

Open Science and Citizen Engagement: LIASTRA's Contribution to the Democratization of Knowledge



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INTRODUCTION & AIM

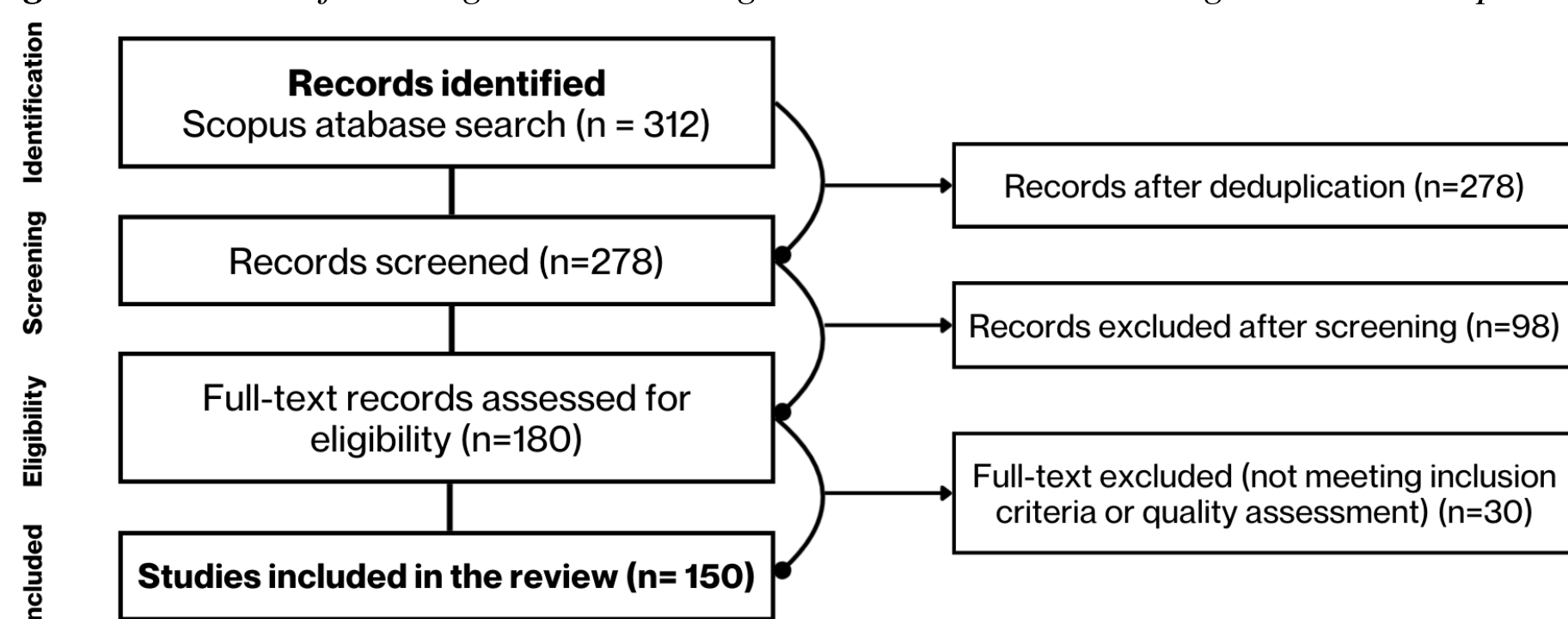
The expansion of Open Science has transformed the scientific and educational landscape by promoting transparency, open access to data, and collaborative research practices that broaden societal participation and reduce inequalities in access to knowledge. In education, these principles support experiential learning and scientific literacy by engaging learners with authentic research practices. Astronomy is particularly well suited to this approach due to its extensive open datasets, strong international collaboration, and high public interest. Within this context, the International Astronomy League (LIASTRA Institute), operating under the International Center for Biomedical & Space Sciences (ICBS), implements integrated educational programs that combine open data, digital tools, and citizen participation. This study examines how LIASTRA's initiatives translate Open Science principles into practice, contributing to STEM engagement, teacher development, and the democratization of scientific knowledge.

METHOD

This study adopted a mixed-methods research design to capture both the global context of Open Science in education and the specific educational practices developed by LIASTRA. Mixed-methods approaches are particularly suitable for educational research because they allow the integration of quantitative trends identified in the literature with qualitative insights derived from institutional experiences and participant perspectives.

The first methodological component consisted of a bibliometric review of peer-reviewed literature indexed in the Scopus database. Publications from 2015 to 2025 were retrieved using search terms related to Open Science, citizen science, astronomy education, and STEM learning. The screening and selection process followed a structured approach consistent with PRISMA guidelines. A total of 312 records were initially identified. After deduplication, screening, and eligibility assessment, 150 studies met the inclusion criteria and were retained for qualitative synthesis. The full identification, screening, eligibility, and inclusion process is presented in Figure 1, which summarizes the PRISMA flow diagram applied in this review.

Figure 1. PRISMA flow diagram illustrating the bibliometric screening and selection process.



The second methodological component consisted of qualitative case studies of LIASTRA's flagship programs, including Asteroid Search Campaigns, Astronomy Olympiads, Scientific Workshops, Teacher Training Programs, and the Open Sky Virtual Observatory. These initiatives represent complementary forms of citizen science and educational engagement. Data were collected through semi-structured interviews with 34 educators, students, and institutional partners and analyzed using content analysis, supported by descriptive statistics from participant surveys.

CONCLUSION

This study shows that integrating Open Science and citizen science into astronomy education effectively enhances STEM engagement, scientific literacy, and inclusivity. LIASTRA's model demonstrates how open data and participatory research can bridge education and science, empowering students and educators as active contributors to knowledge. Astronomy thus emerges as a powerful pathway for democratizing science and fostering global collaboration in STEM education.

FUTURE WORK / REFERENCES

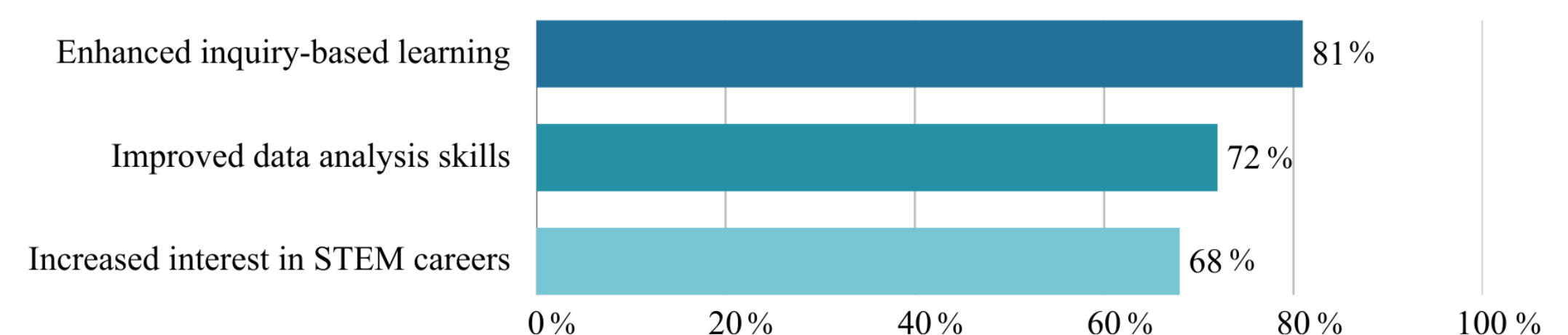
Future research will focus on longitudinal impacts of LIASTRA's programs, comparative studies with other citizen science initiatives, and the expansion of open astronomy education to new regions and educational contexts.

RESULTS & DISCUSSION

The empirical analysis of LIASTRA's educational initiatives demonstrates that the integration of Open Science principles into astronomy-based activities produces meaningful educational outcomes for both students and educators. Participants consistently reported that engagement with real astronomical datasets enhanced their interest in science and increased their confidence in addressing complex scientific questions. Educators emphasized that open access to data and research tools enabled the adoption of inquiry-driven pedagogical practices, fostering active learning, hypothesis testing, and collaborative problem solving within STEM education contexts.

Quantitative feedback collected from participants reinforces these qualitative observations. As shown in Figure 2, 81% of participants reported enhanced inquiry-based learning, 72% indicated improved data analysis skills, and 68% expressed increased interest in pursuing STEM-related careers. These findings suggest that astronomy-based citizen science functions as an effective entry point for developing core STEM competencies, particularly data literacy and scientific reasoning, while sustaining long-term motivation for science learning.

Figure 2. Participant feedback on learning outcomes.



Beyond individual learning outcomes, LIASTRA's initiatives demonstrate substantial institutional and social reach. Participation data between 2021 and 2025, summarized in Figure 3, highlight engagement across asteroid search campaigns, astronomy olympiads, teacher training programs, and international activities. Unlike many citizen science initiatives that focus primarily on data collection, LIASTRA embeds research participation within structured educational frameworks that include pedagogical scaffolding, curriculum alignment, and professional development. This integrated approach enhances both educational effectiveness and sustainability, as further detailed in Table 1, and underscores the potential of astronomy-based Open Science initiatives to promote inclusive and scalable STEM

Figure 3. Educational reach and participation across LIASTRA programs between 2021 and 2025.

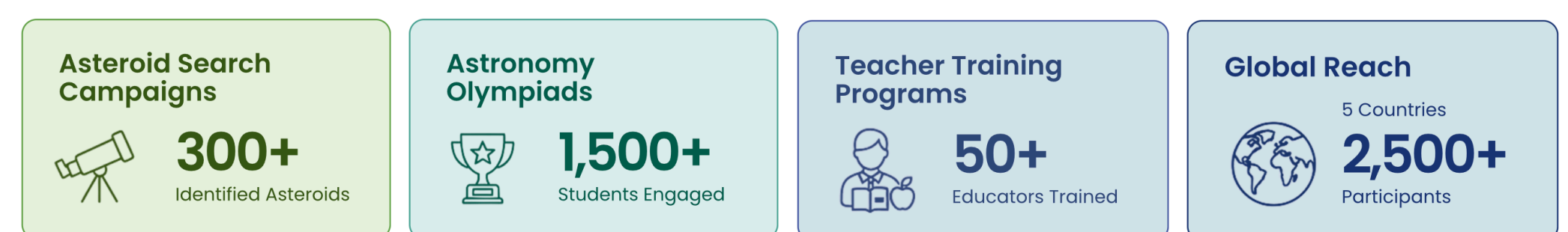


Table 1. Overview of LIASTRA Educational Programs and Core Objectives

Program Type	Educational Focus	Open Science Contribution
Asteroid Search Campaigns	Research-based learning	Discovery of real asteroids
Astronomy Olympiads	Scientific competition	Problem-solving with real data
Teacher Training Programs	Professional development	Open pedagogy and data literacy