COALESCE

Co-creating the EU Competence Centre for Science Communication

Deliverable 4.4

Report on Educational Needs in SciComm for quadruple helix stakeholders and R&I actors

Version: v1.0

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STATEMENT OF ORIGINALITY

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DISCLAIMER

COALESCE
Co-creating the EU Competence Centre for Science Communication

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Executive Summary

The COALESCE project is building the European Competence Centre for Science Communication, which will operate under a virtual platform connected to a distributed network of physical National and Regional Hubs. The Competence Centre will include a Science Communication Academy to provide training and support to quadruple helix stakeholders and research and innovation (R&I) actors with a view to improving the quality of science communication. This report focuses on understanding the skills used, training needs and preferred formats for training delivery expressed by the various different actors that play key roles in science communication.

Initial desk research collated previous research carried out by projects funded through the "Science with and for Society" (SwafS-19) programme as part of Horizon 2020, namely CONCISE, ENJOI, GlobalScape, NEWSERA, PARCOS, QUEST, RETHINK and TRESCA. Other literature and resources were identified through the project partners. In addition to the literature research, a series of workshops, interviews and surveys were used to deepen our understanding of the skills and training needs of a range of key stakeholders and potential end-users. In this latter work, we also explored potential formats that could be used to deliver training.

Key findings highlight an **ongoing need for training and resources** in the following areas:

Researchers need training in: understanding the role of researchers in science communication, including in addressing perceptions around trust in science; areas that would help address a lack of motivation to communicate science; developing confidence in communicating their science; the theoretical underpinning for science communication; understanding and reaching audiences. In terms of training format, flexibility emerged as a key requirement, with researchers wanting to tailor training to their needs and interests.

Communication officers need training in: evaluating the impact of their work; addressing misinformation, poor quality coverage of research and the related issue of communicating uncertainty/statistics; addressing the challenge of getting others involved (especially researchers) and of interacting with journalists; responsible use of artificial intelligence (AI) and a range of skills around visibility and visualisation; engaging young people (Gen Z). Communication officers also highlight management challenges around workloads. We also identified a number of areas where there appears to be a gap in training provision for communication officers, including digital skills training and general communication skills training, with a special interest in impact evaluation. In terms of training format, flexibility was again preferred.

General journalists identified the following challenges and training needs: understanding scientific research and its methods and norms (including publishing and ethics); access to reliable scientific information; communicating uncertainty; AI technological development and use in the context of journalism. All of these can facilitate and improve the effectiveness of their work, including when it comes to communication during times of crises.

Staff from science museums and science centres require training that falls into four categories: managerial challenges, staff challenges, audience-related challenges and external pressures. These include facets such as how science museums and centres are positioned, the increasing complexity of science, making science more accessible and engaging, and creating safe spaces. Particular gaps in training faced by staff in these organisations include understanding of science, its processes and norms; audience related skills, particularly reaching out to Gen Z; networking and sharing skills within museums, and communication skills such as writing and visualisation. Unlike the other key stakeholder groups, here the format of training varied by staff experience level, with local training needed for junior staff and national/EU level training required for more senior staff. In terms of format, hybrid sessions formed of 2-3 hour online sessions were preferred.

Those working in civil society organisations (CSOs) are often operating in polarised communication spaces and they may need to make use of scientific evidence in highly politicised and charged environments. A key concern is how to present evidence fairly and accurately, and how to work with audiences who have strongly held views (e.g. on climate change). Staff within this sector highlight the need for a better understanding of social science research, and how this could be applied to e.g. change behaviours. Appropriate use of AI tools was also highlighted as a need.

Based on the evaluation of training needs we have carried out, we have identified a **wide range of gaps in training provision**. Broadly, these fall into five areas: digital skills; audience skills; science skills; personal skills; other skills. While some skills are needed by particular groups, there are areas of overlap, with a need for training in artificial intelligence, social media, understanding and reaching audiences, writing, evaluation and public engagement identified as cross-sectoral needs.

In terms of **format,** there is broad agreement that training should be flexible, with participants preferring hybrid formats that include self-paced work and online-live sessions, but also occasion to exchange experiences. Certain stakeholders identify particular needs, with differences in the needs of junior and senior staff more clearly evident for the science museums and centres sector than the other groups.

These point to a need for the Science Communication Academy to develop both general and sector specific training amongst its offerings. It also points to a need to trial training resources so that these can best address the needs of specific stakeholders.

Highlights

- Five skills areas in which training is particularly needed: digital; audience; science; personal; other.
- Overlapping areas among the needs and gaps of the different stakeholders are: training in artificial intelligence, social media, understanding and reaching audiences, writing, evaluation and public engagement. These were identified as cross-sectoral needs.
- Hybrid, online and in person training formats are considered valuable, with a preference for hybrid ones when it comes to long lasting courses, since they combine the ease to attend with the opportunity to work in person.
- Peer exchange is broadly considered a key element of the learning process.

1 Introduction

The COALESCE project is building the European Competence Centre for Science Communication, which will operate under a virtual platform connected to a distributed network of physical National and Regional (N&R) Hubs. The Competence Centre will include a Science Communication Academy to provide training and support to quadruple helix stakeholders and R&I actors with a view to improving the quality of science communication.

The Competence Centre will initially be developed through consolidation of learning from projects funded through the "Science with and for Society" (SwafS-19) programme as part of Horizon 2020, namely CONCISE, ENJOI, GlobalScape, NEWSERA, PARCOS, QUEST, RETHINK and TRESCA. The role of the Competence Centre is to further develop and mainstream science communication knowledge and to foster connections between science and society.

The Competence Centre will be also supported by an External Stakeholder Panel (ESP), which is composed of topic networks; national, international and regional networks of science communication or related areas; professional networks; university alliances; and a network of N&R hubs. These are being established in EU countries as well as the UK and Ukraine.

Within the different tools and services to be developed, the Science Communication Academy will play a major role. The Academy aims to build capacity and facilitate mutual learning, offering training and services built on the real needs of the different actors who contribute to science communication activities. To this end, and as a starting point, the COALESCE project investigated the needs of a range of stakeholders, including those joining its Community of Practice (CoP)[1]. These activities focused on understanding the skills they use, identifying gaps in training provision within science communication and assessing the formats in which training could be delivered.

To understand the skill needs, desk research, online and in-person workshops, surveys and semi-structured interviews were carried out from June 2023 to June 2024. In addition to the activities carried out specifically to explore skill and training needs, all COALESCE project activities involving stakeholders delivered so far (close to 20) have included questions or discussion about training needs; these data are also captured in this report. This report provides an in-depth overview of what emerged in terms of skills needed by different stakeholders, gaps perceived in existing training provision and views on the format in which this could be offered.

In Chapter 2, the methodology used is described, and in Chapter 3, the outcomes are presented for each stakeholder, e.g. researchers, communication officers, non-science

[1] The COALESCE CoP gathers those interested in the project and the future Competence Centre, who registers through an online form. The Science communication Communities of Practices considered in COALESCE are Scientists/researchers, Science communication scholars, Science journalists, Generalist Journalists, Museum experts, Communication officers, Science communication practitioners, Policy makers, Citizens, Software developers, Science communication trainers, Others.

journalists, museums and science centres staff and civil society organisations. Finally, Chapter 4, summarises the key findings and outlines recommendations arising.

2 Methodology

In order to define the training needs in science communication, we considered key challenges in science communication, the skills needed to tackle them and the gaps in what is currently available to various stakeholders as well as the preferred training formats. To this end, several activities have been carried out between June 2023 and June 2024, as described below.

2.1 Literature review: SwafS-19 outcomes and other key studies

Desk research was used to explore recent studies on identifying skill needs and available training provision. This literature review draws on the materials produced by the eight Science with and for Society (SwafS-19) projects on which the COALESCE project is built. The SwafS-19 projects ran in the period 2019-2023 and several of them explored science communication education and training, directly or indirectly, focusing on either specific stakeholders or science communicators more generally. These projects undertook extensive literature reviews and participatory activities and produced a series of reports and tools (see Table 1 below). COALESCE has drawn on these resources and reports as context and a starting point for identifying the core competencies for science communication and training needs for each stakeholder category.

Table 1. Summary of resources and reports produced by previous SwafS-19 funded projects

Name of resource	SwafS-19 project	Target stakeholders	Link
Llorente C., Revuelta G. (2020). Deliverable 1.4: Teaching science communication in Europe	CONCISE	Communicators and scientists	https://concise-h2020.eu/wp-content/uploads/2020/09/D1.4_Teaching-science-communication-in-Europe.pdf
Llorente C., Revuelta G. (2020). Communication role on perception and beliefs of EU citizens about science. Policy Brief 2020	CONCISE	Science communicators in general	https://concise-h2020.eu/wp-content/uploads/2020/12/CONCISE_policy_brief_EN.pdf
Fähnrich B, Wilkinson C, Weitkamp E, Heintz L, Ridgway A and Milani E (2021) RETHINKING Science Communication Education and Training: Towards a Competence Model for Science Communication.	RETHINK	Science communicators in general	https://www.frontiersin.org/articles/10.3389/fcomm.2021.795198/full
Analysis of the status quo on demands for science communication training	RETHINK	Science communicators in general	https://www.rethinkscicomm.eu/wp-content/uploads/2020/06/D3.1-Report-on-analysis-of-status-quo-and-requirements-in-focus-countries.pdf
RETHINK SciComm Training Navigator	RETHINK	Science communicators in general	https://www.rethinkscicomm.eu/resources/rethink-scicomm-training-navigator/
Fähnrich B, Wilkinson C, Weitkamp E, Heintz L, Ridgway A and Milani E (2021) RETHINKING Science	RETHINK	Science communicators in general	https://jcom.sissa.it/article/pubid/JCOM_2104_2022_A04/

Communication Education and Training: Towards a Competence Model for Science Communication. Front. Commun. 6:795198.			
Fähnrich, B., Weitkamp, E., & Kupper, J. F. (2023). Exploring 'quality' in science communication online: Expert thoughts on how to assess and promote science communication quality in digital media contexts. *Public Understanding of Science*, *32*(5), 605-621.	RETHINK	Science communicators in general	https://journals.sagepub.com/doi/10.1177/09636625221148054
Wilkinson, C., Milani, E., Ridgway, A., Weitkamp, E. (2021) Roles, incentives, training and audiences for Science Communication: perspectives of female science communicators, JCOM, 21(04) A04.	RETHINK	Science communication professionals	https://doi.org/10.22323/2.21040204
Karinna Matozinhos, & Joana Magalhães. (2023). Pathways for adopting Outstanding Open Science Communication addressed to Scientists, Journalists, Teachers, Policy Makers and Entrepreneurs. Zenodo.	ENJOI	Scientists, Journalists, Teachers, Policy Makers and Entrepreneurs	https://zenodo.org/record/8300543
Catanzaro, M., Rivera, M., Toran, R., Tola, E., Salandin, T., Bonelli, G., Boscolo, M., Zolotonosa, M., Creek, M., Dijkstra, A., Marín-González, E., & Matozinhos, K. (2022). ENJOI Manifesto for an Outstanding Open Science Communication for OOSC. Zenodo.	ENJOI	Journalists	https://zenodo.org/record/7525672
Costa E., Davies S.R., Franks S., Jensen A., Villa R., Wells R., Woods R. (2019). Deliverable 4.1: Summary report: Science Communication education and training in Europe	QUEST	All scicomm stakeholders	https://questproject.eu/download/deliverable-4-1-summary-report-science-communication-education-and-training-in-europe/
Interactive map about science communication education and training in Europe	QUEST	All scicomm stakeholders	https://enricounive.carto.com/builder/d4da5208-e732-4034-b789-e4ce86b86fdb/embed
Mannino I., Fornetti A., Pasotti P., Franks S., Schofield B., Maiden N., Costa E., Villa R., Zollo F., Roche J., Bell L., Fozard S., Henriksson T., Olesk A., Renser B. (2021). Deliverable 4.3: Educational Toolkits for Science Communication (for scientists, journalists, museum staff, on social media)	QUEST	Researchers, Journalists, Museum staff, social media content managers	https://questproject.eu/download/deliverable-4-3-educational-toolkits-for-science-communication/
Mannino I., Bel, L., Costa E., Di Rosa M., Fornetti A., Franks S., Iasillo C., Maiden N., Olesk A., Pasotti J., Renser B., Roche J., Schofield B., Villa R. and Zollo F. (2021). Supporting	QUEST	Researchers, Journalists, Museum staff, social media content managers	https://doi.org/10.22323/2.20030207

quality in science communication: insights from the QUEST project JCOM 20(03), A07.			
Chase J., Russo P., Blumenthal K. (2021). D5.1: Professional training gap analysis	GlobalScape	Science communication professionals	https://cordis.europa.eu/project/id/101006436/results
Smyth f., Murphy k., Bell l., and Roche j. (2021). GlobalSCAPE Deliverable 2.2: Academic Discipline Assessment	GlobalScape	Not specified	https://cordis.europa.eu/project/id/101006436/results
Science Communication in Higher Education Global Database	GlobalScape	Not specified	https://www.pcst.network/teaching-forum/science-communication-programmes-and-courses/
Deliverable 3.6 Formal and informal training mechanisms for science communication	NEWSERA	Young researchers, undergrad students (science curriculum and communication curriculum), citizen science practitioners	Unpublished data

The COALESCE project is also collaborating with other projects in order to find synergies, including identifying training provision and needs, and understanding complementary skills and competences. For example, we have connected with the European Citizen Science project to explore scicomm needs in the area of citizen science and citizen engagement. Regarding Research and Responsible innovation (RRi), we have established a relationship with the REiNFORCING project, and we are linked with the PATTERN project and Skills4EOSC to explore scicomm needs under the umbrella of open science, but also to start the discussion on offering complimentary training. These links will also help us to develop an Academy that is fit for purpose, allowing us to effectively exploit work previously funded under SwafS-19 and develop models for the sustainability of the Competence Centre that fit stakeholders' interests. We are also working to align our offering with existing competency frameworks, like the European Competence Framework for Researchers[2] and the Research Managers and Administrators professional development framework and roadmap[3] (that include science communication professionals), developed under the EARMA project. From these, we have collected other relevant studies and publications taken into account here:

Table 2. Additional resources consulted that focus on training needs and competencies in science communication

Name of resource	Year	Study focus	Link
Delphi study - The perception of science communication professionals on the most relevant and used competences when designing and executing science communication actions", Fundación Española para la	2024	Researchers in different fields of science communication and scicomm professionals	Unpublished data

[2]https://research-and-innovation.ec.europa.eu/jobs-research/researchcomp-european-competence-framework-researchers_en
[3] https://earma.org/roadmap/

Ciencia y la Tecnología (FECYT), Preliminary results			
Communication training for researchers Survey of ERC host institutions	2023	Researchers and research institutions	Unpublished data
Arvidson S., Fleetwood A. M., Hed L., Jonsson A., Stier J. (2022). Framework for courses in science communication of the Swedish Research Council	2022	Researchers	https://www.vr.se/english/analysis/reports/our-reports/2022-09-29-framework-for-courses-in-science-communication.html
State of the art of Open and Responsible trainings, PATTERN PROJECT	2023	Researchers at all stages of their careers	https://zenodo.org/records/10409792
Bruce V. Lewenstein & Ayelet Baram-Tsabari (2022) How should we organise science communication trainings to achieve competencies?, International Journal of Science Education, Part B, 12:4, 289-308,	2022	From occasionals to professional communicators	DOI: 10.1080/21548455.2022.2136985
Cléa Montanari, & Zahra Farook. (2023). Needs of citizen science educators and trainers (Versión 1). Zenodo. https://doi.org/10.5281/zenodo.8183969	2023	citizen science educators and trainers	https://zenodo.org/records/8183969
Haklay, M., & Montanari, M. C. (2023). D4.1 Blueprint for the European Citizen Science Academy. Zenodo. https://doi.org/10.5281/zenodo.10521787	2023	citizen science educators and trainers	https://zenodo.org/records/10521787
World Economic Forum. Putting Skills First: A Framework to Action	2023	Public and private sectors	https://www.weforum.org/publications/putting-skills-first-a-framework-for-action/
Barnes S.A., Kispeter E., Eikhof D. R., Parry W. (2018). Mapping the Museum Digital Skills Ecosystem. Phase One Report. One by one project.	2018	Museums	https://doi.org/10.29311/2018.01

2.2 Training needs participatory workshops

Participatory trainings, both online and in-person, were organised between November 2023 to June 2024 with key stakeholder groups to confirm and extend what emerged from the literature review (Table 3). Stakeholder groups were chosen based on who would be most likely to benefit from the Academy services, i.e. researchers, communication officers, science museum and centre staff. In addition, we sought the perspectives of two groups who contribute to the sharing of scientific information but are often overlooked within projects focusing on science communication: generalist journalists and civil society organisations. This follows the project sessions held internally with the consortium which aimed to better define who the end-users of the virtual platform, which includes the SciComm Academy, would be (see Magalhães et al., 2024[4]).

Table 3: Categories of stakeholders involved in workshops and geographical representation

[4] Magalhães J, *et al.* (2024). Co-designed virtual Competence Centre requirements specifications. Deliverable report (D3.1), COALESCE project (grant agreement No 101095230), funded by the European Union. DOI: 10.5281/zenodo.12088890

Workshop Stakeholder	Online/In person	Number of Participants	Countries represented
Multi-stakeholder workshop	In person (Italy)	23	Italy
General journalists	In person (Italy)	14	Italy
Researchers	In person (Italy)	22	Estonia, Germany, Israel, Italy, Latvia, South Africa, UK
Communication Officers	Online	8	Belgium, Denmark, France, Ireland, Italy, Norway, Switzerland, UK
Science Museums and Centres	Online	5	Belgium, Italy, Serbia, Slovenia, UK
Civil Society Organisations	Online	6	Belgium[5], Croatia, Italy, UK

Three in person workshops were organised to explore training needs relating to science communication.

One **multi-stakeholder** workshop held at the SISSA Conference in November 2023, included 23 participants (two journalists, seven science communicators, three communication officers, three scientists, three museum experts, a science communication scholar and four others, according to our CoP stakeholder categories). This workshop allowed us to also collect insights about what the different stakeholders perceive as challenges and skills needed by both their reference stakeholder group and others. The participants also proposed the ideal format of training for their stakeholder group.

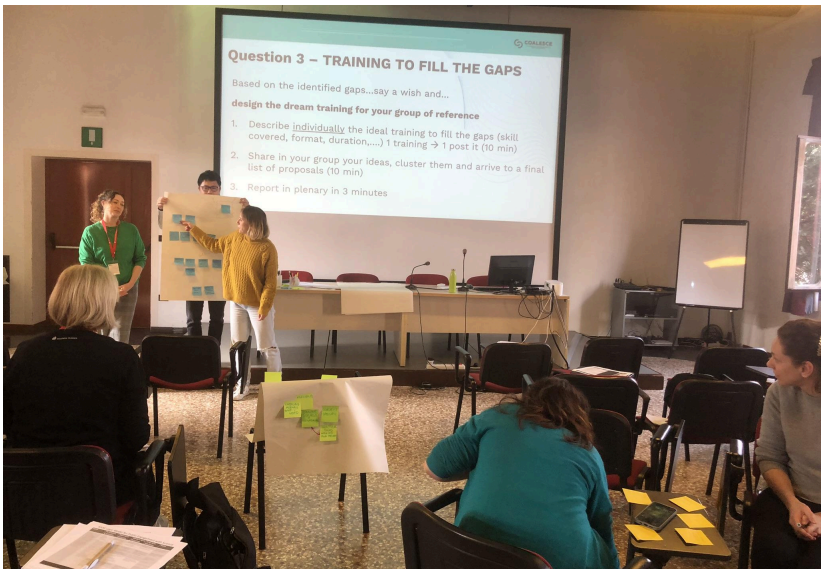
A face to face workshop was held with **generalist journalists** (i.e. not science specialist journalists) in January 2024 in Trieste, with 14 participants (Fig. 1). The workshop focused on journalists' communication in times of crisis and in this context explored their perspectives, challenges and needs in relation to training and skills development.

[5] Note that many of the participants in this workshop operate at Pan-European or International levels.

Figure 1: Non science journalists workshop in Trieste.

A face to face workshop was held with **researchers** in March 2024 (Fig. 2). This comprised 22 participants, from a range of countries and fields (environmental sciences - five, education - five, human rights - five, medicine - four, science communication - three). The workshop was held within the framework of the VIU Spring School on Science Communication. As in the other workshops, the participants explored the challenges and skills needed for communication of research divided by field of expertise and proposed ideal formats for training.

Figure 2: Researchers workshops at the VIU Spring School.



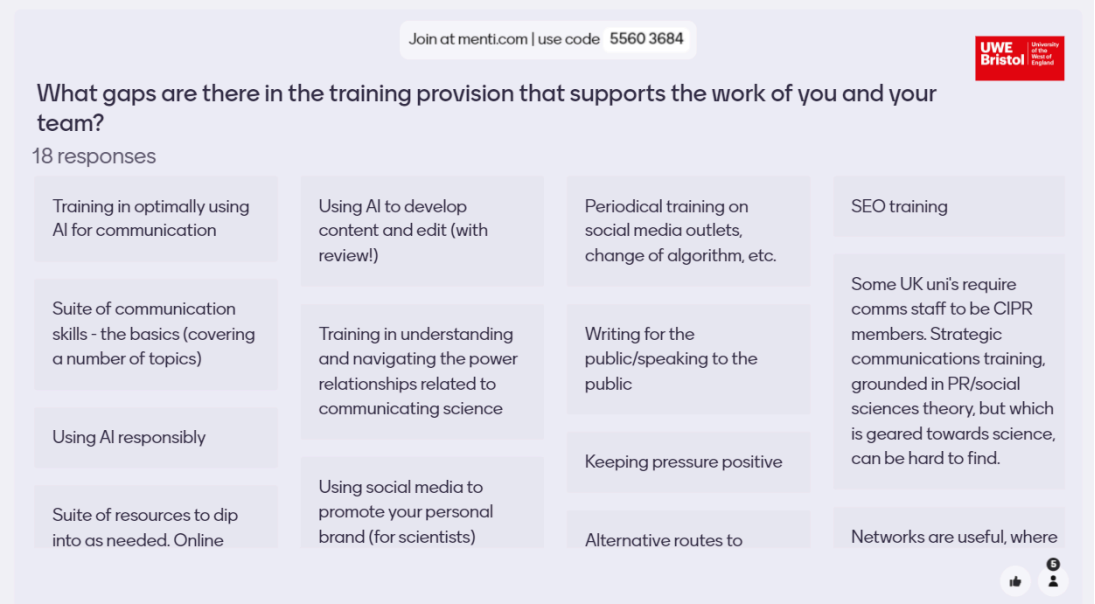
Three workshops were carried out online with decision makers and experienced practitioners from three stakeholder groups: science communication officers; science centres and

museums; and civil society organisations. The participants were identified as key informants, through screening of the COALESCE CoP members, suggestions from the consortium and searching the Internet for specific expertises. In recruiting participants, we sought to broadly represent different countries in Europe, organisations of varying sizes and reach, and to ensure representation across the four topics that form the case studies within COALESCE, i.e. Climate Change, Artificial Intelligence, Oceans and Health. Experts were chosen who have decision making roles to enable the inclusion of management perspectives.

The online workshops were designed to capture key skills by stakeholder groups, an understanding of perceived gaps in training provision and an indication of the preferred formats for training, taking into account the needs of staff at different levels. Workshops lasted approximately 75 minutes and the format of the workshops was improved across the discussions, following feedback and reflection after each workshop.

In the first online workshop (**science communication officers**), the focus was on assessing the challenges communication officers face when communicating science. This was followed by an open discussion of the gaps in training provision, which included conversations on the training needs of staff at different career stages, a final session focused on understanding the different formats that training could take, and the constraints, e.g. in terms of travel or language, that might have a bearing on provision. Menti.com, together with open discussion, were used to capture insights from the participants (Fig. 3). The first online workshop was attended by eight communication officers representing different contexts, from universities to large research organisations, as well as different countries within the EU.

Figure 3: Example inputs from Menti.com activity.



The second workshop, organised online, involved senior staff from **Science Museums and Centres**, including both large and small organisations and those that deliver travelling experiences. In this workshop, we included a collaborative visual workspace online (using

Miro) to capture the discussion (see Figure 4 below). We encouraged participants to post their reflections on the board. This session again focused on the three core areas of investigation - the challenges they face in communicating science and the skills needed to address these, the gaps in training provision and the format that such training might take, including discussion around the needs of staff at different career levels. Five stakeholders, representing different organisational contexts and national perspectives attended this workshop.

Figure 4: Illustrative example of the science museums and centres discussion on Miro.

The third and final online workshop involved **civil society organisations**. This group of stakeholders was chosen to reflect organisations which typically communicate science with particular, often non-neutral, goals. Representatives reflected a broad range of organisations working from local to international level. This workshop again adopted Miro as a collaborative platform to capture thoughts on the skills needed in this sector to communicate and engage with science, training gaps and formats. Six participants attended this workshop.

2.3 Other COALESCE participatory activities

Questions on training needs were also included in other COALESCE activities (e.g. interviews and workshops) to exploit opportunities to enlarge the exploration, without replicating the efforts. These included:

- a co-design session with the wider COALESCE consortium to define stakeholders, and their needs and requirements for a competence centre virtual platform, as previously mentioned. This workshop was held online in September 2023, and included 14 participants.

- a second co-design ideation session was held with science communication professionals to further define their needs, requirements and benchmarking for a competence centre virtual platform and associated Academy. This was held in person in October 2023 in Granada, Spain, under the Spanish Presidency of the European Council, and in connection with the European Year of Skills. 21 participants were involved.
- Interviews with non science journalists were carried out in May-June 2024, 10 participants.

2.4 Evaluation and review

The results of these activities were evaluated and reviewed through a series of online surveys distributed and carried out during May-June 2024:

- Survey with researchers distributed among university alliances and COALESCE CoPs in May 2024, 36 respondents. The survey was also promoted through the COALESCE social media accounts.
- Survey with communication officers distributed to workshop participants and through the European Association of Communication Professionals in Higher Education (EUPRIO) network and COALESCE CoPs in May 2024, 45 respondents.
- Survey with museum and science centre staff distributed to workshop participants, to direct contacts in science centres and museums and through the COALESCE CoPs in May 2024, 24 respondents.

The surveys were also promoted to the External Stakeholder Panel and shared on social media (Twitter and LinkedIn).

The surveys comprise two sections, one exploring training needs and the other training formats. In total there were 10 questions comprising multiple choice, rating and open response options.

Furthermore, an in-person workshop with over 20 communication officers was held in June 2024 at the EUPRIO 2024 Conference in Turin as an opportunity to share and evaluate the results on the training needs identified during the workshop, literature review and survey with science communication officers. The inputs were collected through menti.com.

Figure 5: Illustrative example of the inputs collected through mentimeter.

Moreover, on the 20th June a COALESCE-ECS-PATTERN-REINFORCING cross-projects meeting discussed the state of the art in each project, regarding training and Academies, for commonalities, synergies and gaps and next steps.

3 Results

Insights emerging from the activities described in Chapter 2 have been synthesised as key needs, competences, skills, and training gaps for each stakeholder group. On the basis of the workshops and surveys, preliminary ideas on possible training formats were also identified.

3.1 Findings from prior literature and studies

Several studies and research projects, including the SwafS-19 funded projects, highlight a series of barriers and training needs faced by those communicating science. **Researchers**, together with the needs of **science journalists**, **are the most thoroughly explored in the literature, which otherwise tends to lump other 'science communicators' under the same banner**. These were explored further and refined in our workshops, with a focus on groups that have been under-represented in the literature.

Where research on training needs focuses on specific stakeholder groups (notably researchers and journalists), this is incorporated below within the appropriate section. The key aspects that emerge from the literature referring more generally to science communicators are summarised below.

In terms of barriers to communication, SwafS-19 projects (Wilkinson et al., 2022; Mannino et al., 2021; Llorente & Revuelta. 2020) found that lack of time, lack of resources for science communication and a difficulty in getting others involved (e.g. researchers) were seen as the biggest challenges. Other issues that emerged include being satisfied with the amount of science communication already undertaken, lack of reward and recognition for science communication work, insufficient encouragement from funders and insufficient financial rewards for science communication work. Several studies have identified evaluation as a challenge for science communication, and respondents to Fähnrich et al. (2021) study report that while many do undertake evaluation there was a clear need for training in this area that focused on how to evaluate and for whom the evaluation is undertaken (i.e. moving beyond a tick box in a funding application to meaningful evaluation).

Fähnrich et al. (2021) identified core areas where training was already available to science communication practitioners. These comprised: public speaking, writing for non-specialists, media training, public engagement training, social media and storytelling. Training was also available on organising public events, making videos/podcasts and visual communication. Despite some training being available, training was particularly sought in the areas of visual communication, making videos/podcasts, storytelling, public engagement, media training and using social media for public engagement and outreach. Other areas of training people sought include: web design, understanding statistics, getting published (e.g. magazines), working with young people and the financial aspects of project management.

In terms of the kind of courses and training available in science communication, the mapping carried out in QUEST in Europe highlights that the training landscape is complex, consisting of credit bearing and non-credit bearing provisions and offered by both higher education institutions and other providers (including commercial organisations). This work was extended in relation to credit bearing taught programmes at a global scale by the GlobalSCAPE database. The focus of the two mapping exercises is primarily on higher education providers, and gaps exist in our understanding of the wider provision available to science communicators, particularly those that may receive training internally from workplace colleagues and those making use of provision offered by not-for profit (e.g. learned societies) and for-profit agencies (e.g. widely available provision of media training courses).

Work has also focused on the training needs of organisations running citizen science initiatives. These are projects that actively seek to involve citizens directly in research. Such projects have been widely explored in the science communication literature, including the current special issue "Bridging citizen science and science communication"[6], and attention in the PCST conference (Metcalfe et al., 2022). However, little work has explored training needs in this area. Within the NEWSERA project a survey was conducted about training needs of staff working in 40 citizen science projects in Portugal, Italy and Spain (22% CSOs, 30% RFOs, 30% Academia, 3% RFOs and 13% Others). Key challenges faced include improving audience recruitment, retaining volunteers and long-term engagement (of in particular, citizens), tailoring communication to various target audiences (particularly the quadruple helix stakeholders, i.e. academia, public sector, private sector and society at large) and how you involve them as partners, social media communication, out-of-the-box approaches on science communication and evaluation of the different activities. Other needs identified include skills in co-creation and participatory methodologies, ethics and tackling misinformation, data journalism and visual narratives and finally evidence-informing and scientific advice to policy makers and decision makers.[7]

3.2 Researchers

This section incorporates findings from the literature on researchers' needs, as well as providing additional context and findings from the in-person researchers workshop. Researchers have been encouraged to share the findings of their research with broader publics for many years, though the extent to which they do this varies considerably. The key role of researchers and the need to find ways to incentivise them to communicate their research more widely is one reason this group has been heavily explored in the literature.

[6]https://www.frontiersin.org/research-topics/48185/bridging-citizen-science-and-science-communication/magazine

[7] C Luís, I Navalhas, E Marín-González, L Leguina, P Giardullo, J Magalhães, R Arias. Deliverable 3.6 Formal and informal training mechanisms for science communication (2023), and M Pelacho, J Magalhães, F Sanz, P Giardullo, MA Citarella, I Navalhas, E Marín González, C Luís, L Leguina, B Guasch, R Arias. Deliverable 5.1 Iteration Cycle I and II: Impact assessment of the new communication strategies for each stakeholder group (2022).

3.2.1 Challenges & Needs

- Understanding the role of research and researchers in society

Societal development requires research and scientific knowledge to be shared with wider society. Further, public communication of research is needed to enhance the relationship between science and society. Although this is well recognised in the literature (Arvidson et al. 2022), training and resources are needed to enable researchers and the institutions they work for, to **understand their role and fulfil their obligations** to society as well as capitalise on and appropriately govern new scientific developments.

- Motivation

A challenge that arises is a **lack of motivation amongst scientists** (and the institutions they work for) to communicate their work. Different causes are identified, including a lack of understanding of the relationship between science and society. This barrier is linked to other barriers identified, in particular a perception of a lack of time for communication, a lack of recognition for science communication work and insufficient funds for communication activities.

- Confidence

Researchers/scientists often claim they **lack confidence in communicating** their research, a problem that is even more relevant for female researchers. Training in science communication could address this challenge, increasing researchers' confidence and improving their capacities. Preparing for and responding to online harassment on social media would also benefit researchers.

- Increasing trust and passion in science

Despite several studies claiming that science and researchers are highly trusted by the public, **building trust** is still perceived as a challenge by researchers, an issue also expressed by some workshop participants. While a perceived lack of trust may limit scientists' willingness to undertake public engagement activities, at the same time, undertaking science communication could increase trust, and alter researchers' perceptions about public trust. Science communication can contribute to increasing trust together with raising aspirations and interest in science. Such aspirations are fundamental to inspiring young people to undertake science careers and thus supporting further science development.

- Knowledge of science communication theory

Science communication has developed over decades as a discipline, with its own **theories that support the practice** of science communication. Nevertheless, training in science communication offered to researchers often neglects this theoretical underpinning.

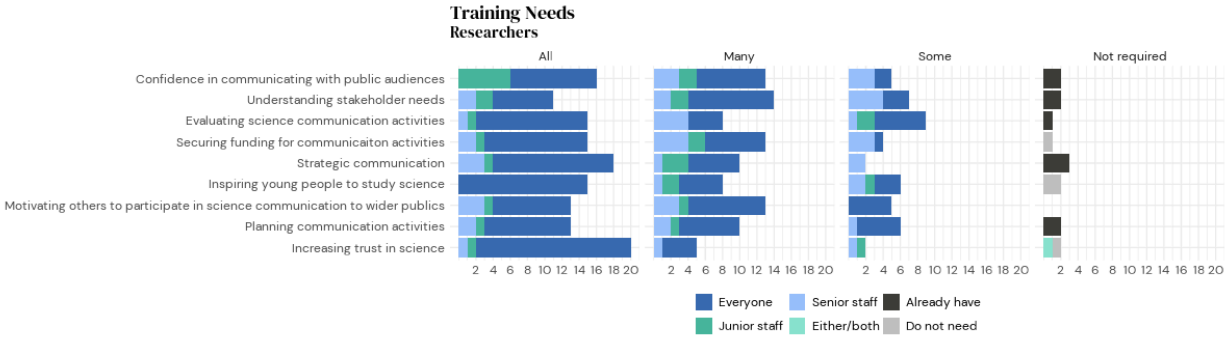
Grounding science communication practice in a theoretical context emerges as a key factor that could enhance the quality of researchers' science communication.

- Understanding and reaching out to different publics

Effective science communication has to be targeted at the audience. Different audiences have different needs, attitudes and knowledge and this has to be taken into account when communicating with them. While researchers/scientists are used to and trained to communicate with their peers, other publics, such as policy makers, citizens, children, may be less familiar to them.

The survey conducted with researchers asked about training needs for junior and senior staff. We invited respondents to indicate whether all staff, many staff or some staff required training (a separate question asked whether training was needed in the area). For those indicating training was needed, we found little distinction between junior and senior staff, with many respondents indicating that both groups needed this type of training. A few areas that stood out were that trust and strategic communication are considered areas of training needed for all researchers, alongside understanding stakeholder needs and securing funding. Few respondents suggested that only some staff need training in any of the areas investigated as indicated in figure 6. In this figure, the first three columns refer to whether all, many or some staff need the training. The fourth shows reasons why training might not be required. (Figure 6).

Figure 6: Training needs for researchers to address the communication challenges.



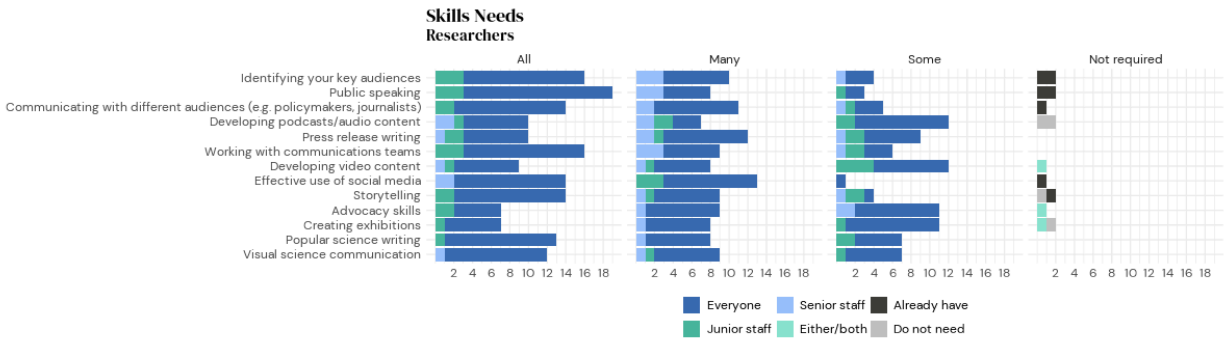
3.2.2 Skill needs

Several skills emerged from the workshops as needed by scientists and, more broadly, researchers, to enhance their science communication practice. As listed below, these skills are related to the capacity to communicate orally or in written form, through different media and other formats to specific publics. Moreover, certain skills need to be developed for particular scientific fields. Other core skills include strategic communication planning, evaluation and getting funding.

- Planning communication, including: identification of the audience, evaluation of communication effectiveness, fund raising
- Genres and language, including: composition, rhetoric, plain language, accessibility of communication forms, including public speaking, story telling, visual communication, video content development, press release development
- Communication channels and platforms, including: social media use, exhibition creation, popular writing
- Communication to and collaboration with different stakeholders, including: communication with journalists (interviews, TV/radio), communication with policy makers ,communication with and engagement of other publics (students, parents, stakeholders…), manage skepticisms and distrust, advocacying, communication specific on scientific topics

We explored these skill needs further through the survey for researchers, receiving 30 full responses (Figure 7). Again, respondents were asked to indicate whether all, many or some participants needed training in this area (a separate question asked whether training is needed). This highlights that training in public speaking and identifying key audiences are needed by all researchers, while respondents thought that many researchers need training in effective use of social media. There are also areas where some researchers may need training, such as in creating exhibitions. The majority of respondents felt these training needs were experienced by junior and senior staff.

Figure 7: Researchers perspectives on areas where SciComm training is needed.



3.2.3 Training gaps

Although training is often available to meet the skill needs of researchers, with differences reported among countries and institutions, such training is not systematically implemented as part of the training of researchers and for this reason the skills identified as needed during the workshops were also all indicated as gaps.

3.2.4 Desired Training Formats

During the workshop we held, several formats were suggested for training of scientists/researchers, from in person courses for PhD students and researchers at different career levels to courses online as well as hybrid formats. From the researchers' perspectives, **flexibility emerged as a key element**: researchers wanted the opportunity to tailor training to their needs and interests through a choice of modules/courses. Researchers also highlighted the benefits of being able to **practise communication skills drawing on their own research field**. Training could also take the form of a **mentorship**, while **the building of networks** that allow sharing of experiences was also seen as useful.

In the survey to researchers, we explored further how they would like to receive training (Figures 8-11). Researchers express a preference for **hybrid training formats** and online training over in person training. In terms of online training, researchers are happy with live sessions or materials to work through at their own pace, though a minority disagree. From researchers' perspectives, when it comes to online training, **personalised feedback, case studies and examples**, short videos and group discussion are highly valued, while quizzes are seen as not essential.

Figure 8: Researchers preferences for training delivery

In terms of in person training, researchers prefer **full or half day workshops** at their organisation or full day workshops delivered elsewhere in their country. They find single day workshops held in another country least appealing.

Figure 9: Researchers' preferences for training formats

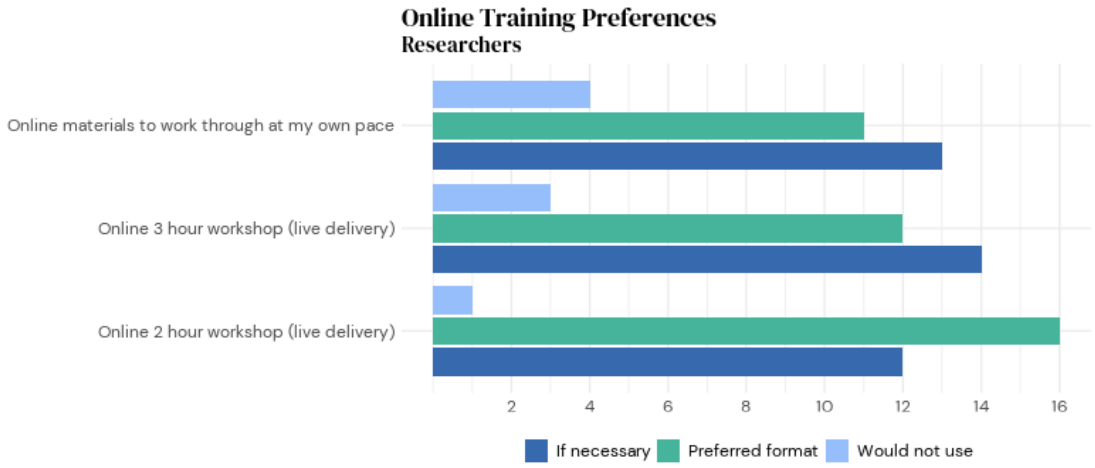


Figure 10: Researchers preferences for training tools in self-paced courses

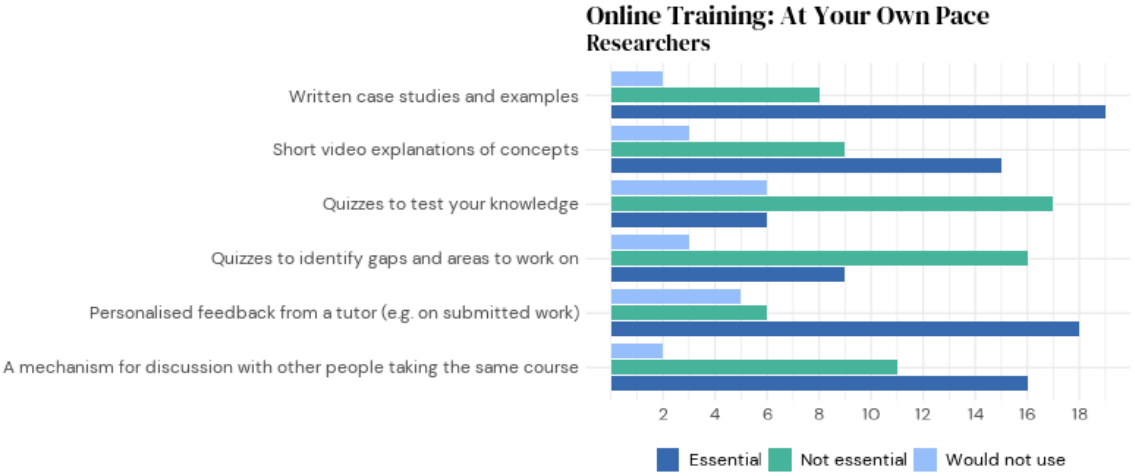


Figure 11: Researcher preferences for in person training

Finally, in terms of general preferences, researchers prefer group training formats with people from other organisations for themselves, but value bespoke training delivered specifically for their staff. Training in a researchers' first language may be beneficial (Figure 12).

Figure 12: Preferences for training formats

3.3 Science Communication Officers

Science communication officers working in universities, research institutes and other research organisations play a key role in the wider communication of research findings. In addition, science communication officers may work as agency staff, offering their communication expertise to a wide range of organisations that produce research (including commercial organisations). These staff often act as a bridge between scientists and other groups, including journalists and policy makers, as well as wider publics. Their roles can be both practical and strategic.

3.3.1 Challenges & Needs

Challenges faced by science communication officers (e.g. working in institutional settings or in communications agencies) and related **needs focus on having an impact, fighting misinformation, and creating positive relationships with science/scientists**.

- Impact

A particular challenge around assessing the impact of their work emerged. There is a feeling that being better able to measure impact, would help them to highlight the value of communication to scientists, who often do not prioritise communications activities, creating pressure on communication officers. In addition, better mechanisms to capture impact

would help to justify costs associated with communication activities, including staff costs. Elaborating on this, one participant of the online workshop highlighted that while you could capture media outputs (press releases sent, news stories published), this did not always lead to more concrete impact in the short term. It might be some time later that the attention received by the media leads to impact that scientists recognise (such as networking opportunities, securing funding or inclusion in wider institutional research metrics, e.g. Research Excellence Framework in UK). In the context of digital media, it can be difficult to capture more complex metrics (beyond viewer numbers), such as how much time is spent on the website, the costs per viewers. However, tracking down these details can help to demonstrate value for money.

- Misinformation

Another issue identified was the **growing challenge of misinformation and how to address this at an organisational level**. For example, one workshop participant highlighted that it can be challenging to encourage an organisation to communicate about controversial topics if they are concerned about how a story might be twisted (e.g. by journalists or others). This can be a particular challenge for organisations that have experienced inaccurate coverage. Related to this, was concern about how you handle ambiguities (e.g. in climate science) without creating distrust. Other challenges were also identified around health topics, where the media may create false expectations through inaccurate reporting. Social media, where there is a higher level of control over the message, was not seen as a solution because things move quickly on social media and it can be challenging for an organisation to respond quickly enough in this space. '*By the time everyone agrees, it's not news or it has escalated, so we are constantly catching up*', reported one participant in the workshop.

The lack of embargoes, pre-print sites (e.g. e-life) which publish articles before they are peer-reviewed and a lack of willingness on the part of scientists to involve the communication officer early enough were all seen to contribute to the challenges around poor quality coverage.

- Relationship with science/scientists

For scientists, these **communication activities are add ons that may not be rewarded**, thus it can be difficult to get scientists involved. Likewise, the **importance of gaining the trust of researchers** was highlighted in this context. One participant explained that you need an '*ability to discuss research with academics and ask probing questions to get at the heart of the story and its relevance*'. Other challenges around the relationship with scientists/science included: getting information from scientists before publication, managing the expectations of scientists, putting results into the bigger picture without *'blowing it out of proportion'* and communicating different scientific perspectives on an issue, and a related issue with judging whether the methods and conclusions of a study are sound. Likewise, there are challenges around producing materials that are useful to society and make science understandable.

- Specific communication challenges

Communicating uncertainty (which was exacerbated in the pandemic), communicating and explaining statistics correctly (without being misleading), using AI responsibly, illustrating complex stories; integrating text, images, video and animation, overcoming the infodemic - how to be heard when you are at the mercy of algorithms on social media, effective storytelling (balancing the need to include findings and limitations of research) were perceived as challenges by communication officers. Many of these skills also revolve around being able to explore science critically, as explained by one participant you need the '*ability to critique research to determine whether the science is high quality or poor*' (e.g. the type of study, sample size, whether it's statistically/clinically relevant, is there potential for bias?).

- Management challenges

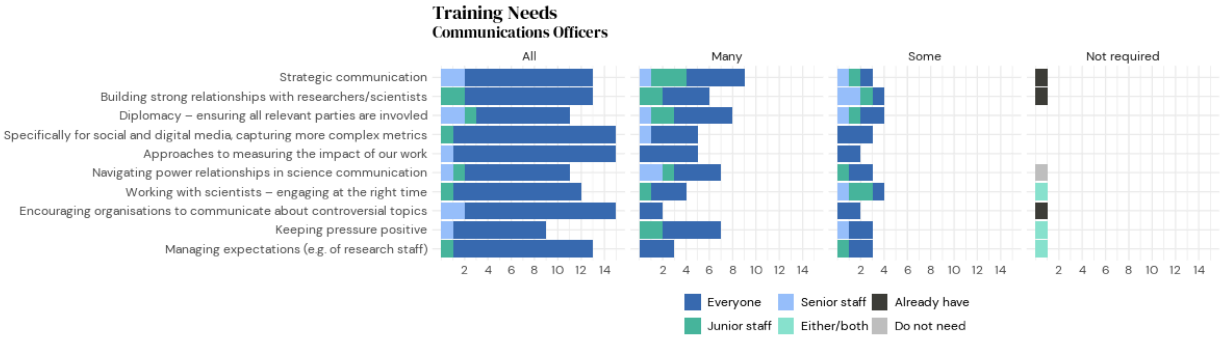
Lack of time, as there are many requests to produce materials, and linked to this, a need to focus communication effort; being strategic and balancing audience with respect to interest, relevance of research alongside expectations of senior staff were all identified as obstacles faced. Maintaining a positive feeling in a pressure-filled environment was also identified as a challenge.

- Particular audience challenges

Engaging young people with research, and linked to this, getting them to respond to calls to participate were identified by workshop participants as challenges alongside finding effective ways to change behaviour. During the in-person workshop, **difficulty interacting with journalists** arose as a challenge, in terms of creating good long term relations.

Drawing on the challenges faced by communication officers as emerged in the online workshop, we developed a survey to explore their training needs with regards to these issues. Figure 13 highlights the areas where communication officers express a need for training to overcome these challenges. Respondents were asked to indicate whether all, many or some staff needed training (specifying whether these staff are junior or senior); there was also an option to specify that no training is needed. Although all topic areas were seen as important, there is **a particular need to provide training on how to encourage organisations to communicate about controversial topics and approaches to evaluation**, including capturing and measuring impact and capturing more complex social media metrics.

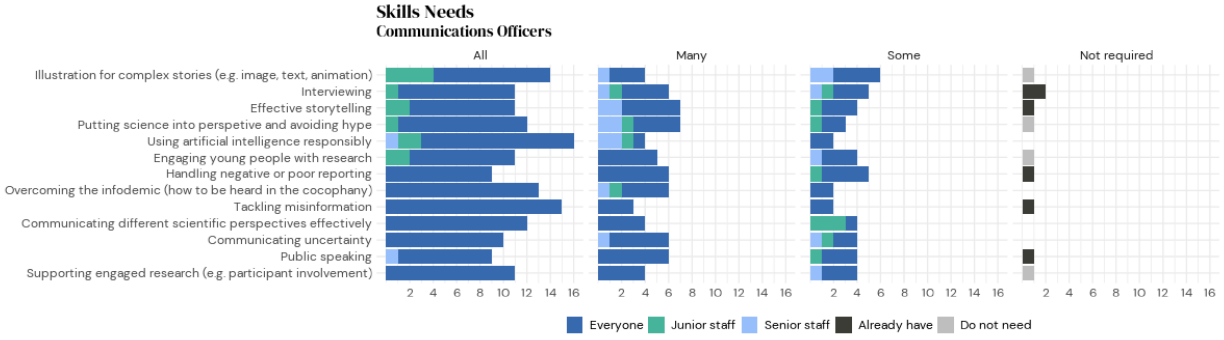
Figure 13: Training needed to overcome communication challenges.



3.3.2 Skill needs

Science communication officers identified a wide range of skills needed to perform their roles. These included: good relationships with professionals (e.g. journalists); diplomacy (ensuring all relevant parties are involved - including co-authors, funders); an ability to have two-way conversations and support engaged research (e.g. citizen science) by creating dialogue; a strong interest in science; capacity to take step back from scientific data/results; awareness of audiences; digital skills; storytelling; listening; writing skills; flexibility; media insights (what's topical); creating an elevator pitch. We explored the skills identified in the workshops with a wider group of communication officers via the online survey. This highlights the **need for skills-focused training across a number of areas, but particularly focusing on illustration, artificial intelligence, tackling misinformation and overcoming the infodemic** (Figure 14; same response options were provided as for communication challenges). The high need of training on the use of artificial intelligence was also confirmed in the in person workshop.

Figure 14: Communication officers' views on the need for specific communication training.



3.3.3 Training gaps

A number of areas were identified with a lack of training provision that COALESCE could potentially fill. Identified gaps **highlight needs in the areas of digital skills** in particular.

- Digital skills training

Training is needed in the following areas: optimal use of AI (e.g. to develop content, to edit and responsible use); social media outlets, and the algorithms they use; Search Engine Optimization - SEO training; using social media to promote your brand and strategic use of social media. Elaborating on some of these topics, participants highlighted the potential power of AI tools to summarise reports in lay language that could then be checked by researchers, or writing catchy headlines to allow the communications team to produce more outputs. The potential of AI tools to create visual illustrations also emerged, but there was also recognition of the emerging nature of these tools and a need to reflect on what responsible use might look like.

- More general communications skills training

Identified areas for training included: a broad suite of communication skills (covering the basics in a number of areas); navigating the power relations in science communication; writing for the public; public speaking; interview skills.

- Other areas

Other training needs identified included: keeping pressure positive, working across communication areas (outreach, informal education), supporting scientists with their communication efforts, alternative routes to engaging people with science (outside of news outlets), networks to share and develop best practice.

3.3.4 Desired Training Formats

Several formats were suggested for training by the participants in the online workshop. Online formats, which allow people to dip into resources aimed at specific groups would be welcome. Design of such resources needs to consider how to make them **interactive** (e.g. through the use of quizzes). **Pairing schemes** that would bring people together from different countries around Europe was suggested; these could be pairs that work through resources together with perhaps less facilitation than a traditional workshop approach. Group training offers the opportunity for cohorts to share practice, and may be helpful in developing **communities of practice in science communication**. Group training was thought to be particularly useful when addressing skills around 'difficult-to-reach groups'.

We further explored in the online survey with communication officers their preferences for training formats, receiving 20 responses (Figures 15-18). Communication officers expressed a preference for **hybrid mode training**, followed by online and in person training. During the in person workshop we further explored this aspect and what emerged was that the in person format would be more effective, but more challenging to attend and hybrid training was seen as a good compromise as well as organising the training at their own organisation. Regarding online training format, communication officers prefer online workshops, with self-paced

materials the least popular, though still welcomed. In terms of materials that communication officers could work through at their own pace, they express a **preference for case studies and videos**. Other potential aspects of self-paced training received mixed responses, with quizzes considered the least useful.

Figure 15: Preferred approaches to online training

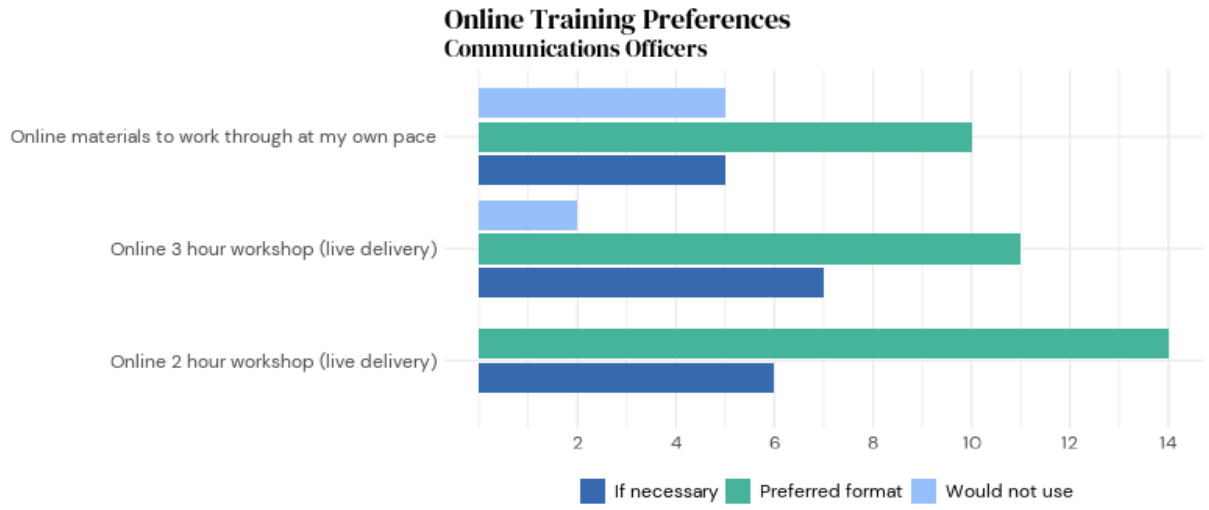
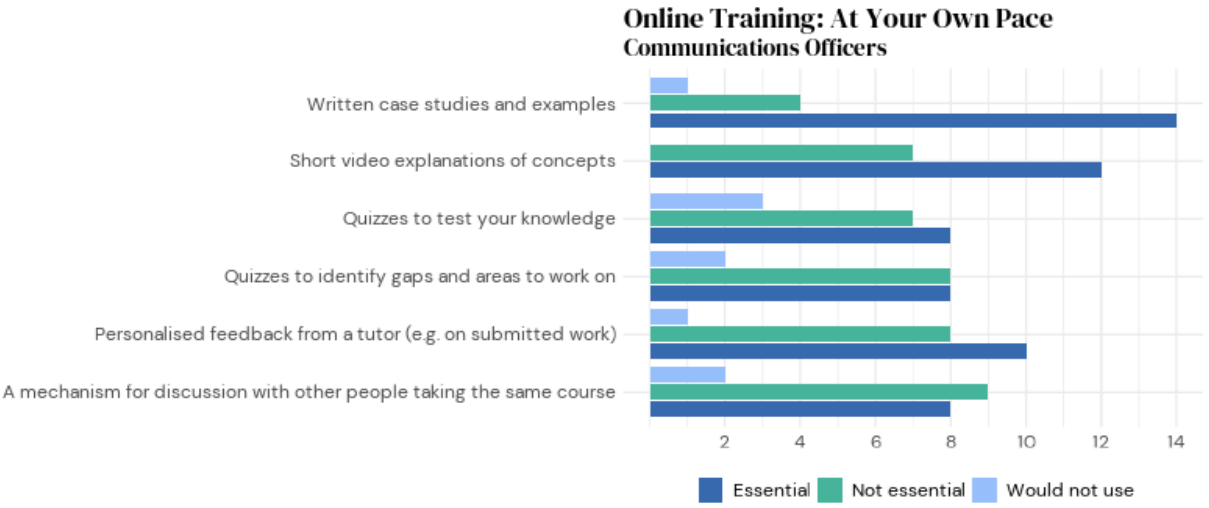


Figure 16: Communication officers' preferences for training delivered at their own pace



When asked about in person training, communication officers prefer **full or half day training offered at their own organisation**, or full day workshops delivered in their country. The least popular option was single day workshops delivered in another country. Group training with staff from other organisations is most important to communication officers, with material also tailored to their national country and language.

Figure 17: Preferences for in person training (communication officers)

Figure 18: Other preferences for training (communication officers)

3.4 Non-science Journalists

General journalists or non science journalists are those journalists that only cover science on an occasional basis, often when it becomes politicised or otherwise high profile. These journalists generally have no scientific training and a limited knowledge of science and its methods. Both the ENJOI and QUEST projects explored journalists' challenges and needs. What emerged is integrated with results of the workshop and interviews carried out in the section below.

3.4.1 Challenges & Needs

The main challenges and related needs for general journalists communicating science are linked to their **limited knowledge of science and the research system,** for example, they

may lack the capacity to identify reliable sources of information, to judge the quality of scientific information or studies and the scientific background that comes from regular reporting of science.

- Understanding of science and research

Previous studies on journalists (Mannino et al., 2021) indicated that those who do not have a scientific or research background need support to understand science topics better. This included understanding the scientific method and process as well as specific scientific terms. Interviews organised in the framework of COALESCE confirm these results "*...in all the areas in which not having a degree ... you feel at a deficit, absolutely, because you need basic physical and mathematical tools to be able to understand certain things...*"'

Particularly important is the need **to understand the scientific publication process and the kinds of scientific publications that exist** (alongside how to judge their quality). One of the key aspects, therefore, is support in order to understand which scientific journals are reliable and which are not. Another important aspect in this context is to understand how university press offices work, since they are becoming a huge source of information on research results.

- Getting reliable scientific information in a short time

Speed is a recognised issue for journalists, which has become a bigger issue now that websites, including newspapers, all communicate almost instantaneously. To meet the time pressure to publish, **non-science journalists need either reliable sources or a way to reach scientists quickly to conduct interviews**.

"I, who worked in radio and television, once had much tighter deadlines than my colleague from the press who had to write the article. That time the deadline was by midnight, by midnight and a half, ...; the journalist working in the newspaper had the whole day to check, call, contact. Today, even for the printed press, with the websites that need to be updated continuously, there too you have to always be quick, always on point and therefore have contacts quickly".

Greater awareness of services provided by science media centres, for example, could help address this challenge. The mapping of research centres and of key contacts in the communication offices could also facilitate exchange with reliable scientists and information. This is particularly relevant in countries where there are no science media centres, which operate as independent press offices for science providing the national news media with access to credible science. However, it should be recognised that science media centres are not always able to respond to the journalists' needs quickly enough. Other initiatives, such as

the Women in Science Database[8] from the Spanish Association of Women in Science and Technology, are designed to support and facilitate journalists' access to reliable sources whilst promoting diversity in terms of gender (as well as scientific knowledge from a gender perspective).

- Peer exchange

Peer exchange was also indicated by participants in our activities as very important, this is especially true for journalists that lack knowledge in the field. This is facilitated, at least in part, by the several networks existing at national and international level, and which also cover specific themes. Nevertheless, many journalists are not members of these specialised networks.

"*Yes, in my opinion sharing is essential, it is even more important when you work as a freelancer, so you don't have daily comparisons with colleagues. If the network is European, so be it, in the sense that obviously also the local has its limits, so hopefully by widening the network we will also discover different ways of acting*".

- Understanding science ethics and conflicts of interest

Non-specialist journalists require training in research ethics to better understand which studies are reputable and which may raise concerns. This would include training in relation to issues such as conflict of interest, understanding how research is financed and the implications of different funding sources.

- Communicating uncertainty in science

Among key scientific concepts, workshop participants highlighted **challenges around understanding and communicating scientific uncertainty**. Linked to this was a need to understand and make clear also for the public why scientists might take different positions on a topic, and that scientific 'opinion' might change as research progresses. For example, when covering climate change it is important to understand the weight of scientific opinion, broader consensus and conflicts of interest, so as to avoid giving undue voice to fringe positions. A similar situation arose during the COVID-19 pandemic when scientific understanding was rapidly changing.

3.4.2 Skill needs

A wide range of skills are needed by journalists when they communicate science. While many of these are common to science and non-science journalists, others are particular to non-science journalists. These include: verification of the quality of sources; good relationships with scientists and research institutions; using and reporting scientific data

[8] https://cientificas.amit-es.org/

appropriately; social media management; use of AI tools; uncertainty and risk communication; and, public engagement.

"*And so in my opinion the first, without going into specifics, would already be a good start to teach us to read statistics, data, rankings, all these things, right? That is, how they are processed. One thing, for example, that I always look at when I see, for example, a survey, is the sample, not only the size of the sample, but also how it was selected, where, which environments, why it is fundamental, right?*"

3.4.3 Training gaps

The extent to which science is covered in journalism curricula is mixed, leading to gaps in initial journalist training. Journalism networks may offer some training that fills these gaps, but this is likely to be via specialist networks to which non-science journalists do not belong. From the work carried out, specific training gaps that the Science Communication Academy should fill include:

- How to verify scientific / scientist sources
- How to develop positive interactions with scientists and research institutions
- Social media management
- Journalism and AI: understanding of how to use AI in journalism as well as how to communicate AI
- Understanding science and communicating key scientific concepts

3.5 Science Museums and Centres

Science museums and centres offer opportunities for members of the public to have hands-on experiences of science and/or see scientific objects of historical interest. As such, they play a key role in engaging the public with science and discovery.

3.5.1 Challenges & Needs

Challenges identified by senior staff working in science centres and museums focused on four areas: **managerial challenges, staff challenges, challenges related to publics and external challenges**. Taking each in turn:

- Managerial challenges

Issues here focused on the wide range of expertises that staff within a science museum or centre setting will bring and finding ways to acknowledge and value these different knowledge. Within this was a recognition that in some situations science communication activities are not valued, and this can make it difficult to bring in external expertise (e.g. scientists). A related challenge was a **shift in the focus of museums from promoting science to promoting a scientific way of thinking** - participants argued that while this was

occurring in some science centres/museums, there is a need to place more emphasis on this within the sector. A structural challenge faced by this sector is securing funding, and there was agreement within the workshop participants that this sector would **welcome greater involvement as partners in EU funded research initiatives** (this could be more widely supported through explicit encouragement of researchers to include partner organisations in funding bids, see also a recent policy brief[9] on informal science communication). A final issue identified was recruitment and retention of quality staff.

- Staff challenges

A key theme under staff challenges relates to staff identity; the close link between this sector and schools led staff to question, '*are we scientists, teachers, performers, etc?*' Linked to this, there was a desire for this sector to **act as role models for formal educators and facilitate change in the way science is taught at school** (but also empowering teachers to feel confident with science). Challenges around science content emerged, with issues identified relating to the selection of exhibition contents, the complexity of science topics, particularly in areas such as climate and health. In addition, **science itself is becoming more technically demanding, making the explainer job more difficult.** Other issues identified include: not being limited to STEAM approaches (which have become popular recently), finding examples of good practice, identifying impartial sources and finding ways to be more viral than fake news.

- Audiences and publics

There was recognition amongst workshop participants that **science (and for those adopting Art-Science approaches, art as well) are elite topics,** creating a challenge in terms of **making the science accessible to different publics** (this focus on marginalised communities was also identified in a recent policy brief[10] on informal science communication); there are real challenges in how these organisations create accessible content, *'without losing quality and complexity'* and promote inclusiveness. Linked to this, was a need to **create safe spaces** where people can make mistakes, and spaces that enable public debate about topics that affect visitors' daily lives as well as providing visitors time to digest these topics. For those working with families, there was a perceived need to be a role model for parents and a challenge in creating activities that engage families.

- External challenges

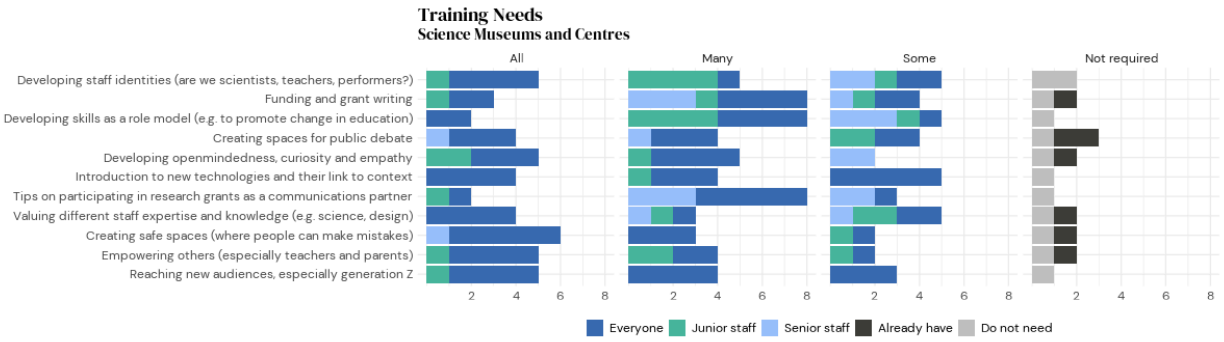
These relate to the close relationship between many science museums and centres and the educational sector. Key challenges here are about empowering teachers and a sense that the educational landscape needs to be transformed: science centres/museums could have a key role to play here and links to the managerial challenge of being a role model. As one

[9] https://zenodo.org/records/10849301
[10] ibid

participant noted, the challenge is '*empowering teachers and helping them find their identity*'.

We explored through the online survey the training that Science Museum and Centre staff need to address the challenges identified above. As previously, respondents were invited to indicate whether all, most or some staff need training, and to specify whether this training is needed by junior or senior staff. Respondents also had the option to specify that no training is needed. Here a picture emerges of all staff needing training in creating safe spaces, empowering others and developing staff identities, while many staff would benefit from developing skills as a role model, funding and grant writing and tips on participating in research grants as a communication partner (Figure 20).

Figure 19: Training needed to address challenges faced by science centres and museums.



3.5.2 Skill needs

Skill needs emerging from the workshop are categorised as **knowledge, communication and personality related,** plus a group of external skills.

- Knowledge related skills

These include: being able to admit you don't know; explaining what you know through questions; taking a rigorous approach to scientific knowledge.

- Communication related skills:

These include: social media; professional skills such as managing and engaging audiences; creating 'magical' experiences; sharing good practice/watching others in action; encouraging curiosity (never say 'no', the curiosity killer word); ability to create graphics (e.g. infographics).

- Personality related skills:

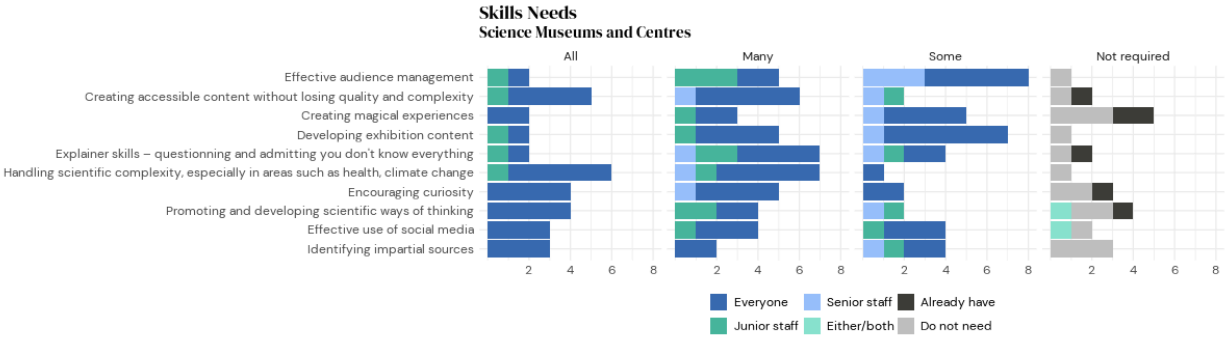
In this category: open mindedness; curiosity, empathy, being communicative; having critical opinions; being engaging were identified.

- External skills:

A final set of skills emerged around how to introduce new technologies and how to match those to spaces and context (e.g. history).

In addition, one participant in the workshop highlighted the need to have excellent professional skills that crossed these categories, including managing audiences, a service attitude and an ability to work in 'real time' (address issues on the spot) and a willingness to undertake ongoing training to broaden your horizons. In the survey to science museums and centre staff, we asked about their training needs in relation to these skills (Figure 21). Key areas where all staff would benefit from training is in handling complexity and producing accessible content. Many staff would also benefit from explainer skills training.

Figure 20: Skills training needed for science centre and museum staff.



3.5.3 Training gaps

Gaps in training provision were identified in several areas. These include:

- Technical skills - e.g. specific emerging science topics and research skills (e.g. how science works), train the trainer models (teach the teachers), creation of engagement activities and materials.
- Community outreach - broadening museum audiences, those who don't come; understanding Gen Z
- Museum related - networking/sharing skills (e.g. visit other museums, clubs, mentoring); skills to engage with decision making; funding / grant writing skills
- Communication skills: journalistic writing for museums; vocal health awareness for presenters; visualisation skills (e.g. data/art); understanding visual knowledge

3.5.4 Desired Training Format

Format can be seen across scales that might also map to career stages. For example, local training is needed for new/junior staff, while more experienced staff benefit from networking offered by in person training at national/regional level. Senior staff benefit from

knowledge sharing/networking at national/EU level. These are expensive in person, but of huge value for professional development. There is a need to meet scientists - to make local links. Quarterly local meet ups are a good way to achieve this (for all staff levels).

Blended learning methods are seen as appropriate in some contexts and enable interaction across geographical boundaries. For hybrid options, having a task that they present adds a focus. Whether in person or online, workshop modalities (rather than lectures) are preferred. Skills workshops can include, e.g. presenting, acting, voice skills, stand up comedy etc, these can be delivered in house or at local/regional level.

In terms of length, half day or shorter sessions are preferred for staff. Training can be one off, or offered monthly or bi-weekly for longer training topics.

One workshop participant offered a useful example of how training could be organised, based on who is being trained:

Who: teachers - Where: COALESCE / science centre
Who: facilitators in science centre - Where: science centre
Who: leading educators - Where: COALESCE via ZOOM workshop
Who: Scientists - Where: COALESCE/science centre/research institution
Who: journalists - Where: COALESCE
Who: parents, families - Where: science centre
Who: kids - Where: school/science centres
Who: policymakers - Where: meetings, conferences, Ecsite Directors forum

Training formats were further explored in the survey to museum and science centre staff. 15 full or partial responses were received for this survey. Science museum and centre staff expressed a strong preference for **hybrid training formats**. In terms of online delivery, respondents preferred 2 or 3 hour live workshops, though many would use self-paced online resources if necessary. Regarding self-paced online materials, staff would prefer **a mechanism for discussion, feedback from tutors and short videos**. Quizzes were least popular and some respondents did not feel they would benefit from tutor feedback.

Figure 21: Science museums and centre staff training format preferences

Figure 22: Science museums and centre staff preferences for online training formats

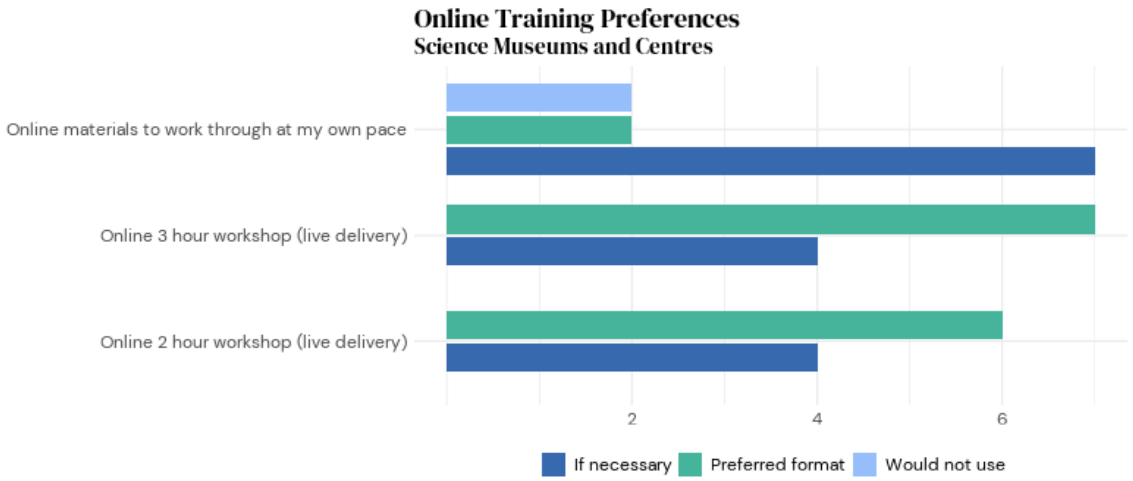
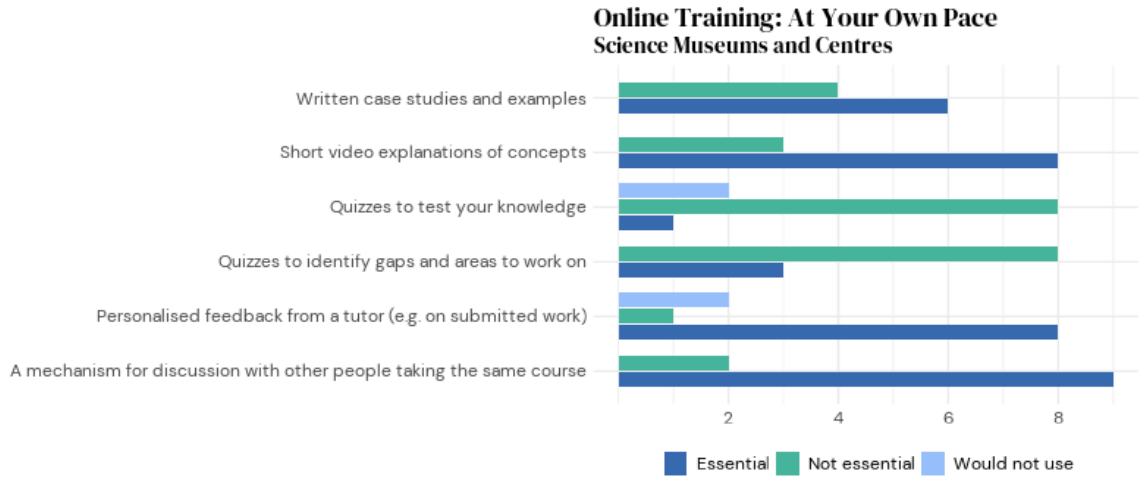


Figure 23: Science museum and centre staff preferences for online, self paced training materials



Regarding in person formats, museum and science centre staff would prefer **full or half day workshops delivered at their organisation**. If necessary, they would attend single day workshops elsewhere in their country or multi-day workshops in other countries. They would not attend single day workshops delivered in another country. Regarding other aspects of training, respondents considered primarily the needs of their staff. These include group training opportunities and materials tailored to their national context and language.

Figure 24: Science museum and centre staff views on in person training formats

Figure 25: Science museum and centre staff views on other aspects of training

3.6 Civil Society Organisations

Civil Society Organisations (CSOs) have been largely overlooked in the science communication literature, but many play a significant role in communicating about scientific issues with the public. These organisations[11] comprise a wide range of groups that provide services, share information, undertake advocacy and hold governments to account. They typically involved volunteers, unpaid and paid staff. These organisations often specialise in a particular area (e.g. health charities, environmental campaigning organisations), but all seek to engage society with their focus issue and to do so, they often mobilise scientific information. To our knowledge, there are no published studies that have looked at the challenges, skills and training needs of this type of organisation.

3.6.1 Challenges & Needs

A key challenge faced by CSOs is the often **polarised nature of the communication spaces they work within**. In this context, science can become a 'club' with which to counter or 'kill' the opinions of others, meaning that within the spaces they are working science can become very politicised and it can be hard to ensure that science is presented fairly and accurately. A particular challenge is **engaging with audiences who may already have a particular opinion** on, for example, climate change. It can be very difficult to change minds even if the science supports an alternative view. This can include changing the minds of scientists as well as audiences.

CSOs comprise a broad range of organisations and it is important to reflect that not all communication from these organisations aims at changing opinion or influencing policy. As one participant noted they are often '*trying to give the audience what they want, not trying*

[11] https://link.springer.com/referenceworkentry/10.1007/978-3-030-66252-3_153

to change anybody's mind about anything. Often working with scientific researchers, but the skills being drawn on are those you would find in broadcast and entertainment companies'.

Further, although they are very connected to their audiences, **work in this space can be driven more by a deficit or transmission oriented approach to communication**. As one participant noted, '*your target audience should shape your message, but actually thinking about it helps researchers to empathise with the audience, so it becomes a two-way conversation instead of the deficit model of communicating facts.*'

3.6.2 Skill needs

A wide range of science communication skills are needed by staff working in CSOs. These range from understanding your audience and creating empathy, through to tackling difficult situations and working in polarised environments. In addition to practical communication skills, participants in the workshop highlighted the management skills needed by more senior staff and also practical science related skills (including health and safety) for those who may be including science shows within their portfolio. Organisational size also influences training needs as smaller organisations may not have all the necessary skills available internally, As one participant explained '*one of the main challenges that small NGOs face is that effective science communication involves a diverse set of skills*'. To address the variety of skills needed, they argue that '*you have to build partnerships*'.

The following training needs were identified:

- Audiences: understanding audience values, writing for different audiences, writing persuasively and clearly, placing yourself in the audience's shoes, thinking beyond the 'general public', reaching a wider audience, making science concrete (talking about 'real world applications');
- Communities and volunteers: how to work with hyper-local organisations, volunteer management, building online communities, building relationships and working in collaboration (including networking with journalists);
- Leadership skills: project and budget management; people management; resources for communication (e.g. working with news agencies);
- Science: balancing science and news needs; managing fake news and denialism, managing uncertainty;
- Policy: knowing government structures/understanding policymaking (local/national/international); stakeholder management and influencing;
- Skills: performance skills and public speaking, being a confident communicator, good practice with (e.g. storytelling techniques); scriptwriting and editing, web design, audio-visual skills (sound desk, vision mixing, filming, production etc), social media manager tools; latest applications/technologies and how to use them (e.g. AI tools); data analysis and impact measurement.

3.6.3 Training gaps

Training available varies by country, with participants from Eastern Europe reporting about their lack of, and also the CSO sector, with some areas (particularly those closely aligned to science communication, such as learned societies) and countries (such as the UK) well served by appropriate science communication training and other areas where there are significant gaps. One common gap identified was around the **appropriate use of AI tools**. For those working in polarised environments, there is a lack of appropriate training on handling debates and presenting science to support debate and decision-making (personal as well as political). Another unmet training need that was not identified by other stakeholders is being an **audience advocate**. Key areas where training gaps exist include:

- Audiences: Audience advocacy; becoming a trusted and influential communicator; inclusion, equity, social justice and racism; audience segmentation; a guide book on how audiences respond to messages that goes beyond experience of the field (research informed);
- Polarised debates: solutions to conflicts, difficult debates and controversial discussion (facilitation techniques), chairing techniques; dealing with social media 'pile ons'; approaching polarised discussion;
- Data related skills: Data analysis for impact evaluation (especially making use of AI/Big Data tools;
- Digital skills: use of AI tools; how AI is changing the communication scene;
- Wider skills: understanding social science; learning from social science research about effective communication; presentation and public speaking (including speaking clearly and precisely); engagement management; tackling fake news and denialism; social media skills; understanding social media dynamics.

3.6.4 Desired Training formats

Regarding formats, within CSOs staff arrive at positions involving science communication from a **wide range of backgrounds**, ranging from scientific training to training in areas as diverse as theatrical skills and design. This presents a challenge in terms of training because you cannot always assume that staff have a background in any particular area (it is not easy to build a training suit that goes 'step-by-step'), yet if training starts with the fundamentals you *'never get to the nitty-gritty stuff'*. Participants in the workshop also recommended that senior staff be offered internships as well as more junior staff.

There were mixed views on the format training would take, with some preferring online training for budget reasons and others wanting deep dives in the form of half or full day sessions. In terms of formats, participants also sought materials you can work through in your own time (guides, YouTube tutorials), a mechanism for best practice sharing (peer-to-peer), **a database of best practice examples** and **summaries of academic papers as these were rarely accessible to CSO staff**. Internships (for senior as well as junior staff) were also rated highly.

4 Concluding remarks

The work carried out in COALESCE highlighted that there are several skills and needs by the different stakeholders in science communication that should be addressed to promote quality science communication, as summarised in the table below.

Table 4. Skills to cover in science communication training per stakeholders

Needed Skills	Researchers	Communication Officers	Generalist journalists	Museums and science centres staff	Civil society organisations
DIGITAL SKILLS					
Artificial Intelligence		Yes	Yes	Yes	Yes
Social Media	Yes	Yes	Yes		Yes
Tackling fake news and denialism	Yes				Yes
AUDIENCE SKILLS					
Creating public debate				Yes	
Understanding and reaching audience, including new audiences (e.g. Gen Z) and alternative platforms, audience segmentation	Yes	Yes		Yes	Yes
Being an audience advocate					Yes
Being trusted	Yes				Yes
SCIENCE SKILLS					
Understanding and communicating uncertainty	Yes		Yes		
Understanding the scientific publication process and quality issues			Yes		
Reporting / communicating scientific data			Yes		
Understanding emerging topics				Yes	
PERSONAL SKILLS					
Interviewing		Yes			
Writing	Yes			Yes	
Public speaking, presentation skills	Yes	Yes			Yes
Visualisation	Yes			Yes	
Working with scientists			Yes		

Networking and interacting with other stakeholders	Yes			Yes	
OTHER SKILLS					
Developing skills as a role model				Yes	
Evaluation	Yes	Yes			Yes
Working in polarised environments	Yes				Yes
Navigating power relations		Yes			
Understanding and using social science research					Yes
Public engagement	Yes		Yes		Yes
Funding/writing grant applications	Yes			Yes	
Engaging decision makers	Yes			Yes	

There are some skills that are broadly needed, e.g. **knowing your audiences and adapting content, evaluation skills, public speaking, AI use, training in social media, sharing of good practices, funding of science communication activities**; and some others that are more stakeholder group specific, for example, non-science journalists understanding how to verify scientific sources and understanding scientific process and concepts, while CSOs need to mobilise science effectively and accurately as key concerns.

Training is already available that covers several of these skills, in particular on public speaking, social media, etc., even if the range of opportunities available vary depending on which stakeholder group is considered. For example, researchers and journalists have more opportunities than some other stakeholder groups to gain science communication training. Differences in the availability of training by country were reported by participants of the workshops, with western Europe having more established offers.

Further, **science communication training is not yet a natural, systematically implemented part of the educational background** of staff from within these different communicator groups and **training gaps still exist for most of the skills identified.** In the case of researchers it is recommended that science communication is included as part of their higher education. EU funded research projects may offer ways to address these skills gaps, for example, through training provision to researchers funded through ERC. In addition, Marie Sklodowska Curie doctoral networks or postdoctoral fellowships already require the inclusion of training, which could include science communication training. Further, all EU-funded research projects are requested to include communication among the activities listed in the project plan, and researchers' training in science communication could be included as part of it.

Across the different science communication groups explored, **there is a desire for hybrid training opportunities**. There is also evidence that **science communicators would benefit from a range of different training formats, including online self-paced, online live and in person training**. There is also an appetite for training at international and national levels, with a preference for training spread over time. Regardless of the format, in general peer exchange would be welcomed by all of the stakeholders' groups as a very helpful way to learn from others.

4.1 Future Directions

Taking these points into account, the COALESCE project should create a scicomm competences and skills framework and on the basis of this develop services of the Science Communication Academy responding to the needs and gaps highlighted.

Existing resources and training provision from the SwafS-19 projects that could satisfy the needs of different stakeholder groups are under exploration to form an initial set of training materials to be tested with each stakeholder group to shape resources.

Consideration needs to be given to how these resources work together, to provide a mix of materials that can be used for self-learning (e.g. videos) and those materials which would then be developed further with the national and regional hubs.

Remaining gaps in material and training provision should be assessed to determine how these could be met. This may include development of specific resources(e.g. a matchmaking tool for scientists), but also creating synergies with other projects and training. The standards, principles and criteria for resources under development will ensure the quality of what will be part of the Academy.

The exploration of the training formats provide a valuable basis to develop the portfolio of services that the Science Communication Academy could provide.

5 Acknowledgements

The COALESCE consortium acknowledges all the representatives of the quadruple helix (citizens, researchers, policymakers and industry), science communication professionals and journalists, and members of the COALESCE community of practice, that were involved in the interviews and workshops for their generous contributions. Moreover, it acknowledges EUPRIO and WANIFRA for their support in disseminating the survey, participation in the workshops or validating the results.

6 Project details

COALESCE Coordinated Opportunities for Advanced Leadership and Engagement in Science Communication in Europe

PARTNERS

Project website https://coalesceproject.eu

Competence Centre platform https://scicommcentre..eu

For more information please contact: info@coalesceproject.eu

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