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Science Communication Practices in the Fundamental and Applied Research Programme of Latvian Council of Science in 2023

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Abstract. Science communication plays a crucial role in attracting public money for science, promote scientific careers and shaping policy accordingly. Very few studies have been particularly dedicated to the ways how Latvian scientists communicate their research to public audiences. The current study will attempt to fill this gap and offer analysis of scientists' perception of communication and the models they choose to communicate effectively. One must take into consideration the claim of many scholars that definition of science communication remains elusive and multifaceted, often described as vague and fuzzy. This forestalls a clear understanding of what results are expected and how are they to be achieved. At this point, science communication models are of great help to guide and measure expected results. Although the models are usually presented as an evolutionary form, in real life situations they often transpire as a mix and cannot be identified straightforwardly. However, they are usually declared in forms that are separated not only according to the way activities are carried out but also according to the evolutionary forms of transfer. Meanwhile, as evolution implies, there is a need to be ready for change, hence, it is pivotal for society, as well as scientists. This study encompasses projects (*n* = 47) funded by Latvian Council of Science in 2020, whose implementers have submitted their final reports in 2023. Qualitative content analysis has revealed that the focus of project proposals and reports lies in the Deficit model of science communication, often leaving behind Dialogue and Participatory models. This paper aims to explore the nuanced definitions of science communication and contribute the analysis of the progression of its models in relation to societal and scientific readiness. By examining these models, we can gain insights into how science communication practices have adapted to meet the changing expectations and needs of both society and the scientific community.

Keywords: science communication, Fundamental and Applied Research programme (FARP) project proposals, qualitative analysis, thematic analysis, models of science communication

Introduction

As claimed by many scholars, in recent years, science communication has gained greater attention (Volk 2024; Nerghes *et al.* 2022; Trench *et al.* 2020). It could be due to different reasons, use of public money and putting science on the political and social agenda (Fecher *et al.* 2021; Fu *et al.* 2016), attracting young people to choosing their career and remaining in science, being open and transparent to society, gaining new knowledge from and about lay public (Metcalfe 2019), increasing trust in science and scientists (Weingart, Joubert 2019), and many more. Although the need for science communication is pivoting, the term itself, as stated by numerous scholars, is still perceived as vague and "fuzzy" (Faehnrich 2021; Metcalfe 2022). Burns *et al.* (2023, 183) state that "science communication [...] is defined as the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science (the AEIOU vowel analogy): Awareness, Enjoyment, Interest, Opinion-forming, and Understanding." Meanwhile, Bucchi and Trench (2021, 1) tried to sum up all the possible varieties of science communication terms and provided broad and yet compact definition, limiting it to "the social conversation around science." For the sake of shaping the focus of this research paper, **I would like to define science communication as a way of incorporating all science engagement activities referring to scientists that are communicating by any means and targeting different audiences**. Overall, the theoretical science communication models are used in order to describe the relationships between scientists and the public.

Science communication models

As stated by Metcalfe, theoretical perspectives of science communication were initially driven by practice, which, in turn, influenced practice and further science communication scholarship (Metcalfe 2022). Probably, this is the reason and necessity to embed the practice into a theoretical framework that is done by using models to describe science communication. Historically, since 1980, many authors claimed that focus of science communication should be on "scientific literacy", or as suggested by many, "public understanding of science" (Gross 1994), however, it is usually perceived that lay audiences know too little, whilst scientists know too much to translate it into culture, the common language of lay audience. Other studies revealed that "public understanding of science is useful for certain well-defined analytical purposes" (Durant *et al.* 1992, 161) that definitely could be of use for certain scientific disciplines. The shift from the Deficit model emerged in ten years, approximately in 1990 (Wynne 2006), when the two-way communication – the Dialogue model – was adopted for the purpose to make science more "democratic" and increase public trust in scientists. It seemed to provide a possibility to discuss and make scientists more approachable by the public, however, it also posed different questions about their willingness and capacity to conduct this dialogue effectively, not to mention hearing different opinions not supported by data as an argument. These challenges are still pertinent, they hold especially true when discussions occur as to what extent the Dialogue model differs from the Deficit model (Nerghes *et al.* 2022). In the last years, the Participatory model was introduced, where public engagement holds an even greater significance than just posing questions or arguing and questioning scientific endeavours. Gross (1994, 4) states: "To understand that rhetoric is situational is also to understand that only in the special circumstances of scientific and scholarly exchange, and perhaps not even then, can unaided reason hope to prevail upon a public. It is because of this that Aristotle speaks of "the available means of persuasion, means that may originate in the mind (or in the heart), or in the reason (or in emotions and values). Rhetorically speaking, the *sine qua non* of this process is trust. Because the public must trust those who are trying to persuade them, central to all situated utterances is a speaker in whose virtue will and good sense the public has confidence." There is a necessity to create a trustful relationship between science and society, and one of the signs of acknowledging it has been the practice of public engagement. This has become the main focus and obligation since citizen science initiatives are supported by funding authorities. The biggest funding programme for Research and Innovation funded by European Commission (93.5 billion euro) has specifically targeted public, introducing in every consortia-type project the obligation of Communication, Dissemination and Exploitation of Scientific Results work package, allocating it a substantial part of the project budget (European Commission 2024). It encourages scientists to seek new solutions and communication styles, posing even more questions for them to answer, e.g. how ready are they or what possibilities and tools do they have not only to comply with the criteria but also to effectively measure the outputs and outcomes of the different activities envisaged in the project. Furthermore, despite the fact that there are digital tools and resources that boost implementation of different practices and testing of new approaches, the Deficit model of communication is still prevalent (Nerghes *et al.* 2022).

Planning and implementation of activities connected with Participatory model is a challenge. It is not only two-way communication – this is co-creation of knowledge, a process that requires additional effort and competences from scientists. As Smallman *et al.* (2020, 946) stated in their study, the participatory turn appears to be gathering strength. In 2011, the European Commission's concept of responsible research and innovation "developed and adopted a concept of RRI [Responsible Research and Innovation] that built upon the earlier ideas around public participation and dialogue, but with the aim of involving all actors (not just citizens or experts) throughout the process of innovation such that science could be more firmly rooted in society and society's needs and ambitions [...]. This heralded a move from 'science in society' to 'science with and for society'." However, some scientific fields are more open and flexible, while others have greater difficulties, as usually there is a focus on science and technology, where humanities, social sciences and art are as if omitted. That is probably the question of terminology, but still – research is the usual term that encompasses social sciences and humanities, whereas science usually is used to denote STEM disciplines. Meanwhile, in recent years there is a shift of using STEAM definition that includes humanities and arts. Although the usual practices for different disciplines vary, there are "historical" or "traditional" approaches to communication and choice of practices and tools (Metcalfe 2019).

Fundamental and Applied Research Projects (FLPP) is a science funding programme financed by the Republic of Latvia Ministry of Education and Science and implemented by the Latvian Council of Science, one of the most important for the Latvian scientific community. Its aim is advancement of the existing knowledge and technological insights in all fields of science – natural sciences, engineering and technology, medical and health sciences, agriculture, forestry and veterinary sciences, social sciences, humanities and arts. It supports the most outstanding ideas of Latvian scientists and ensures the balanced development of all scientific disciplines. The situation with the projects approved for implementation in 2020 was more challenging. Funding rate per project is up to 300 000 euro (with up to 5% that could be allocated to administrative costs, including communication) and the project duration is up to 3 years. However, the project implementation and planned activities were influenced by COVID-19 outbreak. Analysing project results, it is significant to take into consideration these circumstances, and the reaction to that, since the second call for individual proposals was announced in the same year to allocate emergency funds for research of COVID-19 mitigation measures. Latvian Council of Science as a funding organization keeps all the records about reported communication activities, however, reports are usually focused on numbers and concentrate less on effectiveness. In order for scientists to be effective in their outreach activities, it is valuable not only to monitor but also evaluate the effectiveness of science communication. Such information could be of help for scientists when presented in a coherent and ready to use materials providing insights of good practices and tools that they could use with measurable effect. This goal could be achieved by understanding the state-of-art status of science communication at the moment.

Public financing of science projects in Latvia is reflecting the tendencies of EU, and in FARP projects scientists that want to apply for funding are required to describe their communication plan in applications and reports. For this purpose, the applicants have to complete two sections in their application form – point

2.2. The socioeconomic impact and public availability of the results, and the report section "Socio-economic impact of results", which contains tables which applicants fill in according to channel, activity performed, target group and availability for links or sources, as well as period when the activity was performed. The report contains a special subsection that focuses on publicity and communication, where implementers can describe and report any relevant information about the communication activities in their project.

With the help of such models as formulated by Brossard and Lewenstein (2009), it is possible to understand "what the "problem" is, how to measure the problem, and how to address the problem", the "problem" being the public's understanding of, and relationship with science.

Research questions

In order to describe the relationships that exist between scientists and society in Latvia, this research paper addresses three questions:

- RQ1: What science communication model is usually chosen?
- RQ2: Are there differences in choosing science communication models in different scientific fields?
- RQ3: What are the barriers to effective science communication in lzp-2020/1-financed projects?

The results of this study are based on the qualitative content analysis of documents, including proposals and reports that were submitted to the Latvian Council of Science by the funded project teams ($N = 47$) under the call FARP lzp-2020/1.

Methods

Even taking into consideration the allocated budget, as well as declared goals and objectives, in ensuring information about the significance and contemporary practices of citizen engagement, it is important to establish whether the shift from Deficit to Participatory model has occurred in reality and is adopted by the funded projects. The practices of supported projects across all the funded disciplines according to science communication models were never in the spotlight of a research paper. In order to fill this gap, I have built upon the work of Metcalfe (Metcalfe 2019) that, based on extensive literature review, created a list of objectives of science communication models. Although some researchers have recently been focusing on the science communication topic (Bulderberga 2024; Adamsone-Fiskoviča 2014), there is absence of monitoring of the existing practices in respect of science communication models for all the funded projects. This study provides a snapshot in time that can point the way to similar future studies, and establish a point for later comparison.

The data for the analysis was received from the Latvian Council of Science in an anonymized form, providing project proposals' section 2.2. "Socio-economic impact and publicity of the results", and the report for the same section with description and tables concerning the performed activities. Number of projects was (N = 47), documents were separately arranged according to five disciplines: Life Sciences (projects N = 23); Humanities and Arts (N = 5); Agriculture (N = 5); Medicine and Health Sciences (N = 8); and Social Sciences (N = 6). Coding was performed using *MXQDA Analytics Pro* (version 24.4.1.).

I coded the qualitative data using content analysis (Cho *et al.* 2014), and applied a deductive approach to analyse responses against the objectives identified in the literature and edited by Metcalfe in her study (Metcalfe 2019), as outlined in the previous section.

Due to the prevalence of financed projects in Life Sciences, there were more activities declared and thus this discipline had more codes and variations of reported practices, as there were 23 projects. Figure 1 provides an overview of the application of various science communication models – Participatory, Dialogue, and Deficit – across disciplines of the projects: Life Sciences, Humanities and Arts, Agriculture, Medicine and Health Sciences, and Social Sciences. The figure showcases both the inter-discipline usage and the prevalence of each model within these disciplines. The Participatory model emphasizes collaborative engagement between scientists and the public or other stakeholders. The data indicate varying levels of adoption across disciplines; this model is employed most prominently in Life Sciences (30%), followed by Agriculture (27%) and Medicine and Health Sciences (25%). Humanities and Arts (16%) and Social Sciences (15%) demonstrate lower usage. When comparing the Participatory model to others within disciplines, it appears less frequently overall, with the highest adoption in Agriculture (14%) and Life Sciences (13%). Notably, usage drops in Social Sciences (8%), Humanities and Arts (7%), and Medicine and Health Sciences (4%).

The Dialogue model fosters two-way communication between scientists and the public, emphasizing mutual learning and understanding; it is most utilized within Life Sciences (37%), with Social Sciences (35%) and Medicine and Health Sciences (20%) also showing significant application. The Humanities and Arts (14%) and Agriculture (6%) disciplines apply this model to a lesser extent. However, among other models, the Dialogue model has a strong prevalence in the Life Sciences and Medicine and Health Sciences, with usage rates of 81% and 42%, respectively. Other disciplines, including Humanities and Arts (15%), Agriculture (12%), and Social Sciences (12%), exhibit lower adoption rates.

The Deficit model, which assumes a one-way flow of information from experts to the public, remains prevalent across all disciplines. There is a significant reliance on the Deficit model within Life Sciences (81%), with Social

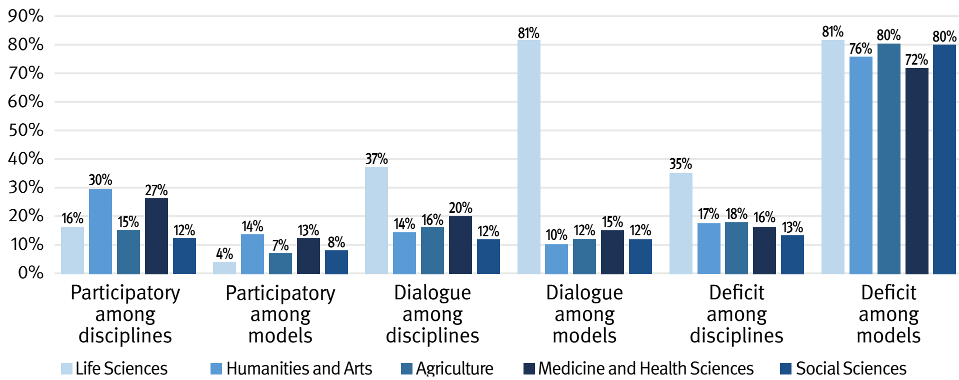

Figure 1. Overview of the use of models in projects

Sciences (74%) and Medicine and Health Sciences (48%) also showing considerable use. Agriculture (43%) and Humanities and Arts (17%) apply this model less frequently. The Deficit model is overwhelmingly dominant among disciplines as well, with near-universal application across disciplines: Humanities and Arts (80%), Agriculture (80%), Social Sciences (80%), Life Sciences (81%), and Medicine and Health Sciences (76%).

This figure highlights the entrenched use of the Deficit model across various academic disciplines, suggesting a traditional preference for one-way communication strategies in science communication. However, the Participatory and Dialogue models show varying levels of adoption, indicating a shift towards more interactive and inclusive communication practices, particularly in disciplines such as Life Sciences and Medicine and Health Sciences. The lower adoption rates in Humanities and Arts and Agriculture suggest potential areas for growth in integrating more participatory and dialogic approaches to enhance public engagement in these fields.

Overall, this analysis underscores the diversity in the application of science communication models, reflecting the nuanced needs and goals, as well as approaches used by different academic disciplines in their outreach and engagement efforts.

Grounded theory implies constant comparative analysis and theoretical sampling. Constant comparative analysis entails an iterative process of concurrent data collection and analysis, which involves “the systematic choice and study of several comparison groups”, whereas in case of qualitative data analysis a researcher who uses qualitative content analysis aims to “systematically describe the meaning” of materials in a certain respect that the researcher has specified from research questions. Although both grounded theory and qualitative content analysis follow coding processes, content analysis does not focus on finding relationships among categories or theory building; instead, it focuses on extracting categories from the data (Oxford Learner's Dictionaries 2023). As stated in the literature, qualitative content analysis can be referred to as "a research method for subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (Even 2023).

The codes were allocated accordingly to the objectives that Metcalfe systematized in her study and examples of the quotes for the text are given in the Code System Handbook developed with the help of *MAXQDA* (Table 1).

After coding all five documents, it was clear that Deficit model was prevalent in the analysed documents for all the disciplines, however, regarding specific objectives, it was observed that each model had more priority objectives than the others. The objectives were allocated accordingly with the frequency of codes for each of them (Table 2).

Table 1. The coding scheme of the objectives identified in the documents (an example)

Code System	Explanation	Frequency	Examples
Code System		1164	
Participatory model			
26 To shape the agenda of science	Shape the scientific research agenda (Bucchi 2008; Palmer, Schibeci 2012).	16	Development of policy documents, guidelines content, informative material content Medicine and health sciences: 168–168 (0)
24 To participate in democratic policymaking	Participate with various public in policymaking, and integrate their views (Brossard, Lewenstein, 2009; Höppner 2009; Palmer, Schibeci 2012; Trench, Junker 2001). Engage citizens more democratically in science and technology issues, including making decisions and formulating policy (Kurath, Gisler 2009; Palmer, Schibeci 2012; Scheufele 2014; Stocklmayer 2012).	58	Conference is intended as a platform to strengthen further collaboration with relevant national stakeholders in policy, clinical and scientific fields, as well as an outlet to raise public awareness of project results and topic in general. Medicine and health sciences: 96–96 (0)

Table 2. Three most frequently used codes for each science communication model applied in FARP projects lzp-2020/1

Deficit model	Codes	Dialogue model	Codes	Participatory model	Codes
2 To transfer information	352	15 To be or to make science/scientists more accessible	84	24 To participate in democratic policymaking	58
7 To promote science as a career	248	20 To make connections between people, including between disciplines	66	26 To shape the agenda of science	16
8 To inspire, build excitement, generate interest in science	82	19 To help people to make decisions	2	23 To participate with other interests to influence the culture of science in society	10

Table 3. Reliability analysis of science communication objectives

No	Item	Mean scale w/o item	Std. dev. scale w/o item	Corrected item-scale correlation	Alpha w/o item
1	Coded Segments	183.60	78.53	0.98	0.64
2	To transfer information	346.00	143.79	0.71	0.58
3	To promote science as a career	366.80	141.89	0.75	0.57
4	To inspire, build excitement, generate interest in science	400.00	161.71	0.90	0.65
5	To be or to make science/scientists more accessible	399.60	162.96	0.83	0.66
6	To make connections between people, including between different disciplines	403.20	161.82	0.67	0.65
7	To help people to make decisions	416.00	169.73	−0.35	0.69
8	To participate in democratic policymaking	404.80	170.77	−0.45	0.70
9	To shape the agenda of science	413.20	168.22	0.73	0.68
10	To participate with other interests to influence the culture of science	414.40	169.98	−0.12	0.69

Hence, as *MAXQDA* software enables conducting a statistical analysis, it was done for the respective aforementioned objectives. Table 3 presents a reliability analysis of various objectives associated with science communication. The analysis includes the mean and standard deviation of the scale if each item were removed, the corrected item-scale correlation, and Cronbach's alpha without each item. This comprehensive analysis helps in evaluating the internal consistency and reliability of the items as part of a broader measurement scale.

The items listed in the table represent different objectives of science communication models, ranging from information transfer and career promotion to public engagement and policy participation.

Each item is evaluated based on how its removal would impact the overall scale's mean and standard deviation, providing insights into its relative importance and consistency within the scale. The metrics of Corrected Item-Scale correlation measures the correlation between individual item and the total score of the remaining items, e.g. as the "To be or to make science/scientists more accessible" (0.83) and "To inspire, build excitement, generate interest in science" (0.90) show high consistency, there are found items with negative or low correlation such as "To help people to make decisions" (−0.35) and "To participate in democratic policymaking" (−0.45), indicate potential issues with consistency and may not align well with the other items. That could be a result of low number of codes or insufficient information provided in the reports.

The column "Cronbach's Alpha Without Item" presents the Cronbach's alpha coefficient for the scale if the specific item were removed. Cronbach's alpha is a measure of internal consistency or reliability, e.g. removing "Coded Segments" would result in a slightly lower alpha (0.64), while removing items with lower corrected correlations, such as "To participate in democratic policymaking", would slightly increase the alpha (0.70).

It is suggested that most items have acceptable to highly corrected item-scale correlations, indicating that they contribute positively to the overall consistency of the scale. However, a few items, particularly those with negative correlations, may require further examination to understand their alignment with the other goals and their impact on the overall measurement scale.

This reliability analysis provides valuable insights into the consistency and alignment of various science communication goals. The results highlight the strengths and potential weaknesses within the scale, guiding future refinements to enhance the robustness and reliability of the measurement tool. Further investigation into items with negative correlations may help in optimizing the scale for more accurate and effective assessment of science communication objectives.

By using the visual tool of models that are prevalent across the documents and presented disciplines, it is observed that the Deficit model is dominant in every field of science. The most objective used in coding was "To transfer the information", that involved such explanations, as "information to other scientists", "informing policy makers", and the most used was "information available on web page of the project and social media". Although in Table 3 for project reports the main activities included social media and web pages, it is not clear how effectively it contributes to the information transfer, as the presence there is not measured and evaluated. According to the Oxford Dictionary stating that

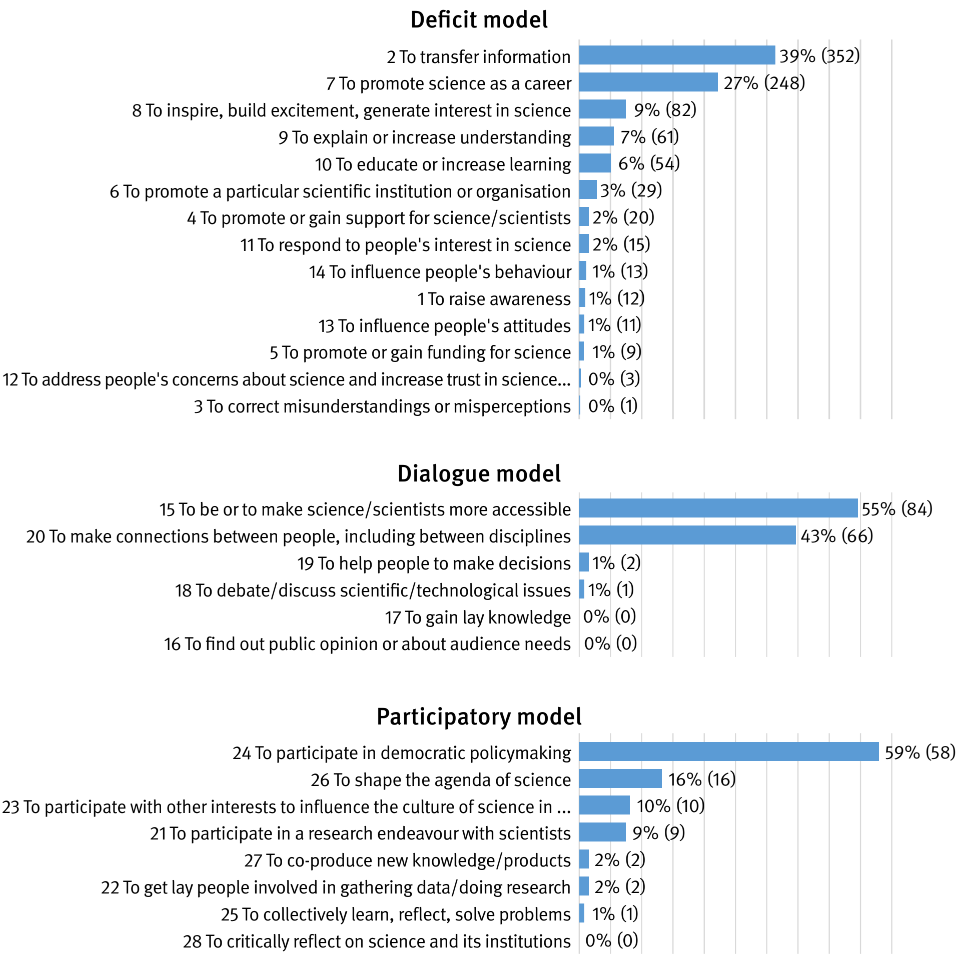

Figure 2. Representation of each model separately in projects

"a barrier is a problem, rule or situation that prevents somebody from doing something, or that makes something impossible", it is important to evaluate how effective the information was and whether it reached the expected outcomes (Schäfer 2009).

Results

As the project documentation was anonymized, it posed definite limitations, since it was not possible to take into consideration demographic factor and analyse it from the perspective of who was responsible for the project and how many different stage researchers or fields of science were involved in the project implementation and thus contributed to implementation of the project and especially "Impact" part, where all the communication, dissemination and exploitation results were presented.

I further elaborate on the implications of this finding in in the section "Discussion" below.

Likewise, I will provide considerations regarding the general science communication goals, and how these goals align with the three science communication models discussed in the introduction of this paper, namely, the Deficit, Dialogue, and Participation model.

Discussion

Models of science communication are not linear; they frequently coexist in project proposals and reports. Using various models in communication is important, since it enriches the practices and ways of delivery of scientific knowledge to the public. There should not be one-way communication only, or, as Priscilla Van Even formulated it, "public science dissemination" (Van Even 2023, I). Notably, the use of those methods and practices are not coherent, improper balance of practices, lack of knowledge as to what science communication actually is and what and how it should be done, planning activities with target audience and its expectations are usually the barriers that hinder effective implementation of science communication models.

There are definite practices that are "traditional" and characteristic to some disciplines, e.g. in Medical Sciences, the Participatory model, in the objective 24 "To participate in democratic policymaking", in comparison to other disciplines, is used more often. Clear statement of target audience as policy makers, entrepreneurs or industry representatives is better outlined and targeted by communication activities than in case of addressing society at large. However, the event "Researcher's Night" is referred to as an example with a broad coverage of objectives, to this one could attribute such objectives of the Deficit model as 2 "To transfer the information", 4 "To promote or gain support for science/ scientists", 6 "To promote a particular scientific institution or organisation", 7 "To promote science as a career", 8 "To inspire, build excitement, generate interest in science", 9 "To explain or increase understanding", 10 "To educate or increase learning", and Dialogue model – 15 "To be or to make science/scientists more accessible". The second event that is usually reported in the context of communication is festival "Lampa", where the actual discussions with scientists occur.

Only in Medical Sciences in one instance it was clearly stated that Deficit model was used – 3 "To correct misunderstandings or misperceptions", other projects did not take into consideration lay people's knowledge, likewise, there were no declared activities in Dialogue model as to 16 "To find out public opinion or about audience needs" or 17 "To gain lay knowledge". However, this knowledge and approaches are of crucial importance, as the information that is provided by the project or aim of communication practices could be irrelevant to the audience's needs or understanding of the current situation in the field. Many scholars have claimed that the Deficit model approach is "unsuccessful and empirically faulty", it is highly focused on the content that researchers are translating to the lay audience, based on the researchers' assumption of what this audience does not know, following the concept of "Public Understanding of Science" (Bucchi 2016). Meanwhile, it is not clear how it could be properly addressed if there are no previous studies or analysis defining lay people's knowledge about the particular subject that is planned to be communicated. It was supposed that this gap could be addressed by introducing the Dialogue model. However, Trench has critically reflected on Dialogue model, as it is supposed to bring more to discussion between science and public and to a certain extent these expectations have been met, which also is further stimulated by digital transformation and digital media use by scientists. However, Trench primarily argues as to whether it has had a real impact on shifting science communication practices (Trench 2008).

COVID-19 influenced different on-site activities that were reported by some projects. To overcome the limitations imposed by pandemic, online events were introduced, supporting Bucchi's (2016, 265) claim that "Digital media allow, among other things, research institutions and actors to supply to end-users an unprecedented amount and variety of materials, for example, videos, interviews with scientists, selected news items." There is no need to include media or journalists as mediators between scientists and society. It gives opportunities to make contacts directly and increases visibility of scientists, their approachability and, if implemented successfully, establishing connections and trust.

As all of this information is attributed to the "Impact" section of the project, it could be stated that communication practices of most projects are not well-shaped and thus the results are disorganized and sometimes unclear whether these were intended to be achieved. Digital media are of great help for information dissemination purposes, but in case of the analysed projects they are overused. Instead of creating a platform for discussion, they denote the reported activity as being present. Many project reports stated that news on their websites are posted regularly and general audience would be informed in this way about the project and scientific results, however, it was not stated how many users there were and how often they checked on the information, and whether the page of their scientific institution was even usually perceived as a source of reliable information for general public. There is a need for clear distinction between Communication, Dissemination and Exploitation, where communication could focus on any type of activity with the categories to help choose the possible activity and use it effectively while performing communication activities. Notably, only in one project it was clearly stated that for implementation of communication activities they would be cooperating with the communication department of their institution. It is of crucial importance to build public trust in science and research methods, engaging with different types of audiences, and using various models of science communication could be of great help for scientists. Collaboration between scientists and media, policy makers and higher educational institutions' press departments could promote science as an important topic of the everyday agenda. However, there is a necessity to support the scientific community in communication activities' planning, implementing and measuring the effectiveness thereof. Such support measures could address the needs of FARP project applicants or consider additional funding to projects that are focused on science communication, to ensure that these measures could be supported by introduction of data monitoring of scientific content consumption, thus ensuring that scientific content is timely, focused and effectively reaches its target audience.

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