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Children's Science Outreach Platforms through Informal Science Education: A Scoping Review with a Focus on Iran

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Abstract

Purpose: Informal science education is a prerequisite for successful science outreach; without it, the effectiveness of outreach programs diminishes. This study aimed to identify effective informal education platforms for promoting science among children and to evaluate Iran's engagement within each platform.

Methodology: A scoping review was conducted following Arksey and O'Malley's five-stage framework. A systematic search identified and selected 31 relevant sources for analysis.

Findings: The analysis identified seven primary platforms for children's science outreach: (1) Organizational Coordination, (2) Events and Exhibitions, (3) New Technologies, (4) Nature-Based Experiences, (5) Interdisciplinary Science-Art Programs, (6) Family Participation, and (7) Direct Involvement of Scientists.

Conclusion: In Iran, despite valuable institutional efforts, science outreach activities remain fragmented. Platforms combining science with art and those involving the direct participation of scientists have received less attention. The establishment of national programs, support for interdisciplinary projects, and the cultivation of networks among scientific institutions could enhance coordination and expand the impact of children's science outreach across the country.

Value: This research provides a valuable mapping of effective global platforms and a critical analysis of Iran's position within them. This enables evidence-informed policymaking for national science outreach development. The findings can guide educational, cultural, and research institutions in designing participatory, interdisciplinary, and creative programs to advance children's scientific literacy.

Keywords: ***Active Children's Participation, Science Outreach Activities, Scientific Literacy, Informal Science Education, Scoping Review.***

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Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

Extended Abstract

Introduction: Informal science education refers to structured learning activities that occur outside the formal school system (Sefton-Green, 2012). These activities may take place in settings such as museums, science centers, and aquariums, or through digital media platforms (Rautela, 2023). This concept has emerged as an effective complement to formal education, offering more flexible and engaging opportunities for science learning (Bell et al., 2009; Bathgate, Schunn, & Correnti, 2014). In contrast to formal education, which is grounded in standardized curricula and structured assessments, informal education is driven by learner curiosity, interaction, and self-exploration (Hein, 2009). It is typically inquiry-based and experience-oriented, fostering intrinsic motivation and promoting long-term engagement with science (Stocklmayer, Rennie, & Gilbert, 2010; Falk & Dierking, 2019). Morrow (2004) emphasizes that informal science education is essential for effective science communication, arguing that a lack of such environments weakens the impact of outreach efforts. The integration of formal and informal learning experiences is key to enhancing children's scientific literacy. Purposeful informal learning can compensate for the limitations of formal education by nurturing curiosity, cultivating positive attitudes toward science, and preparing children for a knowledge-based society (Hinojosa et al., 2021).

Purpose: This study examines the potential of informal science education to enhance children's engagement with science and technology. While limited studies exist in the Iranian context, a systematic, comparative analysis is lacking. Therefore, this study aims to identify the key informal learning platforms used globally for children's science outreach and to evaluate Iran's current position and engagement within this international framework.

Methodology: This study employed a scoping review methodology based on the five-stage framework proposed by Arksey and O'Malley (2005). The process involved a systematic and iterative search strategy using relevant keywords in both Persian and English. International literature was sourced from databases including Scopus, Web of Science (WoS), Google Scholar, and ScienceDirect. Domestic (Iranian) literature was sourced from Magiran, Noormags, ISC, and IranDoc. To enhance transparency and methodological rigor, the PRISMA-ScR framework was followed. Following a two-stage screening process (title/abstract and full-text), 31 studies met the eligibility criteria and were included in the final analysis. Data extracted from these studies were analyzed and thematically synthesized to answer the research questions and map the key thematic domains.

Findings: Based on a scoping review of 31 domestic and international studies, this research identified seven primary informal education contexts used globally to promote science among children: (1) Workshop-based activities in museums, libraries, and science centers; (2) Public events, exhibitions, and science festivals; (3) The application of digital and multimedia technologies; (4) Nature-based exploratory experiences; (5) Integration of science with art, crafts, humor, and entertainment; (6) Family-centered participation programs; (7) Direct interaction between scientists and children.

Qualitative analysis revealed that successful global models emphasize interactive, experiential design and incorporate play, humor, and storytelling. A

common feature is the prioritization of children's active participation as the core of the science learning process.

Regarding the Iranian context, the results indicate that despite valuable initiatives by institutions such as the Center for Intellectual Development, science museums, and scientific associations, outreach programs are often fragmented, short-term, and lack coherent national policy support. Figure 1 illustrates these seven major outreach platforms, with examples from Iran showing uneven development. While workshops are relatively common, platforms integrating science and art, facilitating family involvement, and enabling direct scientist-child interaction have received less attention. Furthermore, a lack of sustained collaboration among educational, cultural, and research institutions was identified as a key barrier to expanding informal science education in the country.

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

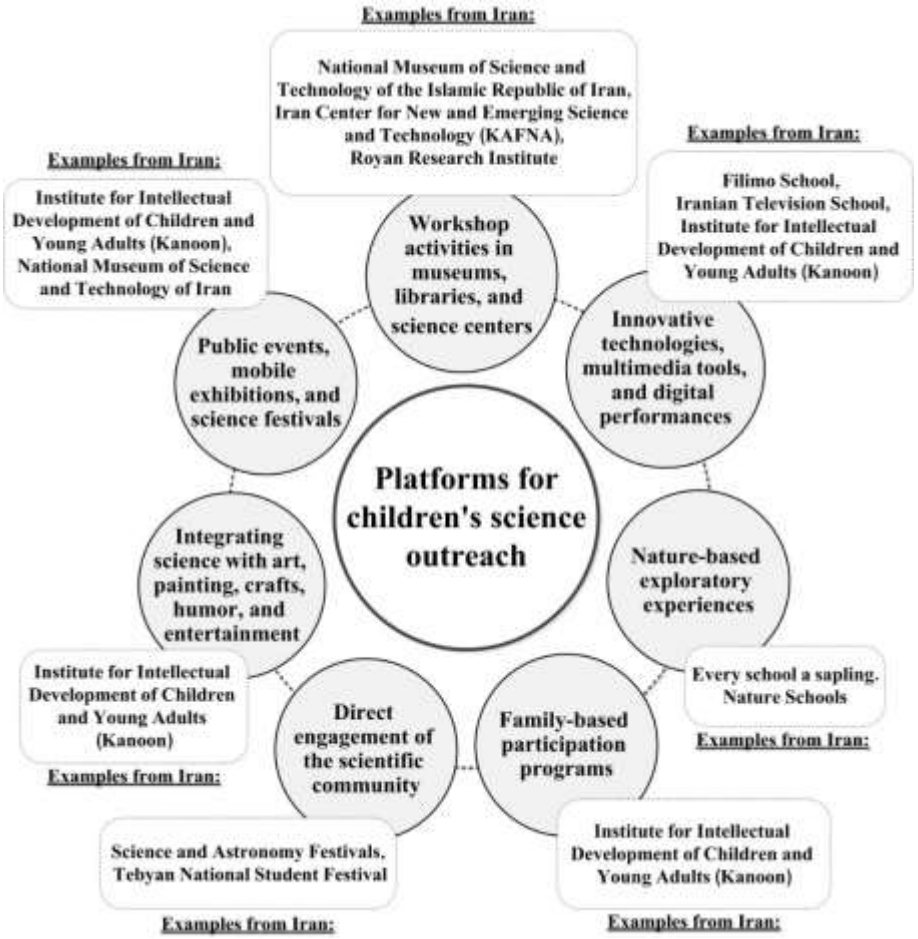

Figure 1: seven major platforms for children's science outreach.

Conclusion: Despite existing promising examples, science outreach activities in Iran remain fragmented, institutionally isolated, and lack a coherent national strategy. Many programs continue to rely on a one-way transfer of information rather than embracing interactive, inquiry-based, or participatory learning methodologies. To address these gaps, institutions such as libraries and schools must move beyond their traditional roles and transform into dynamic hubs for hands-on science exploration. Achieving this transformation in the Iranian context necessitates the formulation of coordinated national policies, dedicated support for interdisciplinary projects, and the strategic use of media, technology, and art to present scientific concepts in engaging and accessible ways. Consequently, strengthening collaboration

among schools, universities, and cultural institutions to create an integrated network of informal science education centers represents a critical step toward fostering a sustainable culture of science and enhancing scientific literacy among children. Ultimately, the findings of this review affirm that informal science education should not be viewed as a peripheral activity but rather as a strategic and essential component of effective science outreach and holistic child development policy.

Value: This research provides significant insights for both policymaking and practice by mapping effective global platforms for children's science outreach and critically analyzing Iran's current position within this landscape. The findings offer an evidence-based foundation for developing informed national science promotion policies. Furthermore, the results provide practical guidance for educational, cultural, and research institutions to design collaborative, interdisciplinary, and creative programs that effectively advance children's scientific literacy.

Specifically, the study makes two key contributions: (1) It highlights the critical need for institutional synergy among museums, universities, NGOs, and families to transition from isolated, short-term projects to a sustained, coordinated national effort. (2) It underscores the strategic importance of currently underutilized approaches- particularly the direct participation of scientists and the integration of science with the arts- as high-impact domains for cultivating positive attitudes and deeper engagement with science among children.

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

References:

Abbaspour Esfahani, N., Hatami, J., Sadeghzadeh Qamsari, A., Imani, M., & Peighami, A. (2022). Comparative study of financial literacy curriculum in formal general education in Australia, South Africa, and the USA: Recommendations for Iranian curriculum planners. *Comparative Education, 5*(4), 2146–2163. https://doi.org/10.22034/ijce.2022.277565.1295 [In Persian]

Afshar Kohan, Z. (2022). Educational humor: An overlooked capacity for improving education quality. *Education and Training, 38*(1), 69–88. https://dor.isc.ac/dor/20.1001.1.10174133.1401.38.1.4.2 [In Persian]

Alexandre, S., Washington-Nortey, M., & Chen, C. (2022). Informal-STEM learning for young-children: A systematic-literature-review. *International journal of environmental research and public health*, *19*(14), 8299. https://doi.org/10.3390/ijerph19148299

Allner, M., McKay, C., Coe, L., Rask, J., Paradise, J., & Wynne, J. (2010) NASA's explorer school and spaceward bound programs: Insights-into-two-education-programs designed to heighten public support for space science initiatives. *Acta Astronautica*, *66*(7-8), 1280-1284. https://doi.org/10.1016/j.actaastro.2009.09.019

Arksey, H., & O'malley, L. (2005). Scoping-studies: towards a methodological framework. *International journal of social-research-methodology, 8*(1), 19-32. https://doi.org/10.1080/1364557032000119616

Bagherian, H., Zare, A., & Jafari, A. (2021). Stories as a bridge from imagination to reality: The role of librarians using stories in teaching life skills to children and adolescents. *New Approaches in Psychology and Educational Sciences, 3*(11), 127–142. https://www.ijpk.ir/showpaper/1234056 [In Persian]

Barnes, J., FakhrHosseini, M., Vasey, E., Park, H., & Jeon, M. (2020). Child-robot theater: Engaging-elementary-students-in-informal-STEAM-education-using robots. *IEEE Pervasive Computing, 19*(1), 22-31. https://doi.org/10.1109/MPRV.2019.2940181

Bathgate, E., Schunn, D., & Correnti, R. (2014). Children's motivation-toward-science across-contexts, manner-of-interaction, and-topic. *Science-Education*, *98*(2), 189-215. https://doi.org/10.1002/sce.21095

Bell, J., Falk, J., Hughes, R., Hunt, G., Parrish, J., Ruffin, M., & Troxel, G.(2016). Informal-STEM education: Resources-for-outreach, engagement-and-broader impacts. *Science-Education(CAISE),*1-28. http://drbob.pbworks.com/w/file/fetch/107996069/CAISE_Broader_Impacts_Report_2016.pdf

Benabdallah, G., Bourgault, S., Peek, N., & Jacobs, J.(2021, May). Remote learners, home makers: How digital fabrication was taught online during a pandemic. *Proceedings of the 2021 CHI Conference on Human-Factors-in-Computing-Systems* (pp. 1-14). https://doi.org/10.1145/3411764.3445450

Bertram, N. (2012). *An investigation into bridging formal and informal education in schools* (Doctoral dissertation, University-of-Glasgow). https://eleanor.lib.gla.ac.uk/record=b2931825

Bevan, B., Calabrese-Barton, A., & Garibay, C.(2020). Broadening perspectives on broadening participation: Professional-learning tools for more expansive and equitable science-communication. *Frontiers in Communication*, *5*, 52. https://doi.org/10.3389/fcomm.2020.00052

Boeve-de Pauw, J., Van-Hoof, J., & Van-Petegem, P.(2019). Effective Field-Trips in Nature: The Interplay Between Novelty and Learning. *Biol. Edu.* 53 (1), 21–33. https://doi.org/10.1080/00219266.2017.1418760

Bultitude, K., McDonald, D., & Custead, S. (2011). The rise of science-festivals: An international review of organised events to celebrate science. *International Journal of Science-Education, Part-B*, *1*(2), 165-188. https://doi.org/10.1080/21548455.2011.588851

Burns, A., & Manouchehri, B.(2021). Reconnecting children with nature: foundation and growth-of-the-nature-schools movement in Iran. *Interdisciplinary Journal of Environmental and Science-Education, 17*(3), e2244. https://doi.org/10.21601/ijese/10934

Carballido, V., Díez-Palomar, J., Garcia-Yeste, C., & Morejón, O.(2024). The effects of children's participation and co-creation in science. *Humanities and Social Sciences Communications*, *11*(1), 1-8. https://www.nature.com/articles/s41599-023-02473-5

Chase, E., Hoffman, L., & Lasnoski, M.(2024). *Cultural-Heritage Conservation for Early-Learners: Outreach-and-Engagement-with-the-Next-Generation*. Routledge. https://doi.org/10.1080/01971360.2025.2458350

Chen, X., & Zhang, Y.(2023). Virtual Field-Trips in K-12 Classroom Teaching: A Systematic-Review. International Journal of Technology in Teaching and Learning, *19*(1), 52-68. https://doi.org/10.3389/fcomm.2020.00052

Clark, G., Russell, J., Enyeart, P., Gracia, B., Wessel, A., Jarmoskaite, I., & Roux, S.(2016). Science-educational-outreach-programs-that-benefit-students-and-scientists. *PLoS biology*, *14*(2), e1002368. https://doi.org/10.1371/journal.pbio.1002368

Cornelis, G.(1998). Is popularization of science possible?. *The-Paideia-Archive: Twentieth-World-Congress-of-Philosophy* (Vol. 37, pp. 30-33). https://doi.org/10.5840/wcp20-paideia199837647

Dardani, A., & Markabi, S. M. (2023). Pathology of educational TV programs with a focus on "Iran TV School" and "Filimo School." *Audiovisual Media, 17*(48), 101–136. https://doi.org/10.22085/javm.2023.376556.2020 [In Persian]

Darzi Ramandi, H., Kian, M., Abbasi, E., & Haji Hosseinzadeh, G. (2019). Designing and validating an extracurricular-based curriculum model for primary education based on Klein's model. *Theory and Practice in Curriculum, 7*(14), 193–230. https://www.jcstpicsa.ir/article_192036_en.html [In Persian]

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

Dettweiler, U., Ünlü, A., Lauterbach, G., Becker, C., & Gschrey, B.(2015). Investigating the Motivational Behavior of Pupils During Outdoor-Science-Teaching Within Self-Determination-Theory. *Front. Psychol.* 6, 125. doi:10.3389/fpsyg.2015.00125

DeWitt, J., & Archer, L. (2017). Participation in informal-science learning experiences: The rich get richer?. *International Journal of Science Education, Part B, 7*(4), 356-373. https://doi.org/10.1080/21548455.2017.1360531

Dibaei Saber, M., Heydari Qomi, A., & Malahosseini, A. (2022). Comparative evaluation of the quality of extracurricular activities in secondary schools of Qom. *Tarbiyat Islami, 17*(40), 45–58. https://doi.org/10.30471/edu.2021.5175.2441 [In Persian]

Doulati, M. (2024, November 21). *Effect of formal and informal education on the effectiveness and performance improvement of primary schools*. Bandar Abbas. https://civilica.com/doc/2127183 [In Persian]

Falk, H., & Dierking, D. (2019). Reimagining public science-education: the role of lifelong free-choice learning. *Disciplinary and Interdisciplinary-Science-Education Research, 1*, 1-8. https://doi.org/10.1186/s43031-019-0013-x

Fox, J. (2015). Changes in urban youths' attitude towards science and perception of a mobile science-lab experience. *Columbia-University*. https://www.proquest.com/intermediateredirectforezproxy

Freitag, C., & Siska, M. (2019). Evaluating Nature Museum Field-Trip Workshops, an Out-of-School STEM-Education Program. *Connected-Science-Learning*. https://doi.org/10.1080/24758779.2019.12420554

Froost, H. (2022). Developing biology education using modeling and hands-on activities. *Iranian Biology, 6*(Fall–Winter), 203–225. https://www.ijbio.ir/article_2371.html [In Persian]

Ghadimi, A., & Hejazi, E. (2021). Science promotion model in Iran: An empirical study. *Research and Planning in Higher Education, 27*(1), 153–182. https://journal.irphe.ac.ir/article_703023_en.html [In Persian]

Gomes, D., & McCauley, V. (2012). Science-outreach-and-science-education in the primary level: conceptual and pedagogical challenges faced. *Literacy Information and Computer Education Journal*, 930-93. http://dx.doi.org/10.20533/licej.2040.2589.2012.0123

Halonen, E., & Aksela, K. (2018). Non-formal science-education: The relevance of science-camps. *International Journal on Math, Science and Technology Education, 6*(2), 64-85. https://researchportal.helsinki.fi/en/publications/non-formal-science-education-the-relevance-of-science-camps

Hammond, L. (2020). Bird-feeders increase connection to nature in parents but not in their children. *Ecopsychology, 12*(1), 44-53 https://doi.org/10.1089/eco.2019.0036

Hands, C., Kurucz, E., Spencer-Mueller, K., Gudz, N., & Archer, K. (2025). Beyond school newsletters and memos: Family engagement in planning, developing, and delivering an innovative-STEM program. *Education-Sciences, 15*(6), 665. https://www.mdpi.com/2227-7102/15/6/665

Hein, G. (2009). Learning science in informal environments: People, places, and pursuits. *Museums & Social Issues, 4*(1), 113-124. https://doi.org/10.1179/msi.2009.4.1.113

Heras, M., Ruiz-Mallén, I., & Gallois, S. (2020). Staging science with young people: Bringing-science closer to students through stand-up comedy. International Journal of Science-Education, 42(12), 1968-1987. https://doi.org/10.1080/09500693.2020.1807071

Hinojosa, L., Swisher, E., & Garneau, N. (2021). The organization of informal-pathways into STEM: designing towards equity. International Journal of Science Education, 43(5), 737-759. https://doi.org/10.1080/09500693.2021.1882010

Hobbs, L., & Stevens, C. (2022). Investing in the future of science: Assessing UK environmental science-engagement with school- aged children. *Plants, People, Planet, 4*(3), 232-242. https://nph.onlinelibrary.wiley.com/doi/abs/10.1002/ppp3.10250

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

Holmes, A. (2011). Informal-learning: Student achievement and motivation in science through museum-based learning. *Learning-Environments-Research*, *14*(3), 263-277. https://link.springer.com/article/10.1007/s10984-011-9094-y

Jafari Nejad, M. (2014). The role of science and technology museums in science promotion: Case study of the Islamic Republic of Iran Science and Technology Museum. *Science Promotion, 5*(1), 9–23. https://www.popscijournal.ir/article-92808.html [In Persian]

Joy, A., Law, F., McGuire, L., Mathews, C., Hartstone-Rose, A., Winterbottom, M., & Mulvey, K. L. (2021). Understanding parents' roles in children's learning and engagement in-informal-science-learning sites. Frontiers-in-Psychology, 12, 635839. https://doi.org/10.3389/fpsyg.2021.635839

Jungmann, H., Mascini, E., Kiss, A., Smith, F., Klinkert, I., Eijkel, B., & Heeren, M. (2013). A MASSive laboratory-tour. An interactive mass spectrometry outreach activity for children. *Journal-of-The-American-Society-for-Mass-Spectrometry*, *24*(7), 979-982. https://pubs.acs.org/doi/10.1007/s13361-013-0663-4

Kanoon Children & Adolescents News Agency. (2025). *Special program "Night Sky: Science Education and Promotion*." https://www.kanoonnews.ir/news/340527/ [In Persian]

Kidd, C., & Hayden, Y. (2015). The psychology and neuroscience of curiosity. *Neuron*, *88*(3), 449-460. https://doi.org/10.1016/j.neuron.2015.09.010

Kucirkova, I., & Speed, J. (2023). Children's multisensory experiences in museums: how olfaction interacts with color. In *Frontiers-in-Education* (Vol. 8, p. 1242708). Frontiers Media SA. https://doi.org/10.3389/feduc.2023.1242708

Kumar, V., & Nanda, P. (2024). Social media as a learning tool: A perspective on formal and informal-learning. *International-Journal-of-Educational-Reform*, *33*(2), 157-182. https://doi.org/10.1177/1056787922109430

Laine, H., Nygren, E., Dirin, A., & Suk, J. (2016). Science-Spots AR: a platform for science learning-games with augmented reality. *Educational-Technology Research and Development*, *64*(3), 507-531. https://doi.org/10.1007/s11423-015-9419-0

Lawrence, M., & Tinkler, A. (2015). What can you learn about science in a natural-history museum?*School Science-Review*, *97*(358), 61–66. https://dialnet.unirioja.es/servlet/articulo?codigo=5321842

Leblebicioglu, G., Metin, D., Yardimci, E., & Cetin, P. (2011). The-effect-of-informal and-formal-interaction-between-scientists-and-children-at-a-science-camp-on-their-images of-scientists. *Science-Education-International*, *22*(3), 158-174. https://eric.ed.gov/?id=EJ941681

Li, Q. (2022). Effects of different types of digital exhibits on children's experiences in science museums. *The Design Journal*, *25*(1), 126-135. https://www.tandfonline.com/doi/full/10.1080/14606925.2021.2015162

Luckie, D., Aubry, R., Marengo, B.., Rivkin, M., Foos, L., & Maleszewski, J. (2012). Less teaching, more learning: 10-yr study supports increasing student learning through less coverage-and-more-inquiry. *Advances-in-physiology-education*, *36*(4), 325-335. https://doi.org/10.1152/advan.00017.2012

Mahmoudpour, B. (2020). Examining the achievement of goals and conformity with the characteristics of informal education in a science promotion event: Case study of "Let's Ask from Stone." *Science Promotion, 11*(18), 200–228. https://dor.isc.ac/dor/20.1001.1.22519033.1399.11.1.9.8 [In Persian]

Martins-Gomes, D., & McCauley, V. (2021). Creativity in science: A dilemma for informal and formal-education. *Science-Education*, *105*(3), 498-520. https://onlinelibrary.wiley.com/doi/full/10.1002/sce.21614

Matlabi, D. (2017). Public libraries in the service of science promotion. *Journal of Book Criticism, Information, and Communication, 4*(13–14), 183–200. https://www.magiran.com/p1755219 [In Persian]

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

McClure MB, Hall, Brooks EF, Allen CT, Lyle.(2020) A pedagogical-approach-to-science outreach. PLoS-Biol. 2020 16;18(4):e3000650. https://europepmc.org/article/pmc/7188294

McGuire, L., Hoffman, J., Mulvey, L., Winterbottom, M., Balkwill, F., Burns, P., & Hartstone-Rose, A. (2022). Impact of youth and adult informal-science educators on youth learning at exhibits. *Visitor Studies*, *25*(1), 41-59. https://doi.org/10.1080/10645578.2021.1930467

Mehr News Agency. (2017). *Participation of 6,000 students in Tebyan student projects festival*. https://mehrnews.com/xHKgf [In Persian]

Metz, C. J., Downes, S., & Metz, J. (2018). The-in's-and-out's-of-science-outreach: assessment-of-an-engaging-new-program. *Advances-in-physiology-education*, *42*(3), 487-492. https://doi.org/10.1152/advan.00085.2018

Momeni, F. (2024). Effect of chemistry laboratories on learning and interest in chemistry among students. *Research in Chemistry Education*, *3*(6), 32–63. https://doi.org/10.48310/chemedu.2024.16617.1247 [In Persian]

Morris, J., Owens, W., Ellenbogen, K., Erduran, S., & Dunlosky, J. (2019). Measuring informal-STEM-learning-supports-across-contexts-and-time. *International-Journal of STEM-Education*, *6*(1), 40. https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-019-0195-y

Morrow, A., & P. Dusenbery. Workshops for scientists and engineers on education and public outreach." Advances in Space Research 34, no. 10 (2004): 2153-2158. https://doi.org/10.1016/j.asr.2003.05.061

Mumelaš, D., & Martek, A. (2024). Benefits of citizen science for libraries. *Publications*, *12*(1), 8. https://www.mdpi.com/2304-6775/12/1/8

Muñoz-Losa, A., & Corbacho-Cuello, I. (2025). Impact-of-Interactive-Science Workshops-Participation-on-Primary-School-Children's-Emotions-and-Attitudes-Towards Science. *Internationa-Journal of Science and Mathematics-Education*, 1-18. https://doi.org/10.1007/s10763-024-10539-2

Naseri, A., Abedi Rajooni, M., Vahdatipour Bijar Pasi, H., & Heyranian, A. (2024, October 22). Examining the importance of connecting science and art: Effects on multi-dimensional learning of students. Tehran. https://civilica.com/doc/2129976 [In Persian]

Nasir, S., & Hand, V. (2008). From-the-court-to-the-classroom: Opportunities for engagement, learning, and identity in basketball and classroom-mathematics. The *Journal of the Learning-Sciences*, *17*(2), 143-179. https://www.tandfonline.com/doi/abs/10.1080/10508400801986108

Negahban, M., Ahmadi, G., & Kabiri, M. (2020). Identifying some misconceptions of fourth-grade students in science based on TIMSS 2015 study. *Research in Educational Systems*, *14*(48), 127–143. https://sid.ir/paper/137490/fa [In Persian]

Norouzi, B., Iivari, N., Kinnula, M., & Milara, S. (2024). Challenges in starting to design and make together: Examining family-engagement-in-Fab-Labs: A nexus-analytical inquiry. *International Journal of Human-Computer-Studies*, *183*, 103185. https://doi.org/10.1016/j.ijhcs.2023.103185

Novikova, E., & Gallo-Fox, J. (2025). Maintaining-family-engagement-during-the-initial months-of-COVID-19 in-an-early-childhood-nature-program. *Journal of Outdoor and Environmental Education*, *28*(1), 131-153. https://link.springer.com/article/10.1007/s42322-024-00159-3

O'Connor, A., Roberson, T., de-Castella, C., & Leviston, Z. (2023). The-value of public-science-events: insights-from three-years-of-communicating-climate-change research. *Journal-of-Science-Communication*, *22*(5), N05. https://doi.org/10.22323/2.22050805

Pakizeh, A. (2015). Investigating the effect of integrated art-based teaching on creativity and learning of first-grade male students. *Jundishapur Education Development*, *6*(1), 52–60. https://edj.ajums.ac.ir/article_79731.html [In Persian]

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

Peleg, R., & Baram-Tsabari, A. (2017). Learning robotics in a science-museum theatre play: Investigation of learning outcome. *Journal-of-Science-Education-and-Technology*, *26*(6), 561-581. https://doi.org/10.1007/s10956-017-9698-9

Peters, D., Marnie, C., Tricco, C., Pollock, D., Munn, Z., Alexander, L., & Khalil, H. (2020). Updated methodological guidance-for-the-conduct-of-scoping-reviews. evidence-synthesis, 18(10), 2119-2126. https://journals.lww.com/jbisrir/toc/2020/10000

Piper, M., Frankle, J., Owens, S., Stubbins, B., Tully, L., & Ryker, K. (2025). A review of inquiry and utility of mineral-and-rock-labs for use in introductory-geology courses. *Journal of Geoscience Education*, *73*(2), 106-116. https://doi.org/10.1080/10899995.2024.2305981

Poliakoff, E., & Webb, L. (2007). What factors predict scientists' intentions to participate in public-engagement of science-activities? *PLOS ONE*, *2*(11), e1062. https://doi.org/10.1371/journal.pone.0001062

Prins, J., van-der-Wilt, F., van-der-Veen, C., & Hovinga, D. (2022). Nature-play in early childhood-education: A systematic-review and meta-ethnography of qualitative research. *Frontiers-in-psychology*, *13*, 995164. https://doi.org/10.3389/fpsyg.2022.995164

Rakani Lamuki, G., & Haqbin Nazar Pak, M. (2024). Theoretical review of mathematics education in Iran. *Mathematics and Society*, *10*(3), 119–148. http://doi.org/10.22108/msci.2025.141819.1670 [In Persian]

Raturi, A. (2025). Stars-Over-the-Hills: Enhancing Rural Students' Interest in Physics Through-Astronomy-Outreach. (p. 20). https://episteme10.hbcse.tifr.res.in/docs/epiSTEME-Extended-Abstracts-2025.pdf#page=36

Rautela, S. (2023). Outdoor-and-Outreach: Informal-Science-Education Outside-the-Four Walls of Science-Centers. In Amplifying-Informal-Science-Learning (254-264). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781003145387-28/outdoor-outreach-ganga-rautela

Raven, S., & Wenner, A. (2023). Science-at-the-center: Meaningful-science-learning in a preschool classroom. *Journal of Research in Science Teaching*, *60*(3), 484-514. https://doi.org/10.1002/tea.21807

Refaati Panah Mehrabadi, M. (2022). History of environmental education in Iran: Environment in textbooks of the 1980s. *Tarikh Negari va Tarikh Negari*, *31*(28), 121–151. https://doi.org/10.22051/hph.2023.42852.1650 [In Persian]

Reyes, L., Isleta, P., Regala, D., & Bialba, R. (2024). Enhancing-experiential-science learning with virtual-labs: A narrative-account of merits, challenges, and implementation strategies. *Journal of Computer Assisted-Learning*, *40*(6), 3167-3186. https://doi.org/10.1111/jcal.13061

Ribeiro, G., & Sant'Ana, G. (2019). The entomological exhibition of a Science-museum and its contributions to non-forma-Education. *Acta Scientiarum. Biological Sciences*, *41*, 43668. https://www.redalyc.org/journal/1871/187160125012/

Rillero, P., Jiménez-Silva, M., Short-Meyerson, K., & Rillero, M. (2025). From seeds to harvest in seven weeks: Project-based-learning with Latina-girls and their parents. *Education-Sciences*, *15*(2), 246. https://www.mdpi.com/2227-7102/15/2/246

Roberts, T., Jackson, C., Mohr-Schroeder, J., Bush, B., Maiorca, C., Cavalcanti, M., & Cremeans, C. (2018). Students'-perceptions of STEM-learning after participating in a summer informal-learning-experience. *International journal of STEM-education*, *5*(1), 35. https://doi.org/10.1186/s40594-018-0133-4

Roche, J., & Davis, N. (2019). Broadening horizons: Science-communication for young-audiences in digital-spaces. Frontiers-in-Communication, 4. https://doi.org/10.1177/10567879221094303

Rose, M., Markowitz, M., & Brossard, D. (2020). Scientists' incentives-and-attitudes toward public-communication. *Proceedings-of-the-National-Academy of Sciences*, *117*(3), 1274–1276. https://doi.org/10.1073/pnas.1916740117

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

Rowe, P., Lobene, V., Mott, W., & Lester, C. (2020). Play in-the-museum: Design and development of a game-based learning exhibit for informal-science-education. In *Natural-Language-Processing: Concepts, Methodologies, Tools, and Applications* (pp. 214-231). IGI Global Scientific Publishing. https://intellimedia.ncsu.edu/wp-content/uploads/sites/42/Rowe-IJGCMS-2017.pdf

Santos, M., & Sá-Silva, R. (2022). Science-and-technology workshops as a pedagogical strategy for teaching-science in elementary-schools. Ciência & Educação, 28(19), 1–12. https://doi.org/ 10.1590/1516-731320220035

Schilhab, T. (2021). Nature-experiences in science-education in school: Review featuring-learning gains, investments, and costs in view of embodied cognition. In *Frontiers in Education* (Vol. 6, p. 739408) .Frontiers-Media SA. https://doi.org/10.1080/10899995.2024.2305981

Schweingruber, A., & Fenichel, M. (2010). *Surrounded-by-science: Learning-science in informal-environments*. National-Academies-Press. https://www.google.com/books/edition/Surrounded_by_Science/u-g5vSHMg1kC?hl=en

Sefton-Green, J. (2012). Learning at not-school: A review of study, theory, and advocacy for education in non-formal settings (p. 100). The MIT Press. https://doi.org/10.7551/mitpress/9351.001.0001

Seif, H., Bagheri, A., Ebrahimi, A., & Akhundi, M. (2024, December 21). *Investigating the integration of art with science education to enhance creativity and learning in second-grade primary students*. Tehran. https://civilica.com/doc/2149747 [In Persian]

Selvakumar, M. (2019). Portal-to-the-Public. In *The Reflective Museum-Practitioner* (pp. 123–136). Routledge.https://www.taylorfrancis.com/chapters/edit/10.4324/9780429025242-10/portal-public-meena-selvakumar

Seyedkalan, S. M., & Hosseinzadeh, R. (2021). Integrating art with teaching science in primary education: An evaluative approach. *Journal of Research in Curriculum Studies, 1*(1), 70–83. http://doi.org/10.48310/jcdr.2022.2320 [In Persian]

Shabibavi, H., Kalbat-Mousavi, H., & Hassanzadeh-Arab, S. (2024, March 1). *Examining the effect of informal education on students' life skills*. Tehran. https://civilica.com/doc/2210359 [In Persian]

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., & Stewart, A. (2015). Preferred reporting items for systematic-review and meta-analysis protocols (PRISMA-P) 2015: elaboration-and-explanation. *Bmj*, *349*. 1. https://doi.org/10.1136/bmj.g7647

Sharafi, M., Mahmoudi, S., & Hosseinbar, B. (2021). Impact of exploratory education at nature school on knowledge, attitude, and environmental behavior of primary students. *New Approach in Educational Management, 12*(1), 15–17. https://doi.org/10.30495/jedu.2021.19422.4035 [In Persian]

Short-Meyerson, K., Sandrin, S., & Jimenez-Silva, M. (2024). Informal-elementary science: Repertoires of parental support. Education-Sciences, 14(6), 611. https://psycnet.apa.org/doi/10.3390/educsci14060611

Shouse, W., Schweingruber, A., & Duschl, A. (2007). *Taking-science to school: Learning and teaching science in grades K-8*. http://www.nap.edu/catalog/11625.html

Smedley, K. (2015). Using Informal-Learning Spaces to Increase Meaning-Making: Museum Visits with Young-Adults. In Research-Informing the Practice-of-Museum Educators: Diverse Audiences, Challenging-Topics, and Reflective Praxis (pp. 183-200). Rotterdam: SensePublishers. https://doi.org/10.1163/9789463002387_015

Sokhan-e Mardom. (2022). *One-day educational-environmental camp at Adab-e Farsi primary school in Sarkareh Natural Resources*. https://www.sokhanemardom.ir/index.php/2021-03-08-13-17-49/1284-1284 [In Persian]

Soleimani, A. (2019). Impact of short-term informal training courses on children's awareness of animal biodiversity. *Journal of Environmental Studies, Natural*

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14

Resources and Sustainable Development, *2*(6), 37–44. https://www.magiran.com/paper/1949498/ [In Persian]

Staus, L., Falk, H., Price, A., Tai, H., & Dierking, D. (2021). Measuring the long-term effects of informal-science-education-experiences: Challenges-and-potential solutions. *Disciplinary-and-Interdisciplinary Science-Education-Research*, *3*(1), 3. https://diser.springeropen.com/articles/10.1186/s43031-021-00031-0

Stefanelli-Silva, G., Pardo, C., Paixão, P., & Costa, M. (2019). University-extension and informal-education: Useful tools for bottom-up ocean-and-coastal literacy of primary-school children in Brazil. *Frontiers in Marine-Science*, *6*, 389. https://doi.org/10.3389/fmars.2019.00389

Steinmaurer, A., Pirker, J., & Gütl, C. (2018). sCool-game-based learning in STEM-education: a case-study in secondary-education. In *International-Conference on Interactive Collaborative Learning* (pp. 614-625). Cham: Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-030-11932-4_58

Stocklmayer, M., Rennie, J., & Gilbert, K. (2010). The roles of the formal-and-informal-sectors in the provision of effective-science-education. *Studies in science-education*, *46*(1), 1-44. https://doi.org/10.1080/03057260903562284

Supreme Council of the Cultural Revolution. (2011). *Fundamental transformation document of Iran's education system*. https://sce.ir/media/note_file/%D8%B3%D9%86%D8%AF_%D8%AA%D8%AD%D9%88%D9%84_%D8%A8%D9%86%DB%8C%D8%A7%D8%AF%DB%8C%D9%86.pdf [In Persian]

Tan, E., Barton, C., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM-related fields: How middle-school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science-Teaching*, *50*(10), 1143–1179. https://doi.org/10.1002/tea.21123

Tselegkaridis, S., & Sapounidis, T. (2022). Exploring the-features-of-educational robotics and STEM-research in primary-education: A systematic-literature review. *Education Sciences*, *12*(5), 305. https://www.mdpi.com/2227-7102/12/5/305

Turkay, S. (2010). Student-engagement-and-attitude change-towards science when learning with a virtual-world based curriculum: A case study. Media Innovate Learning (248-257). Association for Advancement of Computing (AACE).https://www.learntechlib.org/primary/p/34646/

Türkmen, H., & Edis, N. (2025). The Effect of Informal-Learning Environment on Learning Wastes and Recycling: The Case of Glass-Bead Atelier. *Science-Insights Education-Frontiers*, *27*(2), 4477-4499. https://files.eric.ed.gov/fulltext/EJ1470247.pdf

Vargas, J., Marshall, L., & Sheldahl, E. (2012). Sharing Science: A Study on the Effects of-Informal-Science-Education-Outreach-with-Elementary-Students. https://digitalrepository.unm.edu/biol_etds/118

Vera, L., Coma, I., Pérez, M., Riera, V., Martínez, B., & Gimeno, J. (2024). The Mediterranean forest in a science-museum: Engaging-children through drawings that come to life-in-a-virtual-world. *Multimedia-Tools and Applications*, *83*(31),76851-76872. https://link.springer.com/article/10.1007/s11042-024-18606-0

Watermeyer, R.(2015). Science-engagement at-the-museum-school: teacher-perspectives on the contribution of museum-pedagogy to science-teaching. *British educational research journal*, *41*(5), 886-905. https://doi.org/10.1002/berj.3173

Young Journalists Club. (2023). *Every school a nursery in the Shahid Moradi project*. https://www.yjc.ir/00aDEX [In Persian]

Ziaie Mehr, A. (2014). Application of educational humor in teaching-learning: Special provisions for second-language learners. *Education and Training*, *30*(4), 31–60. http://qjoe.ir/article-1-185-fa.html [In Persian]

Journal of Knowledge-Research Studies (JKRS)

Vol 4

Issue 4

Serial Number 14