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Inclusive activities and resources in Astrophysics: are they really meaningful and effective?

The importance of assessment and evaluation

S. Varano[1,2], C. Boccato[3,2] S. Casu[4,2], F. Di Giacomo[5], D. Guidetti[1], C. Mignone[6,2], E. C. Molinari[7], S. Ricciardi[4,2], S. Sandrelli[8,2], R. Toniolo[1,9,2], A. Zanazzi[10,2] and A. Zanella[3,2]

[1] Istituto Nazionale di Astrofisica – Istituto di Radioastronomia, via Gobetti 101, Bologna, 40139, Italy
[2] IAU Office of Astronomy for Education, OAE Center Italy
[3] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Padova, Vicolo Osservatorio 5, Padova, 35122, Italy
[4] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Cagliari, Via della Scienza 5, Selargius (CA), 09047, Italy
[5] Istituto Nazionale di Astrofisica – Osservatorio di Astrofisica e Scienza dello Spazio, via Gobetti 93/3, Bologna, 40129 - Italy
The remaining affiliations can be found at the end of the paper.
e-mail: stefania.varano@inaf.it

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Abstract. Inclusive outreach and education resources in Astrophysics should be usable, pleasant, and welcoming for the most diverse involved parties, within the framework of Universal Design. Their validity and effectiveness should be properly assessed and evaluated. For new resources, the assessment should start from the design process, to be carried out in collaboration with experts and self-advocates of specific needs, within an iterative testing and assessment process. Once such co-design is completed, dedicated evaluation tools should be applied, addressing specific research questions. On the other hand, activities that were not specifically designed can also be assessed in terms of their usability and meaningfulness in disadvantaged contexts or for individuals with special needs. In this work, we define the framework relative to Astrophysics, present some existing evaluation toolkits, and introduce a list of tags for the assessment of existing activities in terms of their inclusivity.

Key words. Equity; Inclusion: Evaluation: Assessment: Tags

1. Introduction

The great "super-power" of Astronomy is its universal charm: all outreach and educational activities and resources that make use of Astronomy and Astrophysics benefit from a widespread fascination and curiosity in the users and participants (Sjøberg & Schreiner 2010). This, though being an advantage for practitioners and operators in this field, should not be overestimated and misinterpreted as undisputed effectiveness, which instead depends on the aim of the process. Generally, Astronomy and Astrophysics outreach events and educational activities are engaging (Madsen & West 2003). But in what terms and to what extent? And what about other possible effects and outcomes, such as changes in knowledge and perhaps awareness about science in the participants or other emotional and behavioral aspects?

To properly assess their validity concerning a specific aim, all Astronomical activities and resources should undergo a dedicated evaluation process (Chapman et al. 2015). As for activities in the frameworks of Equity, Diversity, and Inclusion (EDI), the matter is even more delicate: attentive and aware consideration of the proposed activities and resources is essential (Bhandare et al. 2021). Otherwise, such activities risk staying at the stage of nice practices, with the naïve belief that a disadvantaged or difficult context can be enough to make the activity "inclusive", though it may not be much effective or sometimes even counterproductive.

In all cases, the results of the evaluation of EDI activities and resources can become bricks for future works in the framework of Universal Design, i.e. "the design of products and environments to be aesthetically pleasant and usable, without being adapted, to the greatest extent possible by everyone, regardless of their age, ability or status in life"(Mace et al. 1990).

2. How to assess and evaluate in Astronomy outreach and education

A complete overview of all frameworks and toolkits for evaluation is beyond the goal of this contribution. Some useful resources for the evaluation of outreach and educational activities about Astronomy, Astrophysics, and more generally, STEM (science, Technology, Engineering and Mathematics) are: the Europlanet Evaluation toolkit, [1]; the OAE Evaluation Framework and Toolkit (Bartlett 2023); the CAISE (Centre for Advancement of Informal Science Education) digital repository of research and evaluation [2] and other publications providing resources and methodologies for evaluation(Buxner et al. 2011; Fraknoi 2012).

Here we summarize the three moments in which evaluation should be performed during the preparation and implementation of any resource and activity, reporting some specificity relative to EDI.

1. Right from the start, assessing the end-users' needs and tastes, the expected impact, and the tools that are going to be implemented for the evaluation. (*Front-end evaluation* and *assessment-based design*). For EDI activities, this process should include the co-design with experts, self-advocates and end-users (nothing about me without me, Reich et al. (2010), Lee & Cassim (2009)), well-knowing and representing the specific involved instances, in an iterative and recursive pilot testing, assessment, and evaluation.
2. Before proposing the activity: this is done once the activities are already implemented, to assess their effectiveness. For EDI activities, this can be the assessment of their validity and usability in specific contexts (*Formative evaluation*, *assessment*)
3. After the activity: this is a retrospective evaluation, to understand how the performed activities have been received and possibly adjust the approach next time (*Summative evaluation*). This evaluation, mainly if performed alone, should address

[1] `https://www.europlanet-society.org/outreach/europlanet-evaluation-toolkit/`, last accessed on 2 February 2024

[2] `https://www.informalscience.org/projects/evaluation` last accessed on 2 February 2024

a specific and reasonable research question (Friedman 2008). To achieve the expected goal of the evaluation, well-thought-out tools must be chosen, both through quantitative, qualitative, or mixed approaches, to be sustainable also in terms of the human resources involved in the project and the time needed to analyze the collected data. For EDI activities, besides the choice between quantitative and qualitative, the selected evaluation tools should take into account the context. For example, in contexts involving very small children, non-native speakers, intellectual difficulties, etc., the use of tools that require verbalization skills should be avoided, as well as multiple-choice questions that may end in commonplace answers, not very useful for a thoughtful analysis.

3. Tags for the assessment of existing activities

Often astronomical activities and resources proposed in disadvantaged and/or marginalized contexts or to participants with special needs have not been expressly designed for that purpose. Besides an attentive summative evaluation, that could inform changes and adjustments for future works and dedicated design, we argue that a prior assessment considering the usability, effectiveness, and meaningfulness of such activities is even more so needed before using such activities in specific contexts.

In recent years, the working group UNIVERS@LL for equity, diversity, and Inclusion in public engagement at the Italian National Institute for Astrophysics (INAF, Istituto Nazionale di Astrofisica) has developed a list of tags (reported in Table 1) to support the assessment of existing activities and resources in terms of equity and inclusion, concerning different aspects. These tags have been identified on the one hand based on the self-evaluation of our experience; on the other hand, this list results from the advice of experts working with (or representing) disadvantaged communities and/or Special Educational Needs (SEN).

The main aim of these tags is to identify the inclusive potential of activities available in our portfolios and on several platforms for astronomy education, to exploit them at best, and to be aware of any difficulties that could be encountered in their use. For example, an easy way to catalog activities requiring the use of scissors for the creation of artworks could lead to excluding such activities in a proposal for difficult contexts such as prisons or communities including very small children or individuals with specific intellectual disabilities. Or, pinpointing activities where only short and simple texts are used, could help determine what activities could better be used in communities with non-native speakers, first-generation migrants, or very small children.

We have tested such classification in the choice of resources and activities carried on by the UNIVERS@LL group. We have experienced a reduction in unexpected discrepancies, with regards to the engaged groups and the hosting contexts. In addition to that, we have assigned such tags to all educational activities and resources available in EduINAF, the online magazine of INAF dedicated to astronomy education and outreach. [3]. We plan to implement an evaluation of the effectiveness of such classification, through interviews and focus groups with the participants engaged in the resources and activities selected this way.

4. Conclusions

Evaluation is essential: no activity or resource can be considered valid and/or effective for a specific aim, without a proper evaluation process. In the framework of Equity, Diversity and Inclusion (EDI), proper assessment and evaluation processes help pinpoint the validity and effectiveness of resources also concerning the specific context.

Evaluation should always be integrated into the design and implementation process, and even more so for EDI resources, towards the fulfillment of a thoughtful design and implementation, as universal as possible, in the

[3] `https://edu.inaf.it/`, last accessed on 2 February 2024

Table 1. Tags referring to specific properties of astronomical outreach and educational activities, that can be useful to identify the most suitable activity for several contexts and environments and to pinpoint possible critical aspects. SEN stands for Special Educational Needs and ID for Intellectual Disabilities.

Tag	Description	Potentialities
Storytelling	Activities in which the narration (perhaps through images, such as Kamishibai theatre or illustrated books) is predominant	Effective in cases of some ID and/or linguistic difficulties
Short/simple texts	Activities that make use of little text and simple language	Fairly accessible to non-native speakers and to individuals with SEN or ID involving language difficulties
Open goals/open ended	Activities with flexible and not rigidly defined objectives	Suitable with individuals with some SEN or ID, who can feel involved and find satisfaction in carrying out the activity at various levels
Hands-on	Activities involving materials, artifacts production, and personal experimentation	Effective for engaging individuals with predominant kinaesthetic attitudes, some ID, SEN, and language difficulties in general
Cooperation	Activities in which group work is involved, even with some grade of competition, where the participation of all individuals is encouraged and facilitated	Effective for fostering the participation, with different roles, of individuals with diverse social attitudes and behaviors, even towards science
Low tech	Activities that do not require the use of sophisticated and/or expensive technologies	Suitable in schools and communities that do not have easy access to such facilities
Low cost	Activities that make exclusive use of low-cost or even recycled materials	Suitable and affordable also in disadvantaged and/or marginalized contexts
Multisensory	Activities in which communication makes use of at least two senses in a redundant way	Usable by individuals with sensory disabilities, various learning attitudes, and some specific SEN or ID
Safe materials	Activities that make exclusive use of non-cutting and non-hazardous materials	Usable with small children, some ID, and in specific contexts such as prisons
Diversity	Activities that (implicitly or explicitly) foster and stimulate reflection about diversity, in any sense	Effective with children and youngsters, to empower all individuals and encourage their agency as knowledge builders, regardless their identity
Multiculturalism	Activities that pay close attention to different cultures and religions, highlighting the richness of cultural diversity	Favour the involvement of individuals from different cultural and/or social contexts and a better diversity awareness and reception

framework of Universal Design. For activities and resources that have not been specifically designed, it is crucial to assess their usability and validity before proposing them in disadvantaged contexts or to individuals with special needs.

Inclusion tags can be a straightforward and effective support in the selection and preparation of the activities. In addition to that, tags can help face possible critical situations and even suggest possible facets to take into account in future design processes.

Affiliations

[6] Istituto Nazionale di Astrofisica – Sede centrale, viale del Parco Mellini, 84, Roma, 00136, Italy

[7] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Brera, via Bianchi 46, Merate (LC), 23807, Italy

[8] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Brera, via Brera 28, Milano, 20121, Italy

[9] Università degli Studi di Bologna, Dipartimento di Fisica e Astronomia, via Gobetti 93/2, Bologna, 40129, Italy

[10] Istituto Nazionale di Astrofisica – Osservatorio Astrpofisico di Arcetri, Largo Enrico Fermi 5, Firenze, 50125, Italy

References

Bartlett, S. 2023, IAU Office of Astronomy for Education

Bhandare, A., Giobbi, G., Larkin, C., et al. 2021, Proceedings for the 3rd Shaw-IAU Workshop on Astronomy for Education: What Everybody Should Know about Astronomy Education

Buxner, S. R., Wenger, M. C., & Dokter, E. F. C. 2011, in Astronomical Society of the Pacific Conference Series, Vol. 443, Earth and Space Science: Making Connections in Education and Public Outreach, ed. J. B. Jensen, J. G. Manning, & M. G. Gibbs, 125

Chapman, S., Catala, L., Mauduit, J.-C., Govender, K., & Louw-Potgieter, J. 2015, South African Journal of Science, 111, 1–9

Fraknoi, A. 2012, in Astronomical Society of the Pacific Conference Series, Vol. 457, Connecting People to Science: A National Conference on Science Education and Public Outreach, ed. J. B. Jensen, J. G. Manning, M. G. Gibbs, & D. Daou, 370

Friedman, A. 2008, in March 12, Conference and workshop at National Science Foundation on Informal Science Education

Lee, Y. & Cassim, J. 2009, in Proceedings of the IASDR 2009 Conference

Mace, R., Hardie, G., Place, J., for Accessible Housing, N. C. S. U. C., & for Universal Design, N. C. S. U. C. 1990, Accessible Environments: Toward Universal Design (Center for Accessible Housing, North Carolina State University)

Madsen, C. & West, R. M. 2003, Public Communication of Astronomy, ed. A. Heck & C. Madsen (Dordrecht: Springer Netherlands), 3–18

Reich, C., Price, J., Rubin, E., & Steiner, M. A. 2010, Center for Advancement of Informal Science Education

Sjøberg, S. & Schreiner, C. 2010, An overview and key findings, 31