci. Math. Technol. Educ.*, 19, 219–236, 2019.

130 Corrigan, M. W., Wong, J. T., Grove, D., Andersen, S., and Hughes, B. S.: Enhancing elementary students' conceptual understandings of scientific phenomena: The impact of STEAM-first and STEM-first approaches, *Sci. Educ.*, 109, 1336–1364, <https://doi.org/10.1002/sce.21942>, 2025.

de Kluis, T., Romp, S., and Land-Zandstra, A. M.: Science museum educators' views on object-based learning: The perceived importance of authenticity and touch, *Public Underst. Sci.*, 33, 325–342, <https://doi.org/10.1177/09636625231202617>, 2024.

135 Falk, J. H. and Dierking, L. D.: *Learning from Museums: Visitor Experiences and the Making of Meaning*, Rowman & Littlefield, Lanham, MD, 2018.

Gray, M.: *Geodiversity: Valuing and Conserving Abiotic Nature*, 2nd edn., Wiley-Blackwell, Chichester, 2013.

140 Hughes, B. S., Corrigan, M. W., Grove, D., Andersen, S. B., and Wong, J. T.: Integrating arts with STEM and leading with STEAM to increase science learning with equity for emerging bilingual learners in the United States, *Int. J. STEM Educ.*, 9, 58, <https://doi.org/10.1186/s40594-022-00375-7>, 2022.

Lesen, A. E., Rogan, A., and Blum, M. J.: Science communication through art: Objectives, challenges, and outcomes, *Trends Ecol. Evol.*, 31, 657–660, <https://doi.org/10.1016/j.tree.2016.06.004>, 2016.



- Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., and Vílchez-González, J. M.: What are we talking about when we talk about STEM education? A review of literature, *Sci. Educ.*, 103, 799–822, 2019.
- 145 Matias, A., Carrasco, A. R., Ramos, A. A., and Borges, R.: Engaging children in geosciences through storytelling and creative dance, *Geosci. Commun.*, 3, 167–177, <https://doi.org/10.5194/gc-3-167-2020>, 2020.
- McNeal, P. M. and Petcovic, H. L.: Spatial thinking and fluid Earth science education research, *J. Geosci. Educ.*, 68, 289–301, <https://doi.org/10.1080/10899995.2020.1768007>, 2020.
- 150 Mejias, S., Thompson, N., Sedas, R. M., Rosin, M., Soep, E., Peppler, K., Roche, J., Wong, J., Hurley, M., Bell, P., and Bevan, B.: The trouble with STEAM and why we use it anyway, *Sci. Educ.*, 105, 209–231, <https://doi.org/10.1002/sce.21605>, 2021.
- Perignat, E. and Katz-Buonincontro, J.: STEAM in practice and research: An integrative literature review, *Think. Skills Creat.*, 31, 31–43, <https://doi.org/10.1016/j.tsc.2018.10.002>, 2019.
- R Core Team: R: A language and environment for statistical computing, R Foundation for Statistical Computing, 155 Vienna, Austria, available at: <https://www.R-project.org/> (last access: 9 April 2026), 2024.
- Vasconcelos, C. and Ribeiro, T.: The interplay of geoheritage and outdoor experiences through education and communication, in: *Geoheritage: Assessment, Protection, and Management*, 2nd edn., edited by: Reynard, E. and Brilha, J., Elsevier, Amsterdam, 411–430, <https://doi.org/10.1016/B978-0-443-28997-2.00016-9>, 2025.
- 160 Wright, R. A., Jackson, K., Girardin, C., Smith, N., and Wedding, L. M.: GC Insights: Enhancing inclusive engagement with the geosciences through art–science collaborations, *Geosci. Commun.*, 6, 39–43, <https://doi.org/10.5194/gc-6-39-2023>, 2023.
- Wynn, T. and Harris, J.: Toward a STEM + arts curriculum: Creating the teacher team, *Art Educ.*, 65, 42–47, 2012.