Science Communication

Models and elements of science communication

Rui Mata, HS 2024

Version: October 3, 2024

Course structure

Session information

Sessions take place Thursdays, 8.15-9.45, Biozentrum, Hörsaal U1.131.

#	Date	Topic	Instructor(s)	Slides
1	19.09.2024	What is science communication?	Mata	pdf
2	03.10.2024	Models and elements of science communication	Mata	pdf
3	10.10.2024	Scientific uncertainty and trust in science	Mata	pdf
4	17.10.2024	Guidelines for science communication	Mata	pdf
5	24.10.2024	Science communication gone wrong	Mata	pdf
6	31.10.2024	Practical: Knowledge and Data Visualization	Hil/Lachenmeier	pdf
7	07.11.2024	Practical: Modular Information Design	Hil/Lachenmeier	pdf
8	14.11.2024	Practical: Modular Information Design	Hil/Lachenmeier	pdf
9	21.11.2024	Practical: Modular Information Design	Hil/Lachenmeier	pdf
10	28.11.2024	Practical: Modular Information Design	Hil/Lachenmeier	pdf
11	05.12.2024	Practical: Modular Information Design	Hil/Lachenmeier	pdf
12	12.12.2024	Practical: Modular Information Design	Hil/Lachenmeier	pdf
13	19.12.2024	Exam		

Recap of last session

- Recognize the need for effective communication between science and the public, and reflect on the responsibility of scientists (including psychologists) in communicating science effectively

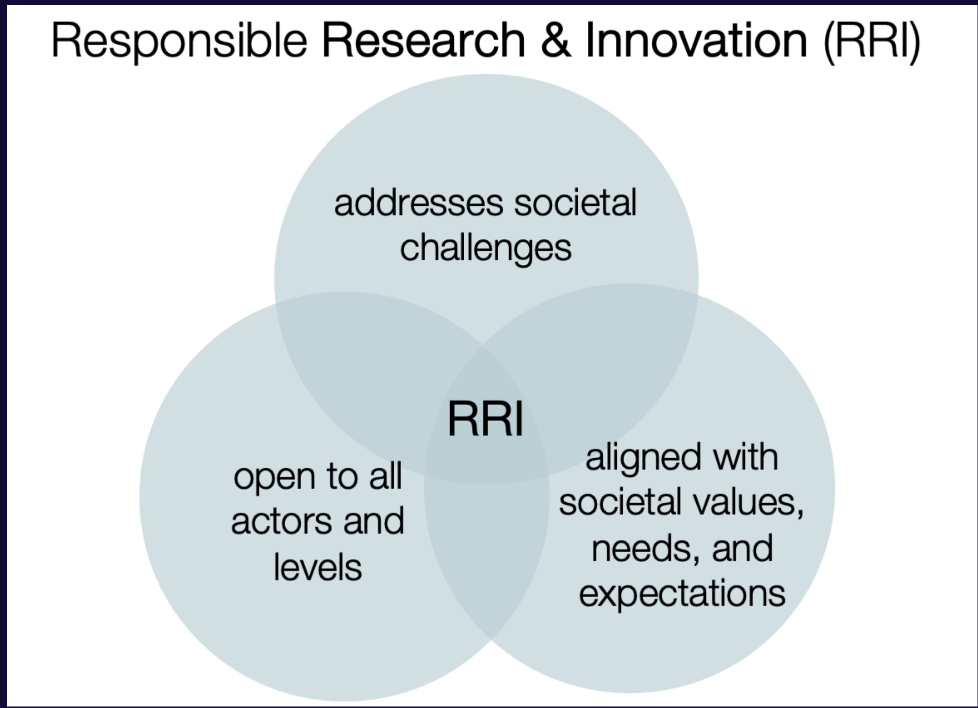
- Grasp the definition of science communication, including various forms and goals

- Become familiarized with the course structure, readings, and website

WHO'S GOT THE ANSWER?

According to the principle of responsible research and innovation…
[Select all the correct answers]

- A: Science is open to all
- B: Science is mostly concerned with human health
- C: Science is efficient and avoids risks
- D: Science is aligned with societal needs



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In the AEIOU definition of science communication…
[Select all the correct answers]

- A: A stands for AWE
- B: E stands for EXPLICIT
- C: I stands for INTEREST
- D: O stands for OPINIONS

SCIENCE COMMUNICATION (SciCom) may be defined as the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science (the vowel analogy)

Awareness, including familiarity with new aspects of science

Enjoyment or other affective responses, e.g. appreciating science as entertainment or art

Interest, as evidenced by voluntary involvement with science or its communication

Opinions, the forming, reforming, or confirming of science-related attitudes

Understanding of science, its content, processes, and social factors

Science communication may involve science practitioners, mediators, and other members of the general public, either peer-to-peer or between groups.

Figure 1. The AEIOU definition of science communication. This definition clarifies the purpose and characteristics of science communication and provides a basis for evaluating its effectiveness

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An example of internal science communication is when…
[Select all the correct answers]

A: a scientist presents findings at an academic conference

B: a scientist discusses preliminary results with a colleague

C: a scientist gives a public talk at a community event

D: a scientist helps write a press release about their work

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An example of institutional science communication is when…
[Select all the correct answers]

A: UNIBAS releases a new episode of UNISONAR

B: a scientist shares opinions about science in a personal blog

C: UNIBAS issues a press release about a new paper

D: UNIBAS sends a science newsletter to its alumni

Form of Science Communication	Description	Examples
Institutional Science Communication	Communication from scientific institutions or organizations to a non-scientific public.	Universities communicating research to the general public.
Science PR (Public Relations)	Interest-driven communication aimed at building reputation. Part of institutional science communication.	Universities promoting their research to enhance reputation.
Non-institutional Science Communication	Science communication by smaller associations, individuals, or teachers outside institutional settings.	Teachers or individuals sharing their passion for science.
Science Journalism	Reporting on scientific topics by journalists, distinct from institutional science communication.	News articles or reports about scientific discoveries.
Internal Science Communication (Scholarly Communication)	Exchange of scientific information within the scientific community, often during conferences or publications.	Presentations or discussions at academic conferences.
External Science Communication	Science communication aimed at audiences outside the scientific community.	Public talks or popular science books for the general public.
Science Education	Education-focused science communication, often aimed at teaching and inspiring interest in science.	School science programs, public lectures, and outreach.
Knowledge Transfer	Communication between science and industry or societal actors, often for practical applications.	Collaborations between universities and industry.

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- A: UNIBAS releases a new episode of UNISONAR
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Goals for today

- Get an overview of the history, models, and elements of science communication
- Identify stakeholders and audiences (public segmentation) of science communication
- Discuss rationale and practices of evaluation of science communication

Historical perspective on science communication

14th -16th centuries

- Rediscovery of classical texts (Greek and Roman), stimulating the revival of natural philosophy and scientific inquiry
- Cabinets of curiosity as informal spaces for discussing the natural world
- Early dissemination of scientific ideas via manuscripts and private letters among scholars

17th -18th centuries

- Ideas of natural philosophy discussed in coffee houses
- Founding of formal institutions to advance science (Royal Society, 1660), introducing the concept of the scientific paper (e.g., Philosophical Transactions) and peer review
- Creation of museums (Ashmolean, 1678)

19th century

- Local science societies in England, France, and America fostered wider communication.
- Formal institutions focused on science communication (British Association for the Advancement of Science, 1831)
- Rise of specialized museums (natural history)

Bertemes, J. P., Haan, S., & Hans, D. (Eds.). (2024). *50 essentials on science communication*. De Gruyter.
https://doi.org/10.1515/9783110763577

Historical perspective on science communication

20th century until today

- Rise of mass media an popular science writing (magazines, radio, public lectures)
- Massive education efforts as part of war (Atomic Energy, 1940s) and public health (vaccination, Polio, 1950s) efforts though films, brochures, and school programs
- Television as major influential medium for science communication (space exploration surrounding Sputnik launch 50s-60s).
- Professionalization of science communication through specific higher-education programs (1970s)
- Growing public concern about environmental issues (Chernoybil, 1980s)
- Rise of the internet, digital communication, and social media (1990s onwards…)

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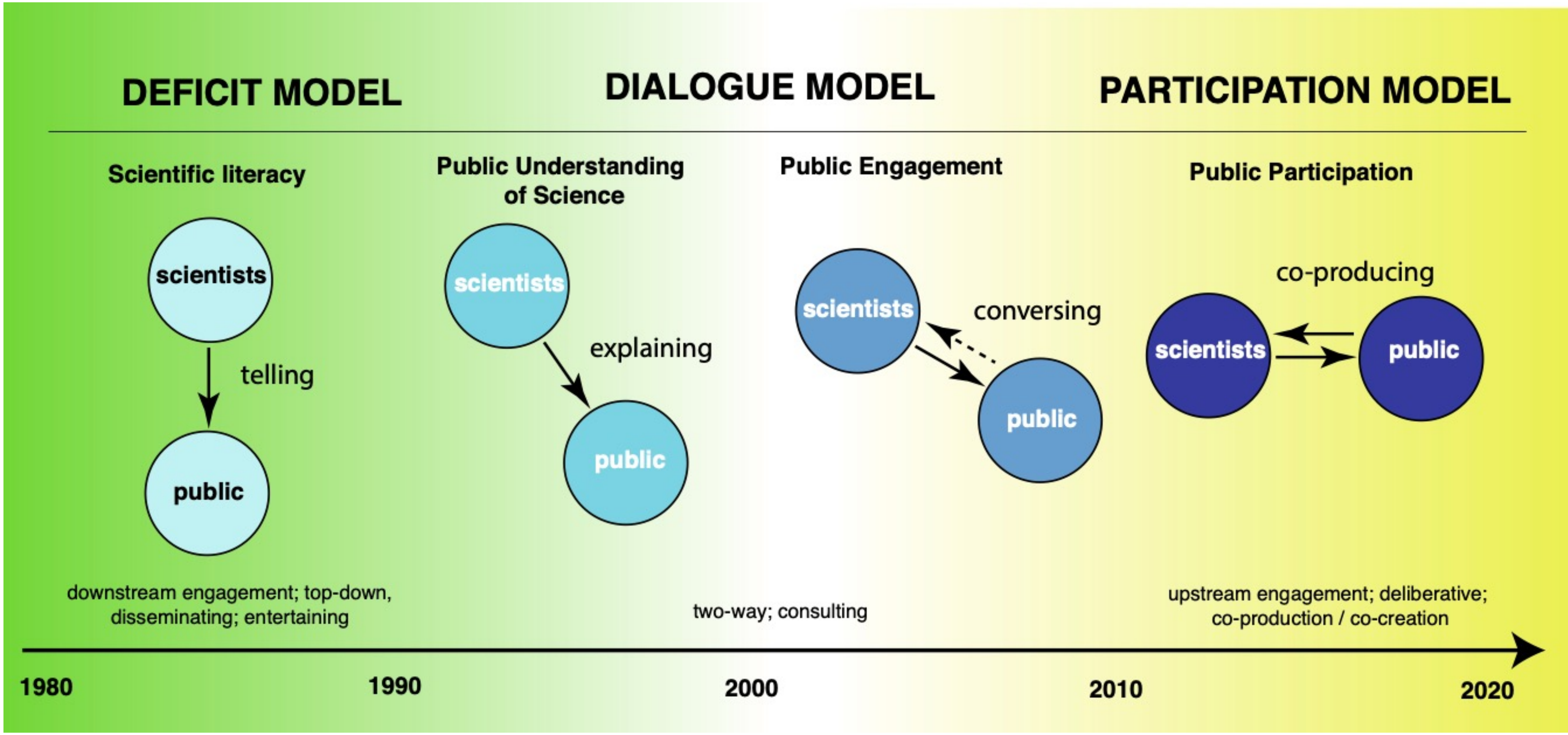
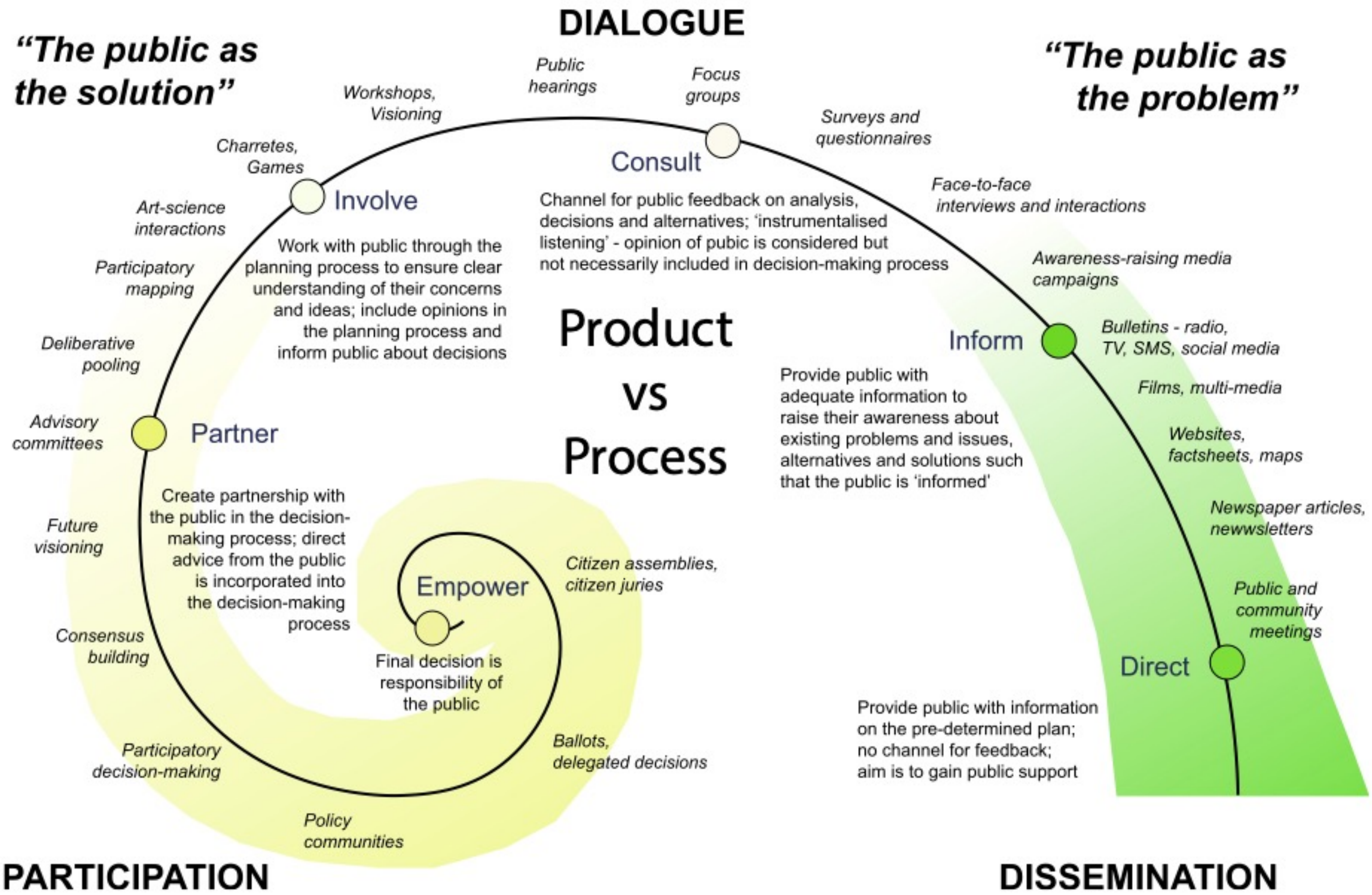


Stewart, I. S. (2024). Advancing disaster risk communications. Earth-Science Reviews, 249, 104677. https://doi.org/10.1016/j.earscirev.2024.104677



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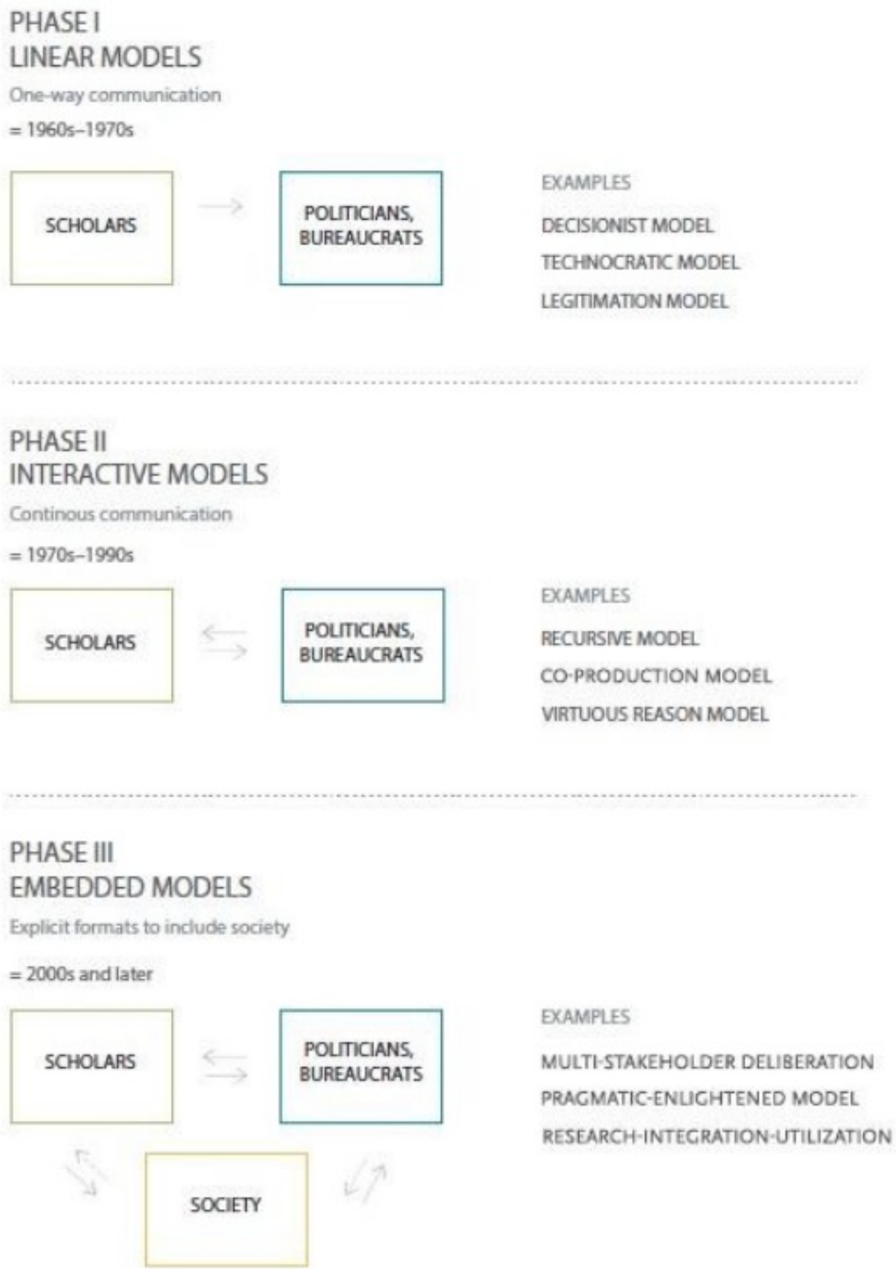
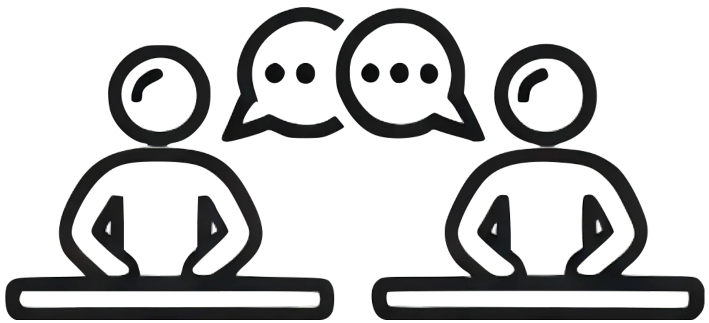


Figure 1. Models of scientific policy advice.

Sokolovska, N., Fecher, B., & Wagner, G. G. (2019). Communication on the Science-Policy Interface: An Overview of Conceptual Models. Publications, 7(4), 64. https://doi.org/10.3390/publications7040064

STRENGTHS & WEAKNESSES OF COMMUNICATION MODELS?



Strengths and Weaknesses of Science Communication Models

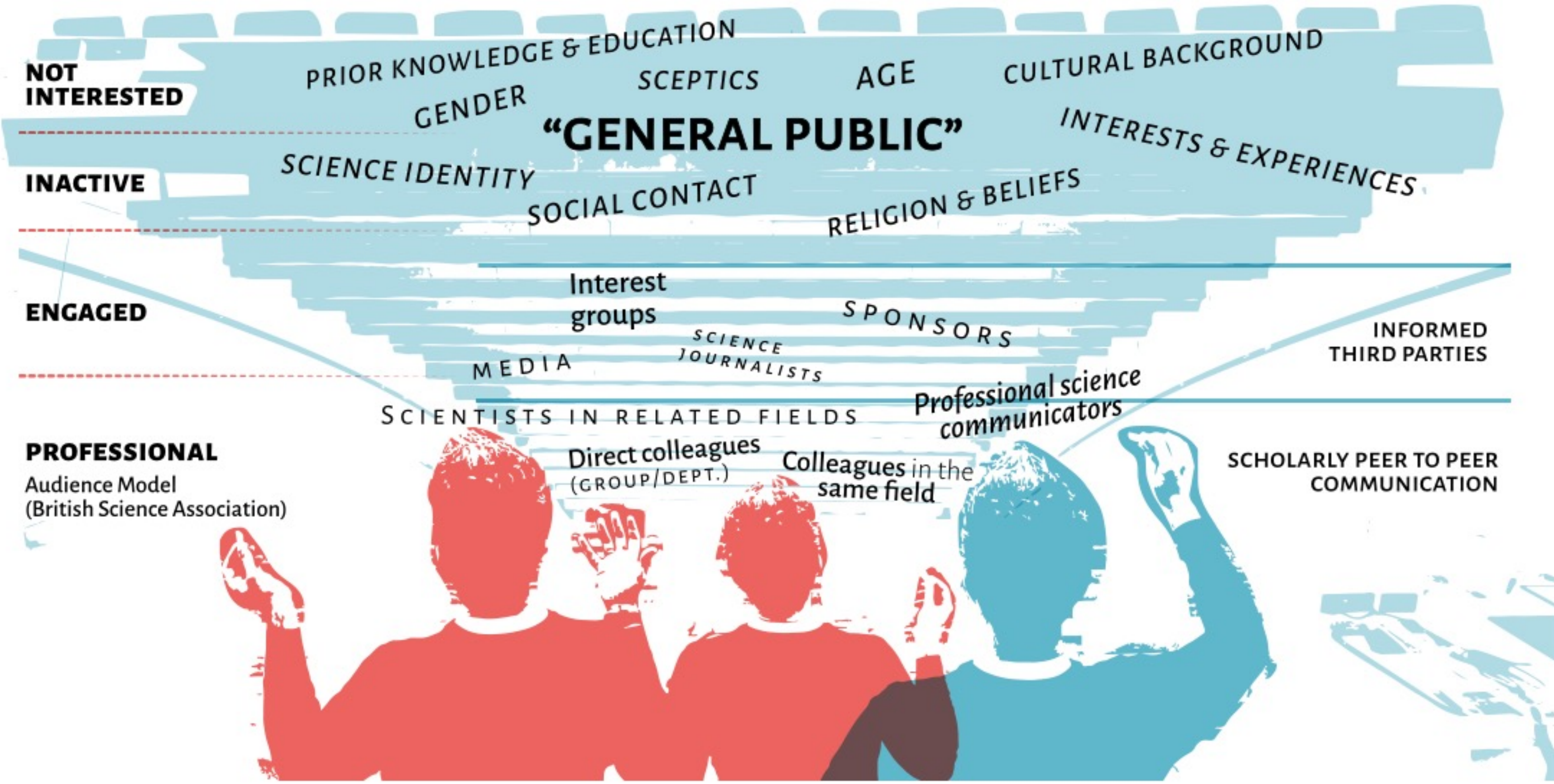
Model	Strengths	Weaknesses	Examples
Deficit Model	Efficient for rapid dissemination; simplifies complex information.	Ignores public values and feedback; one-way communication; limited impact	Public health campaigns (smoking), GMOs and nuclear power debates
Dialogue Model	Builds trust, promotes mutual understanding, and allows tailored communication.	Resource-intensive; power imbalance remains; limited impact and reach;	Public consultations on climate change and renewable energy technologies in the 2000s, resistance to nuclear power
Participation Model	Empowers public; addresses ethical concerns; leads to co-produced, robust solutions.	Resource-heavy, complex; conflicts among stakeholders; scalability issues;	Emergence of citizen science projects (biodiversity monitoring) but challenges in policy consensus (glyphosate debates)

Other (process) models of communication

Lasswell's Model of Communication is a classic framework for analysing the components of communication and it has been applied to science communication to help systematize different **factors** that can be relevant to ensure more effective communication.

ELEMENTS	Who (communicator)	says what (message)	in which channel (medium)	to whom (recipient)	with what effect (effect)
EXAMPLES	expert	evidence	press release	segment (e.g., demographics)	inform
	teacher	uncertainty	radio interview	relation to "who"	persuade
	activist	method	news article	relation to "what"	entertain

Stakeholders



This figure illustrates the Audience Model by the British Science Association, showing the spectrum of stakeholders in science communication, from professional scientists and professional science communicators (e.g., journalists) to the general public with varying levels of interest. Understanding these diverse groups helps tailor communication strategies to better engage each audience and promote effective science communication.

Bertemes, J. P., Haan, S., & Hans, D. (Eds.). (2024). *50 essentials on science communication*. De Gruyter. https://doi.org/10.1515/9783110763577

Brokers: Science Journalism

- **Decline of science journalism**: Science journalism started to emerge as a distinct field in the first half of the 20th century. However, since the 1990s, science journalism is facing increasing challenges due to shrinking newsrooms, tighter deadlines, and economic pressures, leading to less specialized and independent coverage. The shift to online media and reliance on press releases further impacts the quality of science reporting, limiting public access to in-depth, reliable information.
- **Fragmentation of science communication**: The decline of science journalism has been accompanied by fragmentation and democratization of science communication. At the same time, there is a larger degree of professionalization and strategic deployment of institutional science communication now being conducted by journalists.

No miracle philanthropy: A project by the Gebert Rüf Foundation and the Mercator Foundation Switzerland aimed to promote science communication in 20 minutes but after funding was discontinued, scientific topics were scaled to a minimum.

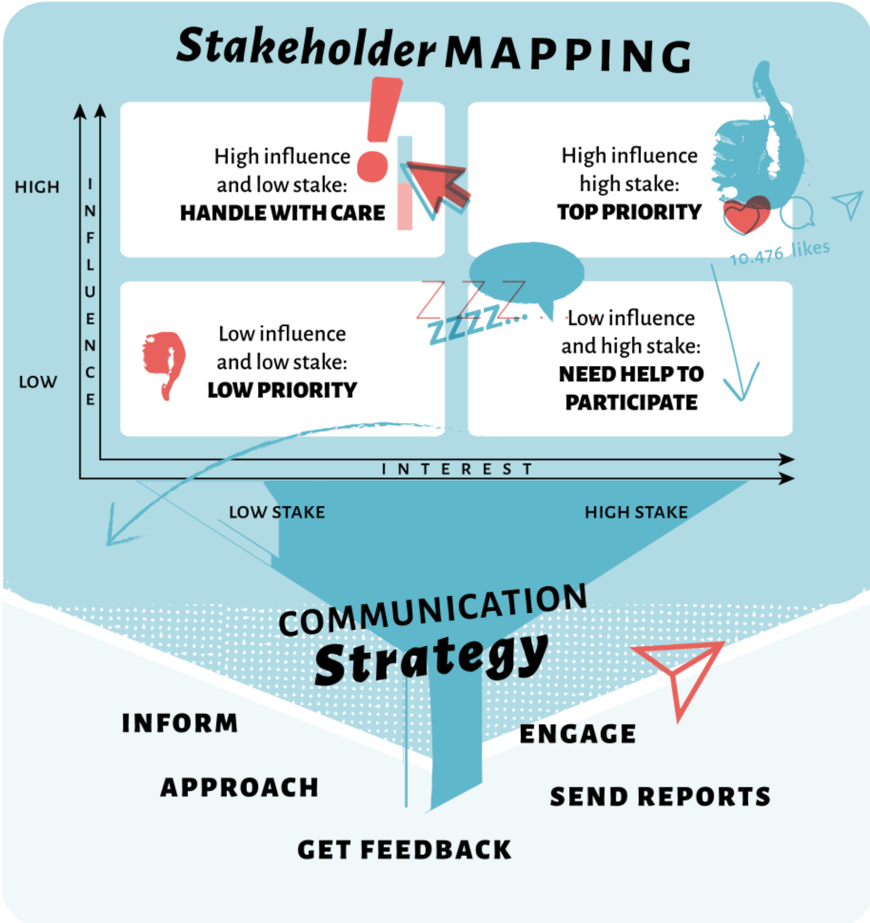
Schäfer, M. S. (2017). How changing media structures are affecting science news coverage (K. H. Jamieson, D. M. Kahan, & D. A. Scheufele, Eds.; Vol. 1). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190497620.013.5

Stakeholder Mapping and Segmentation

Public segmentation can improve the effectiveness and reach of science communication by acknowledging and addressing the diverse needs of the audience.

- **Tailored messaging**: People vary in their trust, knowledge, and interest in science, so a generalized communication strategy may fall short; segmentation allows communicators to customize messages for specific groups, making communication more accessible, engaging, and relevant.

- **Efficient Resource Use**: segmentation can helps focus efforts and resources where they will have the most impact, whether in education or building trust.



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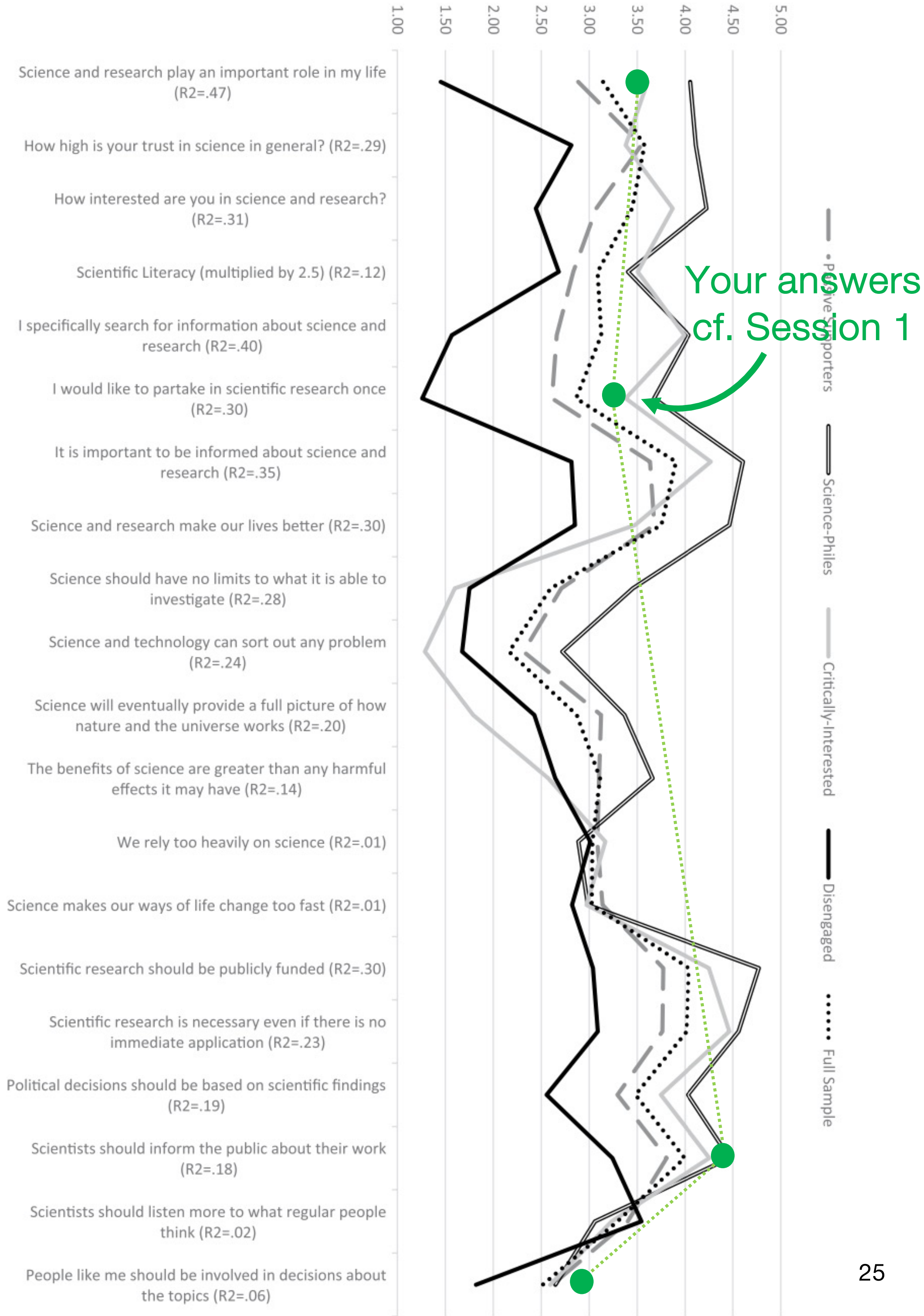
Public segmentation

Methods

- **Survey**: Science Barometer Switzerland (2016) with 1051 respondents.
- **Segmentation**: Latent class analysis (LCA) based on 20 items covering various dimensions: cognitive (knowledge), affective (trust), and conative (actions) aspects of attitudes towards science.
- **Media use**: Analysis of media use patterns (traditional and online) and engagement with scientific content.

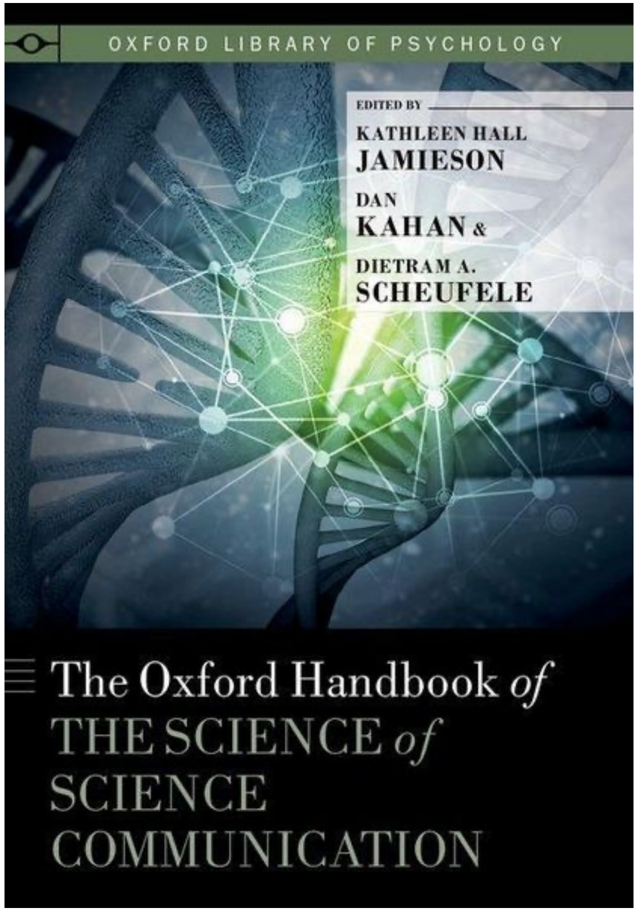
Schäfer, M. S., Füchslin, T., Metag, J., Kristiansen, S., & Rauchfleisch, A. (2018). The different audiences of science communication: A segmentation analysis of the Swiss population's perceptions of science and their information and media use patterns. *Public Understanding of Science, 27*(7), 836–856. https://doi.org/10.1177/0963662517752886



Public Segmentation

Group	Traits	Science Views	Demographics
Sciencephiles (ca. 30%)	- Highest literacy, interest, and trust in science. - Actively seek info. - Optimistic about science's role.	- Strong supporters. - Believe in public funding and science's ability to improve lives.	- Highest education. - Heavy use of Internet, media, museums, books.
Critically Interested (ca. 15%)	- High knowledge, but critical. - Support research with limits. - Liberal, religious.	- Support science but favor constraints. - Want public funding and political use of science.	- Highly educated. - Religious. - Moderate media use, critical of coverage.
Passive supporters (ca. 40%)	- Moderate interest and trust. - Rarely seek info. - Support public funding with limits.	Support science but with reservations. - Favor research funding but not fully engaged.	- Modreate education. - Moderate media use, mostly newspapers. - Less engaged in science.
Disengaged (ca. 15%)	- Lowest knowledge, interest, and trust. - Skeptical of science's impact. - Rarely engage with scientific topics	- Least supportive, - Favor research limits. - Skeptical of science's societal benefits.	- Lowest education. - TV and radio are main sources. - Least engaged.

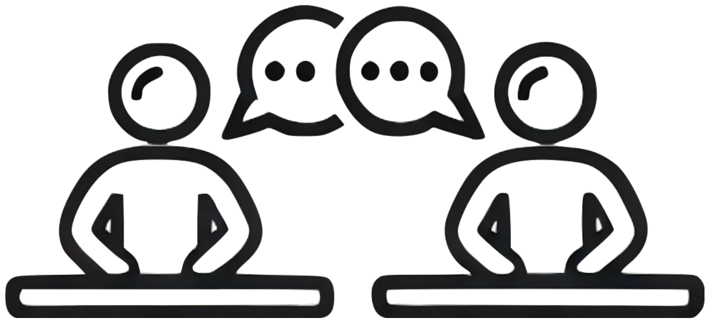
cf. Schäfer et al. (2018)



Science communication has itself become a target of study: The "science of science communication" is today an interdisciplinary field that studies how various dimensions of science information. The focus on objective, measurable outcomes in this literature has led to increased calls for evaluation of science communication.

HOW SHOULD WE EVALUATE SCIENCE COMMUNICATION?

Think of a science communication effort and consider how you would evaluate its impact



Evaluation of science communication

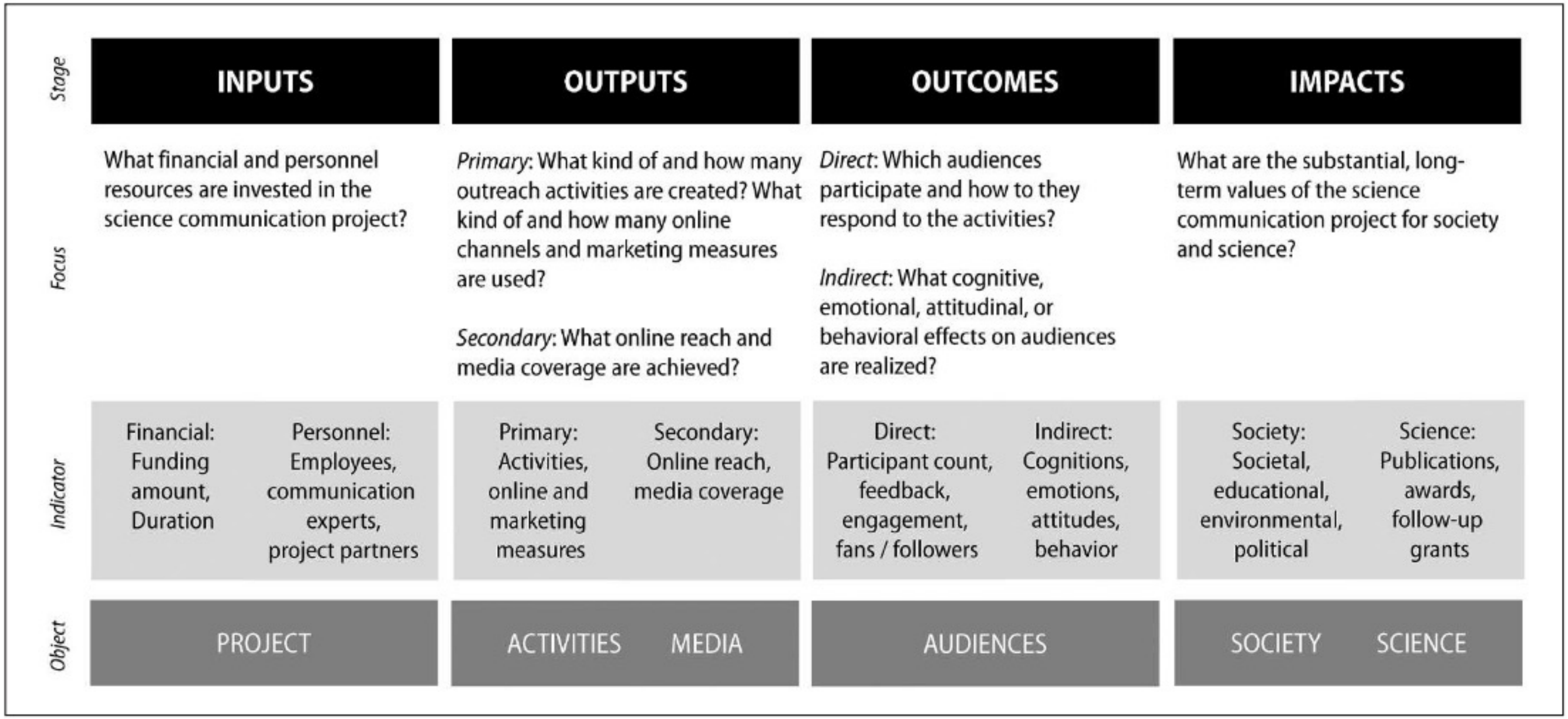


Figure 1. Conceptual model for evaluation of science communication projects.

Volk, S. C. (2024). Assessing the Outputs, Outcomes, and Impacts of Science Communication: A Quantitative Content Analysis of 128 Science Communication Projects. Science Communication, 10755470241253858. https://doi.org/10.1177/10755470241253858

Study of 128 science communication projects funded by the Swiss National Science Foundation from 2012 to 2022.

Table 2. Primary Outputs of Science Communication Projects ($N = 128$).

Item	Operationalization	%
ACTIVITIES		
Main activities[a]	Exhibition, installation	39.8
	Workshop, lectures	18.0
	Online platform	10.2
	Learning/teaching material	7.0
	App	4.7
	Science performance, show	4.7
	Film, video, movie	3.1
	Other (e.g., science festival, MOOC, podcast, game)	12.8
COMMUNICATION		
Online communication channels[a]	Website	82.0
	Facebook	35.9
	YouTube	17.2
	Twitter/X	16.4
	Instagram	7.0
	Other/unspecified social media channel	16.4
	Not reported	12.5
Marketing measures[a]	Promotion through network of partners	57.8
	Public poster, flyer, billboard	43.8
	Media relations	42.2
	Newsletter, direct mailing	38.3
	Advertisement (e.g., TV and radio)	13.3
	Not reported	23.4

[a]Multiple answers were possible.

Volk, S. C. (2024). Assessing the Outputs, Outcomes, and Impacts of Science Communication: A Quantitative Content Analysis of 128 Science Communication Projects. Science Communication, 10755470241253858. https://doi.org/10.1177/10755470241253858

- Most science communication projects are evaluated, but one-third lack any evaluation.
- Evaluation practices are generally weak, with limited use of logic models and using cross-sectional data, rather than more robust pre- and post-test designs.
- Evaluations primarily rely on qualitative methods, such as participants' self-reported knowledge or attitude changes. Overall. the focus is on secondary outputs like media coverage (76%), participant count (77%), and immediate feedback (72%), with less attention to indirect outcomes (e.g., attitudes, emotions, behaviors) and long-term societal impacts.

Table 1. Evaluation Type, Design, and Methods of Science Communication Projects (*N* = 128).

Item	Operationalization	%
Evaluation	Reported	68.7
	Not reported	31.3
Type of evaluation	Summative (ex-post)	53.1
	Pre- and post-test-design	8.6
	Processual evaluation (continuous)	7.0
	Formative (ex-ante)	0
	Not applicable	31.3
Evaluation design	Mainly qualitative (semi-standardized)	28.9
	Mainly quantitative (standardized)	25.8
	Mixed (qualitative and quantitative)	13.3
	Unclear/not applicable	32.0
Evaluation methods[a]	Feedback methods (e.g., guestbook)	42.2
	Standardized surveys	35.2
	User research (e.g., of data collected through apps)	7.8
	Observations	6.3
	Knowledge tests	5.5
	Semi-structured interviews	5.5
	Experiments	0
	Other	0.8
	Unclear/not applicable	31.3

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- Almost half of the projects do not report indirect outcomes
- Metrics for online engagement and reach are inconsistently tracked, making comparisons between projects difficult.

Table 3. Secondary Outputs of Science Communication Projects (*N* = 128).

Item	Operationalization	%
Coverage in the media	More than 30 reports	11.1
	20 to 29 reports	7.2
	10 to 19 reports	13.2
	1 to 9 reports	44.6
	Not reported	24.2
Reach of online channels	Reported	38.3
	Not reported	49.2
	Not applicable	12.5

"a systematic assessment of the effectiveness of these activities is rare, as few projects apply rigorous evaluation designs and combine multiple evaluation methods. Furthermore, many projects emphasize media attention and participant count, but neglect reporting on the effects on audiences and societal impact."

Volk, S. C. (2024). Assessing the Outputs, Outcomes, and Impacts of Science Communication: A Quantitative Content Analysis of 128 Science Communication Projects. Science Communication, 10755470241253858. https://doi.org/10.1177/10755470241253858

Summary

- **Historical perspective:** Science communication has evolved from elite scholarly exchanges to mass media and digital platforms, alongside shifts in communication models: from the **deficit** model (one-way transmission of knowledge), to the **dialogue** model (two-way interaction), and the **participatory** model (co-creation with the public). This reflects a growing emphasis on engagement and public involvement in science.

- **Stakeholders and public segmentation**: Effective science communication requires understanding and addressing the needs of diverse groups, from scientists to the public, to ensure mutual understanding and informed decision-making. Segmenting audiences allows communicators to tailor messages, ensuring that scientific information resonates with different groups based on their knowledge, interest, and trust in science.

- **Science of SCICOM and its evaluation:** Evaluating the impact of science communication helps refine strategies, ensuring that efforts are not just visible but meaningful in fostering public understanding and engagement. Current surveys suggest that current evaluation efforts are suboptimal.