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RESEARCH ARTICLE

Analyzing festival-based public engagement with research: Developing and testing an impact framework for understanding audience responses to science festivals in Europe

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Abstract

Public engagement festivals offer rare opportunities for researchers and citizens to converse, yet organisers often lack robust evidence about whether such events change audience perceptions. Repeated measures surveys were used during European Researchers' Night festivals in Malta and Ireland to explore how attending audiences perceive "research" and "researchers." Open-ended responses were collected before the events and again afterwards and then analysed inductively using grounded-theory techniques to generate a set of thematic codes. Those codes were distilled into an indicators framework that categorises positive, negative and neutral perceptions of both research and researchers. The framework was piloted quantitatively to assess whether indicators linked to the European Commission's expected impacts appeared more frequently after the events. Results showed that positive perceptions of research increased, particularly awareness of its social value, while perceptions of researchers were more ambivalent. The indicator-based approach also highlighted where stereotypes endured or where respondents remained uncertain. These findings provide organisers with a concise set of evidence-based indicators for evaluating festival impacts and suggest that pairing open-ended research with structured measures can improve the efficiency, reliability and generalisability of public engagement evaluations. Future applications should test the framework across diverse settings and investigate how to reach audiences who are not already positively disposed toward science.

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Any reports and responses or comments on the article can be found at the end of the article.

Plain Language Summary
Science festivals aim to bring researchers and the public together, but organisers often have little evidence about whether such events change how people think about research or researchers. This study addressed that gap by developing and testing a new way of measuring audience responses, based on a European Commission priority to understand the benefits of research and reduce stereotypes about researchers.

Surveys were carried out at European Researchers' Night events in Malta and Ireland between 2017 and 2019. Visitors were asked open-ended questions about what comes to mind when they think of "research" and "researchers" before the events, and again afterwards. These answers were analysed to identify common themes, both positive (such as recognising research's value to society), negative (such as scepticism or stereotypes), and neutral (such as factual descriptions). These themes were then turned into a concise "indicator framework" – a checklist of measurable impacts that could be applied in other events.

When this framework was applied to the survey data, results showed an overall increase in positive perceptions of research, particularly greater awareness of its importance and benefits. Perceptions of researchers also improved in some areas, especially reducing stereotypes and recognising problem-solving abilities, but many responses remained neutral. Negative views were rare, but some stereotypes and doubts persisted.

The approach demonstrates how organisers can convert the richness of open-ended feedback into structured, repeatable measures that save time and make comparisons across events easier. While the findings suggest that these festivals work well for people already interested in science, they also highlight the need for further efforts to reach those who are less engaged. This framework can be adapted for other public engagement contexts, such as science museums or online events, to better assess and improve their impact on public understanding of research.

Keywords
public engagement, science festivals, evaluation, indicators framework, European Researchers' Night



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Introduction

Research engagement has moved beyond one-way information transfer. Contemporary practice seeks to show why research matters to people's lives and to create opportunities for dialogue. Audience research, however, lags behind. Many festivals are evaluated with unstructured observations, small qualitative samples or poorly designed surveys, leaving organisers unsure whether their aims are being met. Evidence-based practice requires clear indicators and reliable methods for collecting data. The present study responds to this need by developing an indicator framework to capture how audiences perceive research and researchers.

Background

European Researchers' Night and science festivals

European Researchers' Night (ERN) is a pan-European initiative that has taken place annually since 2005 in more than 400 cities. Each festival aims to bring researchers closer to the public and to highlight the role of research in everyday life. Activities range from performances and hands-on experiments to guided tours, discussions and creative formats. During the COVID-19 pandemic, organisers adopted online and hybrid formats to maintain engagement. ERN resembles science festivals in its scope and goals and therefore inherits similar challenges. Studies of science festivals show that audiences are often already well educated and pro-science and that robust impact evaluations are scarce. Recent research has begun to analyse ERN audiences and online participation(e.g., Jensen *et al.*, 2021; Jensen *et al.*, 2022), but evidence remains limited.

Evaluating engagement and the need for indicators

Evaluation of public engagement events is challenging because outcomes are diverse and often intangible. The University of Southern California's writing guide notes that clear descriptions of methods and transparent analyses are essential to allow readers to assess validity and reliability. Many current evaluations rely on open-ended questions that produce rich but labour-intensive data sets. Transforming those qualitative insights into closed-ended questions can increase efficiency without sacrificing nuance. Our approach uses grounded theory to build a codebook of audience perceptions and then distils those codes into indicators aligned with funder expectations.

Research aims

This study addresses two questions:

- *Developing an evidence-based indicators framework.* How can audience perceptions of *research* and *researchers* be organised into a set of positive, negative and neutral indicators? How can these indicators align with the European Commission's expected impacts for ERN events?

- *Piloting this indicators framework.* Does applying the indicators framework to pre- and post-event survey data reveal shifts in perceptions consistent with funder expectations? Are the identified indicators sufficient to capture the range of audience impacts in two national contexts?

Methods

Study design and procedure

The evaluation used a repeated-measures survey design at ERN events in Malta and Ireland between 2017 and 2019. Visitors were approached by trained staff using systematic intercept sampling and invited to complete short pre-event questionnaires on tablets. After the events, participants received a follow-up questionnaire by email. The software matched individual responses across time points, allowing changes in perceptions to be assessed. Surveys were administered in English and followed identical protocols at all sites. Once pre- and post-visit data were matched, personally identifiable information was removed. Informed consent was obtained digitally from all participants by requiring them to click a consent checkbox before proceeding with the online or tablet-based survey administered at European Researchers' Night festivals in Ireland and Malta between 2017 and 2019. All participants were adults; no minors were included. Ethical approval was granted by the University of Malta Faculty Research Ethics Committee (ID EDUC 2023 00370).

Datasets

Four datasets were collected: one from an ERN in Malta (2019) and three from ERNs in Ireland (2017–2019). Only respondents with both pre-event and post-event qualitative responses were included. For the question "What comes to mind when you think of *research*?" there were 163 matched cases (98 from Ireland and 65 from Malta). For the question "What comes to mind when you think of *researchers*?" there were 152 matched cases (94 from Ireland and 58 from Malta).

Instrument

The questionnaire combined close-ended demographic items with two open-ended questions asking respondents what they thought about research and researchers. Collecting open-ended responses allowed participants to express concepts in their own words, capturing nuances that predefined categories might miss. The data collection platform automated email invitations, reminders and visualisations for organisers.

Analysis

Two stages of analysis were conducted. First, inductive thematic analysis of the open-ended responses was performed using NVivo. Researchers independently coded an initial sample of responses to develop a codebook and refined it as new themes emerged. Codes were applied to phrases or complete responses and multiple codes could be assigned to a single response. Coding was iterative and followed grounded-theory principles.

Second, codes were consolidated into compound variables and grouped into thematic categories. Positive and negative indicators were identified by examining how codes aligned with the European Commission's expected impacts (e.g., increased awareness of research benefits, stereotype reduction). Pre- and post-event responses were compared within each individual case to determine whether indicators increased, decreased or remained unchanged. Cases with net increases in positive indicators or reductions in negative indicators were classified

as showing positive impact, while net increases in negative indicators were classified as negative impact. Neutral cases showed no change or offsetting changes.

Results

Thematic categories of research perceptions

The open-ended question about *research* yielded a diverse set of responses. Codes were grouped into six thematic categories summarised in Table 1. Positive perceptions centered on the importance and societal value of research. Negative perceptions reflected fear, ambivalence or distrust. Neutral perceptions consisted of factual descriptions or general associations.

Overall, positive perceptions were most frequently associated with the importance of research and its societal benefits. Negative perceptions were concentrated in attitudinal responses expressing fear or ambivalence and in stereotypes about researchers. Neutral responses included straightforward definitions and references to specific fields or institutions (Table 2).

Alignment with expected impacts: research

Indicators were mapped to five expected impacts defined by the European Commission (Table 3): increased awareness of research and its funding importance; better understanding of research benefits; reduction of stereotypes about research

Table 1. Research perceptions codebook and examples (n=163).

Category letter	Category	Code	Thematic code	Description	Example codes
A	Importance of research	1	Applied research	Responses indicate the application of research to achieve general goals.	"Invention", "Innovations", "Advance an application", Finding solutions or improvements
A	Importance of research	2	Research value	Responses indicate the broad value of research.	"Valuable investment", "Opportunity"
A	Importance of research	3	Societal benefits	Responses indicate the societal benefits of research.	"Developing or advancing society", " Improve lifestyles", "Find cure for diseases", "New and better medicines", "New technology"
A	Importance of research	4	Aspects of discovery	Responses indicate research as uncovering a mystery or gaining from more knowledge.	"Getting to the truth", "Discover unknown aspects of the world", "Improve one's knowledge", "Explore the universe"
B	Attitudinal aspects	5	Importance	Responses indicate that research is an important endeavour.	- Important, Valuable, Necessary
B	Attitudinal aspects	6	Interest	Responses indicate that research is interesting.	Fascinating, Interesting
B	Attitudinal aspects	7	Ambivalence	Responses indicate that research is uninteresting or boring.	"Boredom", "Not interesting"
B	Attitudinal aspects	8	Excitement	Responses indicate a positive emotion towards research.	"Hope", "Excitement", "Wonderful"
B	Attitudinal aspects	9	Uncertainty	Responses indicate negative emotion towards research.	"Fear", "Confusion"
B	Attitudinal aspects	10	Rigour or quality	Responses indicate rigour or quality in research.	"Peer-review", "Hard-work", "Thorough"
C	Researcher perceptions	11	Personal qualities	Responses detail personal attributes of researchers.	"Smart", "Commitment", "courage", "Persistent", "Highly interested", "Passionate", "Dedicated"
C	Researcher perceptions	12	Stereotypes	Responses relate to a negative stereotypical or conventional idea of research or researchers.	"People surrounded by books and chemistry equipment", "Requires loneliness"
C	Researcher perceptions	13	Personal experiences	Responses reference a respondents own involvement in the research sector or process.	"My job. Career development for Marie curie fellows", "My work - department of occupational therapy- female prisoners and supervision on kids with dyspraxia"
D	Awareness of the research sector	14	Institutional disapproval	Responses indicate disapproval or distrust of academic institutions or practices.	"Self-advancement within academic institutions", "Things that can be misrepresented"
D	Awareness of the research sector	15	Example roles	Respondents give examples of roles within the research sector.	"Scientist", "Academic", "Professor", "PhD student"

Category letter	Category	Code	Thematic code	Description	Example codes
D	Awareness of the research sector	16	Global perspectives	Responses indicate an international or global perspective.	"Globalisation", "Europe", "International"
D	Awareness of the research sector	17	Financial aspects	Responses indicate the funding, finances or monetary aspects of research.	"Low wage", "State funding", "Sponsorship"
D	Awareness of the research sector	18	Institution examples	Responses give examples of institutions or places where research takes place.	"Trinity College", "University"
E	Fields of research	19	Basic definitions	Responses provide broad definitions or simple concepts.	"Discover unknown aspects of the world", "Discovering new things", "Learning about a concept, practice or subject by collecting and analyzing data", "Achieve a greater and deeper understanding of a subject"
E	Fields of research	20	Non-specific concepts	Responses include general concepts related to the research process.	"Asking questions", "Working out different approaches", "Pushing boundaries"
E	Fields of research	21	Specific concepts	Responses include specific method or approach that might be used within an academic discipline.	"Peer review", "Experimental design", "Statistics"
F	Definitions or related concepts	22	Non-specific fields	Responses indicate non-specific fields of research.	"Science", "Technology", "Medicine"
F	Definitions or related concepts	23	Specific fields	Responses indicate specific fields of research.	"Environmental", "Genetics", "Microbiology"
F	Definitions or related concepts	24	Other	Responses fall outside of the scope of all other codes.	Emma Watson
F	Definitions or related concepts	25	Invalid	Responses are not clearly related to the question.	"L"

Thematic categories (A–F) and codes used to classify audience perceptions of research. Descriptions and examples have been edited for clarity; mapping of categories relies on available headings. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

Table 2. Summary of cross-categories in research perceptions (n=163).

Classification	Theme	Details
Positive	Societal	Research value; Societal benefits; Aspects of discovery
Positive	Practice	Applied research; Practical examples
Positive	Individual	Interest; Excitement; Importance
Negative	Attitudinal aspects	Ambivalence; Uncertainty; Fear or distrust
Negative	Researcher perceptions	Personal experiences; Personal qualities; Stereotypes
Negative	Awareness of research sector	Institutional disapproval; Example roles; Financial aspects; Institutional examples; Global perspectives
Neutral	Attitudinal aspects	Rigour or quality; Observations or facts
Neutral	Definitions & related concepts	Basic definitions; Non-specific concepts; Specific concepts
Neutral	Fields of research	Non-specific fields; Specific fields

Cross-category themes grouped into positive, negative and neutral classifications. Positive themes summarise societal, practice and individual benefits; negative themes summarise attitudinal, perceptual and awareness issues; neutral themes summarise rigour, definitions and fields of research. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

Table 3. Expected European Commission impacts for research.

Definition	Value label	Conditions
Expected Impact	***European Commission expected impact definition***	***Value label***
EI1	Increased awareness among the general public of the importance of research and innovation and a more favourable general attitude towards its public funding.	Importance Awareness
EI2	Better understanding of the key benefits that research brings to society.	Benefits Understanding
EI3	Reduction in the stereotypes about researchers and their profession.	Stereotype Reduction
EI4	Increase, in the long term, of people taking up research careers.	Career Interest
EI5	Better understanding of the impact of the European Union's programmes among the general public.	Impact Understanding

Definitions of the European Commission's expected impact categories for research audiences with value labels and assignment conditions. Conditions are simplified using semicolons for readability. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

and researchers; long-term interest in research careers; and improved understanding of EU research programmes. Across 97 respondent cases with at least one expected impact, 62 % of impact instances were positive, 26 % were neutral and 12 % were negative. The most common positive impact was increased awareness of research importance (24 % of all instances), followed by better understanding of research benefits (13 %). Importance awareness was particularly driven by increased mentions of applied research benefits and knowledge-driven definitions. Negative impacts were rare and typically involved persistent ambivalence or distrust (Table 4).

Table 4. Impact outcomes and EC expected impacts for research (cases n=163; EI instances n=146).

Classification	Category	Instances (n)	Percentage (%)
Impact outcome	Positive	81	49.7
Impact outcome	Neutral/no change	64	39.3
Impact outcome	Negative	15	9.2
Impact outcome	Not classified	3	1.8
EC expected impact	Importance awareness	59	40.4
EC expected impact	Benefit understanding	28	19.2
EC expected impact	Stereotype reduction	25	17.1
EC expected impact	Impact understanding	25	17.1
EC expected impact	Interest	9	6.2

Summary of impact outcomes (positive, neutral/no change, negative and not classified) and distribution of EC expected impact categories for research perceptions. Percentages are calculated from counts; minor rounding differences may occur due to formatting. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

Thematic categories of researcher perceptions

For the question about *researchers*, responses were shorter, often three words, and captured attitudes, attributes and stereotypes. Codes were grouped into seven categories. Admirable perceptions emphasised researchers' societal contributions and personal qualities; reductive perceptions focused on financial precarity or negative stereotypes; ambivalent perceptions provided neutral descriptions of roles, settings or activities (Table 5).

Positive perceptions were dominated by admiration for researchers' commitment, problem-solving ability and educational role. Negative perceptions centred on financial insecurity and stereotypes. Neutral perceptions described roles or settings without evaluating them (Table 6).

Alignment with expected impacts: researchers

Indicators corresponding to the European Commission's expected impacts were applied to the researcher responses (Table 7). Among 47 cases with at least one expected impact, 77 % of impact instances were positive, 15 % were neutral and 8 % were negative. The most frequent positive impact was greater importance awareness (51 % of all instances), followed by stereotype reduction (34 %) and increased interest (15 %). Increased mentions of researchers as problem solvers and recognising hard work and commitment drove these positive results. Negative impacts were rare and mainly reflected persistent reductive stereotypes (Table 8).

Table 5. Researcher perceptions codebook and examples (researcher cases n=152).

Category letter	Category	Code	Thematic code	Description	Example codes
A	Attitudinal aspects	1	Importance	References to the value or importance of researchers.	nan
A	Attitudinal aspects	2	Interesting	Reference to a generally appealing nature of researchers.	nan
A	Attitudinal aspects	3	Financially precarious	References indicate life as a researcher being financially precarious.	nan
B	Researcher perceptions	4	Educational	References relate to researchers' ability to educate.	nan
B	Researcher perceptions	5	Enthusiastic	References relate to researchers' enthusiasic interaction.	nan
B	Researcher perceptions	6	Professional	References relate to researchers' formality.	nan
B	Researcher perceptions	7	Interactions	References indicate researchers as detached from the 'real world' or having limited capacity to interact or engage with others.	nan
C	Personal qualities	8	Analytical	References relate to researchers as analysing or critical thinking.	nan
C	Personal qualities	9	Educated	References refer to researchers as possessing knowledge or education.	nan
C	Personal qualities	10	Experience	References indicate researchers as experience or expertise in a field.	nan
C	Personal qualities	11	Innovative	References indicate researcher as innovative or creative.	nan
C	Personal qualities	12	Intelligent	References applied attributes of intellectual ability.	nan
C	Personal qualities	13	Open-minded	References relate to researchers non-judgmental approach or flexibility.	nan
C	Personal qualities	14	Pioneering	References indicate the ideas that researchers may discover or explore.	nan
C	Personal qualities	15	Problem solvers	References relate to researchers' focus on developing practical solutions.	nan
D	Fields of research	16	Curiosity	References relate to curiousity or a desire to know more.	nan
D	Fields of research	17	Conscientious	References indicate diligence throughout the research process.	nan
D	Fields of research	18	Hardworking	References indicate researchers as taking their work seriously and doing it well.	nan
D	Fields of research	19	Commitment	References indicate researchers as having commitment or perseverence.	nan
D	Fields of research	20	Self-interest	References of a negative characteristic, such as being self-interested.	nan
D	Fields of research	21	Passionate	References relate to researchers' sense of drive or passion to achieve.	nan
D	Fields of research	22	Patient	References indicate researchers' tolerance or patience.	nan
D	Fields of research	23	Friendly	References relate to general friendliness or good manners.	nan
D	Fields of research	24	Future outlook	References relate to researchers' sense of hope or optimism.	nan
D	Fields of research	25	Self-transcendent	References indicate researchers as motivated by values.	nan
D	Fields of research	26	Connections	References to researchers' connection with others.	nan
E	Communicative skills	27	Roles in research	References to example of a roles in research.	nan

Category letter	Category	Code	Thematic code	Description	Example codes
E	Communicative skills	28	Education level	Reference to examples of academic qualifications.	nan
E	Communicative skills	29	Fields of study	Reference to examples of academic disciplines.	nan
E	Communicative skills	30	Institutional settings	Reference to examples of spaces where researchers work or study.	nan
E	Communicative skills	31	Famous researchers	Reference to examples of specific or famous researchers.	nan
E	Communicative skills	32	Research activities	References to research processes that researchers may undertake.	nan
F	Intellectual abilities	33	Cliché images	References are underpinned by overused or reductionist opinions of researchers.	nan
F	Intellectual abilities	34	Unclear / Unrelated	References do not fit the above categories or unrelated to the question.	nan

Thematic categories (A–F) and codes used to classify audience perceptions of researchers. Descriptions and examples have been refined; category mapping uses available headings and may involve interpretation when headings were incomplete. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

Table 6. Summary of cross-categories in researcher perceptions (researcher cases n=152).

Classification	Theme	Details
Positive	Societal	Service & outreach; Social & economic drivers; Scientists as advocates; Scientists & society
Positive	Individual	Explorers and dreamers; Personal development; Pride & prestige
Negative	Financial	Financially precarious
Negative	Interaction	Quality of interactions; Lack of connection
Negative	Self-interest	Self-serving; Detached or neutral
Negative	Cliché images	Mad scientists; Misrepresentation or romanticisation
Neutral	Observations or facts	Basic observations; Ambivalence; Routine descriptions
Neutral	Institutional environment	Work environment & types of research; Project management; Funding & policy
Neutral	Research activities	Empirical work; Public engagement; Collaboration
Neutral	Roles in research	Educators; Mentors; Roles & responsibilities
Neutral	Education level	Academic degrees; Lifelong learning; Importance of education
Neutral	Field of study	Specific & general disciplines
Neutral	Famous researchers	Historical & well-known scientists

Cross-category themes for researcher perceptions grouped into positive, negative and neutral classifications. Positive themes encompass societal and individual admiration; negative themes include financial, interaction and self-interest issues; neutral themes cover observations, environments, activities, roles, education, fields and famous researchers. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

Pilot quantitative application

The qualitative indicators were converted into a closed-ended instrument by assigning binary values (present/absent) to each indicator. Applying this instrument to the matched pre- and post-event responses enabled rapid quantitative assessment. Positive indicators increased substantially in both research and researcher categories, confirming the sensitivity of the framework. Importance awareness and benefit understanding showed

Table 7. Expected European Commission impacts for researchers.

Definition	Value label	Conditions
Expected Impact	***European Commission expected impact***	***Value label***
EI1	Increased awareness among the general public of the importance of research and innovation and a more favourable general attitude towards its public funding.	Importance Awareness
EI3	Reduction in the stereotypes about researchers and their profession.	Stereotype Reduction
EI4	Increase, in the long term, of people taking up research careers.	Career Interest

Definitions of the European Commission's expected impact categories for researcher perceptions with value labels and assignment conditions. Conditions have been streamlined for clarity. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

Table 8. Impact outcomes and EC expected impacts for researchers (total cases n=163; EI instances n=146) (cases n=152; EI instances n=53).

Classification	Category	Instances (n)	Percentage (%)
Impact outcome	Positive	56	36.8
Impact outcome	Neutral/no change	90	59.2
Impact outcome	Negative	6	3.9
EC expected impact	Importance awareness	26	49.1
EC expected impact	Stereotype reduction	18	34.0
EC expected impact	Interest	9	17.0

Summary of impact outcomes and EC expected impact categories for researcher perceptions. Percentages are based on counts and may show minor rounding differences. For complete details, refer to the original spreadsheets. Source: Paired pre–post open-ended responses from European Researchers' Night audiences in Ireland (2017–2019) and Malta (2019). Abbreviations: EC = European Commission; EI = expected impact.

the largest gains for research, while stereotype reduction and problem-solving perceptions dominated the researcher results. The indicator framework therefore appears suitable for evaluating public engagement impacts across diverse settings.

Discussion

The indicator framework developed here offers a pragmatic tool for evaluating public engagement events. It transforms the richness of open-ended responses into a structured set of variables that can be used in closed-ended surveys. This methodological shift saves time and resources and enhances comparability across events while still capturing the nuances of audience perceptions. Our findings suggest that ERN events succeed in increasing public awareness of research and its benefits but that perceptions of researchers themselves remain more neutral. This aligns with previous studies showing that science festivals tend to attract already science-interested participants; events may make the converted even more enthusiastic while failing to reach those who are sceptical or disengaged.

Methodological implications

The transition from open-ended to closed-ended measures has important methodological consequences. Closed-ended semantic differential scales, informed by the indicators framework, allow rapid data collection and statistical analysis. They also standardise responses, improving reliability. However, some depth is inevitably lost, and future work should combine both approaches to ensure that unexpected themes are not

overlooked. The indicator framework can also be adapted to other public engagement contexts such as science museums, citizen science projects or online events.

Comparisons with quality indicator studies

Other efforts to assess science communication quality have proposed multidimensional criteria covering trustworthiness, style and societal connection (e.g., Olesk *et al.*, 2021). Our framework speaks to these dimensions by providing empirical evidence on audience perceptions of research and researchers. It also responds to calls for concise surveys that do not detract from the festival experience. By focusing on a small number of high-value questions, organisers can gather actionable data without burdening participants.

Limitations and future research

This study has several limitations. It focuses on festivals in Malta and Ireland and may not generalise to other national contexts. Only open-ended perceptions were analysed; demographic variables were not explored here. The framework does not capture whether audiences understood the events' objectives or how their experiences varied by activity format. Future research should apply the indicators framework to a wider range of ERN events and examine how perceptions differ across demographic groups. Additional qualitative work could also explore why certain stereotypes persist and how engagement can be broadened to under-represented publics.

Conclusion

European Researchers' Night events are intended to bring research closer to society. This study developed and piloted an evidence-based indicators framework that translates open-ended audience feedback into measurable outcomes. Applying the framework revealed substantial increases in awareness of the importance and benefits of research and modest reductions in stereotypes about researchers. The approach offers festival organisers a concise tool for evaluating impacts and planning improvements. Wider application across contexts and a focus on engaging the uninterested are needed to ensure that public engagement efforts genuinely broaden participation.

Ethical approval

The study states that it received ethics approval from the University of Malta Faculty Research Ethics Committee (Application ID EDUC-2023-00370). A complete ethical statement should specify the approving body and reference number and confirm that all participants gave informed consent. Informed consent was obtained digitally from all participants by requiring them to click a consent checkbox before proceeding with the online or tablet-based survey administered at European Researchers' Night festivals in Ireland and Malta between 2017 and 2019. All participants were adults; no minors were included.

Data availability

All data supporting the results and analyses in this article are freely available on Zenodo (DOI: 10.5281/zenodo.17192126; Jensen & Jensen, 2025) under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0). The dataset comprises the de-identified survey responses and the coding framework used in this study, and includes all values used to calculate means, standard deviations, figures, and image-derived data.

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The manuscript makes a significant methodological contribution to public engagement evaluation and is well aligned with Open Research Europe's mission. The main required improvements concern:

- Completing and clarifying the researcher codebook
- Expanding the discussion of biases and generalisability
- Improving transparency in quantitative methods
- Strengthening the discussion through comparison with previously published ERN studies

None of these issues undermine the core findings, but addressing them will greatly strengthen the paper's clarity and reproducibility.

In particular, I suggest the following revisions:

- Add a reference to the "NVivo analysis" software used for qualitative coding.
- Many example codes in the researcher codebook are missing ("nan"), and some category labels appear inconsistent or incomplete. Please provide full examples for all codes and ensure the category structure is fully transparent. If examples were intentionally omitted, please state why.
- Add a more explicit discussion of self-selection bias and how it might inflate positive impacts.
- Add a clearer discussion of how demographic factors may influence perceptions of research.
- Consider introducing a quantitative analysis or at least a discussion of the statistical significance of the survey results (e.g., effect sizes, significance testing, confidence intervals).

I also encourage the authors to compare their findings with previous ERN studies to strengthen the contextualisation of the results. In particular, Jensen et al. (2021, PLOS ONE) and Roche et al. (2017, 2018) show that ERN audiences tend to be highly educated and already positive toward science, suggesting that such events primarily reinforce existing favourable attitudes rather than

transform sceptical ones. Referencing this literature would help situate the stronger shifts observed in perceptions of *research*—compared to the more neutral perceptions of *researchers*—within the broader evidence base and clarify how much these changes reflect characteristics of the audiences reached versus impacts generated by the event. Additionally, comparisons with long-term analyses (e.g., Mazzitelli et al., 2019) and rural case studies (e.g., Branquinho et al., 2025) could help illuminate contextual factors that influence the generalisability of the proposed indicator framework.

Mazzitelli, G., Arnone, S., Bellini, F., et al. (2019). Results from impact assessment on society and scientists of Frascati Scienza European Researchers' Night in years 2006–2015. arXiv preprint, arXiv:1901.05665 https://doi.org/10.48550/arXiv.1901.05665.

References

1. Jensen A, Jensen E, Duca E, Roche J: Investigating diversity in European audiences for public engagement with research: Who attends European Researchers' Night in Ireland, the UK and Malta?. *PLOS ONE*. 2021; **16** (7). Publisher Full Text
2. Roche J, Davis N, Chaikovsky M, O'Boyle S, et al.: European Researchers' Night as a Learning Environment. *The International Journal of Interdisciplinary Educational Studies*. 2018; **13** (1): 1-9 Publisher Full Text
3. Roche J, Davis N, O'Boyle S, Courtney C, et al.: Public perceptions of European research: an evaluation of European Researchers' Night in Ireland. *International Journal of Science Education, Part B*. 2017; **7** (4): 374-391 Publisher Full Text
4. Branquinho R, Duarte M, Sarabando C, Ambrósio S, et al.: Seedling science communication in rural areas through european researchers' night. *Journal of Science Communication*. 2025; **24** (4). Publisher Full Text

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: physics, data analysis, computing, science communication.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.