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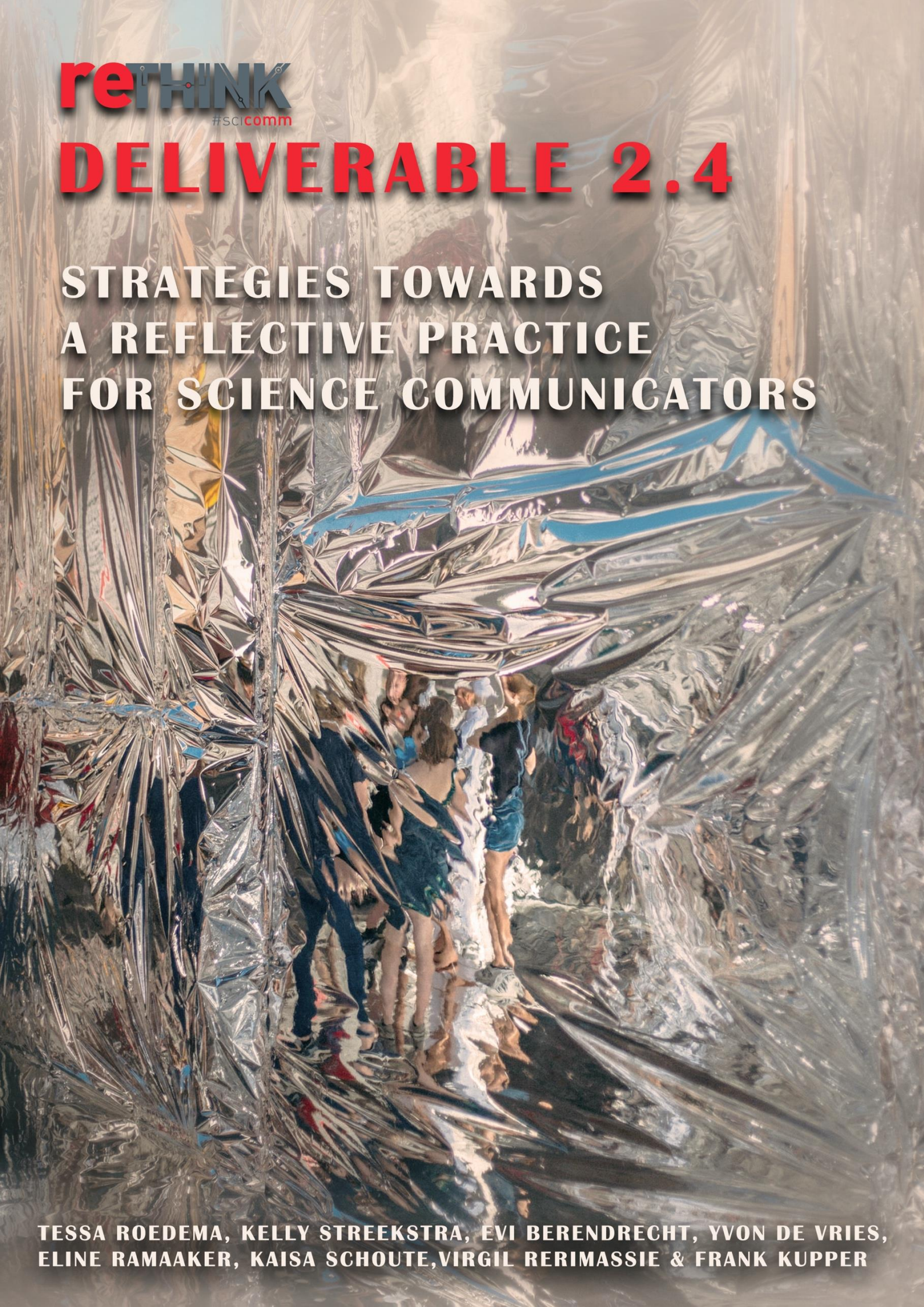
DELIVERABLE 2.4

STRATEGIES TOWARDS A REFLECTIVE PRACTICE FOR SCIENCE COMMUNICATORS



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Deliverable 2.4

STRATEGIES TOWARDS A REFLECTIVE PRACTICE FOR SCIENCE COMMUNICATORS IN ORDER TO OPEN-UP SENSEMAKING PRACTICES OF CITIZENS

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SUMMARY

Due to trends such as digitalisation and blurring boundaries between science and society, the current science communication ecosystem is highly fragmented, dynamic and complex. The number of actors, communication networks and platforms has increased and became more diverse. This has also increased the range of issues and values, ideologies and interests brought into the discussion. Due to digitalisation, a variety of publics can not only find, but also generate information about science online. It is now observed that the wide diversity of people who are present in the public discussion on science have equally diverse ways in which they make sense of science. The sensemaking practices of citizens are heavily influenced by their personal situations, worldviews, values and emotions. Science communication practitioners need to constantly relate to and adapt their role and repertoires to what is required in the ever-changing field of science communication. What helps science communication professionals in dealing with the revolutionised science communication ecosystem – for example regarding dealing with uncertainty of science, (scientific) expertise that is publicly questioned by audiences, whilst providing clarity on misinformation presented online? How do they connect to the widely diverse and contextualised ways in which citizens make sense of science? And given the current science communication dynamics, how can one moderate constructive public discussions on science?

We propose that adopting openness and reflexivity in the practice of science communication helps in dealing with these complex questions for practitioners and facilitates the establishment of constructive science-society interactions. Reflexivity is described as being aware of - and critically reflecting on - your own and other people's situations, context and assumptions; and being capable to take actions on the basis of these insights. Openness is described as taking into account a wide range of information sources, perspectives, values and emotions; and being capable of changing your own opinion based on the offered arguments and stories. By adopting openness and reflexivity in one's practice, practitioners may explore emotions, values and worldviews that lay to the basis of their own science communication activities or interactions; as well as provide an entry point to better understand 'the other' and connect with them. Hence, we assume that openness and reflexivity are crucial components in science communication practice in order to open-up sensemaking practices. Together with communicating scientists, science journalists and other science communicators we set-up small-scaled experiments, in which we explored how science communicators may adopt openness and reflexivity into their practice and the value this brings to the field of science communication. This deliverable provides an overview of strategies that science communicators experimented with in their practice in order to open-up sensemaking practices, and their reflections on the value for the practice of science communication.

The research for this deliverable roughly followed the following methods. Firstly, we asked science communicators, journalists and communicating scientists to join us in a one-hour meeting to discuss

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their practice and identify challenges that the revolutionised science communication ecosystem brought them. Next, the researchers of this study introduced the concepts of openness and reflexivity. In this first interview, the researchers and reflective practice participants together explored possible small-scaled experiments wherein they could experiment with putting openness and reflexivity into practice. Over the course of several weeks, participants kept track of their experiments and experiences in a reflection diary. Lastly, in a second interview, the science communication professionals and researchers of this study together reflected on the value of openness and reflexivity for the field of science communication. This resulted in an overview of strategies for science communicators to become reflective practitioners in an effort to open-up sensemaking practices of citizens.

From the first interviews it became clear that practitioners to a large extend deployed openness and reflexivity attitudes at the onset of this study, for they indicated to see the value of including various perspectives into constructive conversations as well as reflected on their own role in this. However, it seemed that feedback mechanisms on science communication outputs from audiences to science communication practitioners were missing. This made it difficult for practitioners to also deploy openness and reflexivity actions. To this end, participants wanted to conduct small scaled experiments in roughly two categories: 1) to gain a better understanding of their audience, and; 2) experimented with conversational tactics that included openness and reflexivity. Small-scaled experiments mostly involved receiving feedback from their audience – for example in the form of an open conversation or conducting a questionnaire. Moreover, they involved several conversational tactics, such as focussing on listening to the other whilst postponing one's own judgement, and the inclusions emotions next to facts into conversations. As such, the reflection diary facilitated science communication practitioners to deploy openness and reflexivity actions, in the form of asking questions to obtain insights in audiences' underlying stance, emotions or perspective. Participants mentioned this had positively affected conversations about science.

In conclusion, the reflection diary was mentioned to be very valuable in keeping track of and structure the progress and learning opportunities during the small-scaled experiments. The small-scaled reflective practice experiments proved to be valuable for both the individual science communicator as well as the audiences they aim to reach. As such, a reflective practice for science communication opened-up the sensemaking practices of citizens, for practitioners had found new ways to connect to citizens and have conversations about underlying values and emotions. Lastly, with help of the reflection diary, participants mentioned they were able to reflect-in-action, which enabled them to intensify the interactions they had with audiences even more.

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1. INTRODUCTION

The RETHINK project aims to facilitate an approach to science communication that is able to nurture interactions between science and society in an open and reflective way. To this end, in its first phase "understand", the RETHINK project has explored the current science communication ecosystem (Ridgway et al., 2019a; Ridgway et al., 2019b; Roedema, Rerimassie, & Kupper, 2020). This exploration has brought to light that the current science communication ecosystem is highly fragmented, dynamic and complex, and that it provides science communicators with both opportunities as well as challenges. Two trends are fundamental to this observation: the blurring boundaries between science and society and digitalisation. We see the boundaries between science and society are blurring whilst the interaction of citizens with science has increased and science has become interconnected with other fields, such as economics, politics, art and culture (Roedema et al., 2020). Adding to this interconnectedness of science and society is the trend of digitalisation, for this has increased the number of actors involved in the public discussion on science. Furthermore, digitalisation has led to new channels and resources for science communication. A variety of publics cannot only find, but also generate information about science online (Rutsaert et al., 2013). This can lead to an overload of accessible information, part of which may be inaccurate, incomplete or biased. Moreover, the number of fora where public discussions take place increased tremendously due to digitalization. Such fora continuously demonstrate the diversity of voices, all of which underpinned by their own values and worldviews. This links well to the insights of Wynne (2006), who describes how an increase of involved actors leads to an increase in the range of issues that have to be discussed surrounding the sciences. These dynamics complicate how citizens can make sense of science. This report aims to explore how the science communication practitioners can adapt to the complex dynamics and challenges of the contemporary science communication ecosystem. It particularly examines the potential role of *openness* and *reflexivity* in the strife of science communicators to contribute to the quality of interactions in the complex contemporary science communication ecosystem.

1.1 SENSEMAKING PRACTICES OF CITIZENS

Due to the rise of social media platforms, it is not only science communicators that write, blog and vlog about science, but now citizens also generate information online. The public is less dependent on traditional media, has the opportunity to do their own independent research, publish this information independently and can interact with science communicators, scientists and other actors on online platforms directly (Castells, 2007). It has reinforced connectivity within and across societies (Couldry & Hepp, 2016). However, it also means that traditional journalists and other science communicators are no longer the 'gatekeepers' of what scientific information enters our societal debate. The public now often reads and watches information about science from sources where the traditional media's editorial

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oversight and fact-checking are lacking (Trench, 2008). These changes indicate how an increasingly diverse type of public communication is taking shape. Moreover, the current science communication ecosystem is fragmented and holds widely diverse players - all with their own perspectives, voices, values and worldviews, which continuously contribute to the ongoing public conversations about science.

The fragmentated nature of the current science communication landscape is highly relevant for the way of citizens make sense of scientific information: how can citizens determine what information is true, or false or – given the complexities and uncertainties present in the current landscape – who can citizens trust to determine for them what is true or not? Sensemaking can be understood as the dynamic process of building or revising an explanation of something in order to form an understanding of it (Odden & Russ, 2019). In the process of sensemaking, citizens draw on a variety of sources such as previous experience, expectations, emotions, values and interest (Reinhard & Dervin, 2012). Previous work of RETHINK found that people make sense of science predominantly on the basis of their personal situation or social context, and in their sensemaking practice referred less to actual science communication output (Rerimassie, Roedema, Augustijn, Schirmer, & Kupper, 2021). This means that often times, it might be that misunderstandings or disputes in public discussions on science are not necessarily the result of a lack of knowledge, but rather that different worldviews, emotions and values lay to the basis of differing perspectives on the relation between science and society.

1.2 DESIRED ROLE REPERTOIRES FOR SCIENCE COMMUNICATION

This insight has repercussions for the practice of science communication, which traditionally is characterized mainly by the communication of knowledge. In topics where perspectives and actors are diverse, other aspects besides the scientific knowledge itself might require substantial attention when scientific knowledge is increasingly more a subject of public conversations. This implies science communication practice may need to adapt in terms of the so-called 'role repertoires' of its practitioners, in order to make sure supply and societal demand are aligned.

The theory on role repertoires stems from theories on knowledge management, where – amongst others research- Turnhout et al. (2013) analyse the practices of 'knowledge brokers'. Knowledge brokers are those who make scientific knowledge accessible for stakeholders outside of the academia, by use of three repertoires: "supplying, bridging and facilitating; which differ with respect to whether they maintain or clear boundaries between the production of knowledge and use, or set-out to blur them" (Turnhout et al., 2013). Depending on which role a broker plays they draw on different repertoires representing a certain perspective on the relation between knowledge production and use as well as a set of work-related activities that complement these (Turnhout et al., 2013). As this fluidity in reaction to diverse contexts is expected to be valuable in the practice of science communication as well,

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RETHINK intends to explore science communicators' *role repertoires*. In this framework, derived from the work of Turnhout et al., (2013), Bauer et al. (2019) and others, a 'role' refers to the focus or contribution a science communicator wants to make to science-society interactions. Repertoires refer to the underlying perspective a science communicator takes with regards to science-society interactions, and how this is linked to activities undertaken by the practitioner and audiences addressed (Roedema, Broerse, & Kupper, 2021). In one of RETHINK's studies, the role repertoires and complexities in the current science communication ecosystem were studied and defined. These repertoires shed light on how their practitioners perceive their role and the type of intended interaction between science and society.

Analysing the practice of science communication and its many role repertoires shows plausible cause for a change within roles, but also perhaps a shift in roles. Many stakeholders involved in the public discussion on science, including politicians, scientists, science journalists and citizens, seem to remain in a science communication repertoire of 'explaining the scientific facts once more'. This is an example of the lingering idea that disagreement and opposition to scientific knowledge and expertise is caused by ignorance or a lack of information, and that this ignorance can be countered by the provision of scientific knowledge - also known as the deficit model (Wynne, 2006). In this model, science communication becomes a matter of transferring knowledge to people with knowledge deficits, wherein the role of the science communicator is to check the quality of information and ensure accurate transmission of information between science and society (Nisbet & Scheufele, 2009). The insights on how citizens make sense of science, however, indicate how scientific knowledge is but one part of citizens sensemaking of the sciences. If science communication were to consider other elements, like feelings, values and personal situations of those we communicate with, we might enhance our ability to position scientific knowledge within society.

Other science communicators employ other roles that seem to focus on contextualising, 'brokering' or moderating the scientific facts within a public conversation. When practicing science communication from that perspective, the awareness of sensemaking might be an intuitive aspect to take into account. This perspective stems from the notion of two-way or interactive modes of science communication. These modes describe that scientific knowledge is not self-evident, stable nor fixed - but rather that the production of scientific knowledge is co-created or informed by norms, values and practices in society. As such, two-way or interactive modes to science communication allow practitioners to connect to the personal, contextual and collective ways in which citizens make sense of science. In such interactions, the public discussion on science would include a conversation on the underlying values and perspectives that different people have with regards to science - without disregarding the scientific facts that are presented.

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An example of potential changes or differences in repertoires can be found when exploring the literature on the roles of the broker. For science communicators, the role of the broker of scientific knowledge entails being involved in (the workings of) science, as they should be able to differentiate actual scientific evidence from unwarranted claims of scientific expertise. They both report on the results of research, as well as on how science is conducted, by going more "upstream" in the production of knowledge (Brüggemann et al., 2020). Besides the clear eye on the origins of the scientific knowledge, science communicators in the 'broker'-like roles could improve their moderation of communications when they are aware of the personal situation and social contexts that influence the sensemaking practices of their audiences.

In sum, it is found that the digitalised science communication landscape where science and society have come to increasingly interact, the roles of the science communicators have and are diverging beyond well-known roles like the 'watchdog' or 'knowledge-transmitter' to partake in- or moderate the public discussions on sciences. For instance, science communicators now also act as *brokers* for the conflicting ideas and values at the intersection of science and society (Brüggemann et al., 2020; Turnhout, Stuiver, Judith, Harms, & Leeuwis, 2013). This describes how a nuanced but complex diversification or shift might be taking place in the practice of science communication: from practicing the communication of scientific knowledge, towards practicing communications surrounding scientific knowledge. Along with this shift, the RETHINK research on sensemaking highlights need to recognise that different views and values exist when we have public discussions on science, and that personal situations and social contexts influence the way in which we make sense of science - and not the amount of knowledge we have.

In order to connect to various sensemaking practices of citizens, science communicators can benefit when investigating their own perspective and values concerning science, their role in science-society interactions, and the way in which this influences the activities they undertake or interaction patterns they encounter with respect to their audiences (Roedema et al., 2021). Reaching this kind of awareness is a complex process, which can be assisted and or initiated through a constant reflection on the science communicator's role and deployed repertoire in public discussions on science; and requests an ability to adapt one's role repertoire accordingly to their reflections. Therefore, we suggest that science journalists, science communicators and communicating scientists adopt a *reflective practice.*

1.3 NEED FOR A REFLECTIVE PRACTICE OF SCIENCE COMMUNICATION

The concept of 'reflective practice' stems from the science of learning and education, and is defined as 'the ability to reflect on one's actions as to engage in a process of continuous learning' (Schön, 1983). Adopting a reflective practice for science communication entails the reflection on one's own

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assumptions, how they originated, for example by personal experience or social background, and how these may influence their view on the public and the type of science communication activities they deploy (Ridgway, Milani, Wilkinson, & Weitkam, 2020; Roedema et al., 2021; Salmon, Priestley, & Goven, 2017). It is applicable and relevant to this research, as it enables science communicators to all partake in-depth and action-oriented reflection, which can assist in novel atonement towards the personal sci-com objectives through first and second order loop learning, which is further defined in the theoretical framework. This is valuable because in such a practice, science communicators could investigate the sensemaking practices they encounter in their audiences, and at the same time reflect on their own actions, activities and approach in addressing these audiences (Roedema et al., 2021). When science communicators are able to reflect on their own assumptions and beliefs and are open towards the beliefs of their public, a more open and constructive science-society dialogue can be realised.

Two concepts that are central in the reflective practice we want to experiment with in this research, are 'openness' and 'reflexivity'. In recent RETHINK work, Ridgway et al. described "barriers and opportunities to opening-up sensemaking practices" (Ridgway et al., 2020). Herein, *openness* and *reflexivity* are indicated to be crucial aspects of a reflective practice for science communicators, that should enable science communicators to connect to the various ways in which people make sense of science. Openness is the willingness to seek out or thoughtfully engage with new information and other perspectives that potentially contradict your own views - whilst at the same time being able to postpone judgement and willing to potentially change your own perspectives and viewpoints (Ridgway et al., 2020). This way, one takes in more diverse amounts of information, which may immediately conflict either internally or with one's previous intuitions (Carpenter et al., 2018). Relatedly, reflexivity is being aware of and thinking critically about your own assumptions, perspectives, and ideas; and how this shapes your communication activities, influence what you communicate, and shape the interactions with your audience.

However, how science communicators can adopt openness and reflexivity into their practice in order to connect to sensemaking practices of citizens, remains unknown. Therefore, the main research question that this deliverable aims to answer is: *How can the adoption of openness and reflexivity in the practice of science communication enable practitioners to open-up sensemaking practices of citizens?* With this, the RETHINK project would like to move beyond understanding the current challenges and opportunities in the science communication ecosystem – and instead focus on *developing and experimenting* with strategies that enable science communicators to deal with earlier identified challenges. RETHINK expects this can contribute to constructive public discussions on science.

Therefore, this research report is built up as follows. First, we will describe the concepts of reflective practice, openness and reflexivity, and operationalise these concepts to the practice of science

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communication in opening-up sensemaking practices. Secondly, we will outline the different phases of and methods used in this study, and connect these to research questions that this study aims to address. Thirdly, we will present an overview of the results, including the perspective of science communication practitioners on openness and reflexivity, small-scaled experiments conducted, experiences of practitioners with the reflection diary, and their view on the value of openness and reflexivity for the practice of science communication. Lastly, we will discuss the meaning of these results for the changing science communication field and our outlook on future research.

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2. THEORY ON OPENNESS, REFLEXIVITY AND REFLECTIVE PRACTICE IN SCIENCE COMMUNICATION PRACTICE

The main research question that this deliverable aims to answer is: *How can the nurturing of openness and reflexivity in the practice of science communication enable practitioners to open-up sensemaking practices of citizens?* This research draws further on the RETHINK deliverable "barriers and opportunities to opening-up sensemaking practices" (Ridgway et al., 2020). In this deliverable, openness and reflexivity were indicated to be important concepts relating to a reflective practice for science communicators that facilitate in opening-up sensemaking practices of citizens. This section explores the theoretical background of this research. First, theories on reflective practice, reflexivity and openness will be described. Secondly, these concepts will be operationalised for the practice of science communication in opening-up sensemaking practices.

2.1 REFLECTIVE PRACTICE

The idea of reflective practice dates back to early in the 20th century in the writings of Dewey (1933), yet it was Schön (1983) who indicated the need for reflective practice in order to reduce gaps between theory and practice for practitioners. He defined reflective practice as 'the ability to reflect on one's actions as to engage in a process of continuous learning' (Schön, 1983). According to Schön, bridging this gap between theory and practice needs an awareness of the theory or assumptions that lay to the basis of practitioners' work and how this may differ from what they say they adhere to - in an effort to improve both (Fook, 2007). For example, in earlier RETHINK research, it was observed that science communication practitioners foresee a role for themselves in contextualising scientific information for their audiences, democratise science and contribute to citizens taking-up scientific information to 'better arrange their lives'. However, in some occasions they adopted a repertoire that would not take into account the personal situation of audiences, nor the contextualised ways in which people make sense of science. A reflective practice for science communication could help untangle these dynamics.

In the continuous learning process described by Schön, both reflection-in-action and reflection-on-action can be distinguished. Reflection-in-action is the process of thinking about an action while executing it, for instance considering the best practice; reflection-on-action is evaluating the effect of actions that have been undertaken (Schön, 1983). These types of reflection also require different forms of learning or reflecting about one's practice. Argyris & Schön (1978) described single-loop learning and double-loop learning. Single-loop learning is seen when practitioners keep relying on their currently deployed strategies in new situations – for example, when the practitioner is aware of an error being made and deploys the same strategy to deal with this error. Double-loop learning is the modification of strategies so that when similar situations arise, a new approach is deployed (Argyris & Schön, 1978).

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This requires a reworking or deepened form of reflection, for example to be able to recognize how your own and other's actions relate to the situation that took place. As such, besides using reflexivity in order to learn how one's perspective came to be, reflexivity can also be used as a process of continuous learning to change or tailor their own practice.

Many alternative models of reflective practice have been created, such as the reflective model created by Gibbs (1988). It presents a cycle of six key stages: (1) describing what happened, (2) examining feelings and thoughts related to this, (3) evaluating positive and negative aspects of the situation, (4) analysing to make sense of it, (5) drawing conclusions about what else can be done, and (6) developing a personal action plan (Gibbs, 1988). This model on reflective practice has been chosen for it helps practitioners in identifying assumptions they might have about their audiences, seeing how this affects the interactions they have with audiences and to formulate learning goals for the future. As such, this model has a transformative character, as it stimulates both single and double-loop learning. In this study, science communicators will go through these six stages in the reflective practice experiment, by filling in so-called 'reflection diaries'. Doing so allows them to reflect on their deployed role repertoire, science communication activities and interaction patterns with citizens. This will be further elaborated on in the methodology.

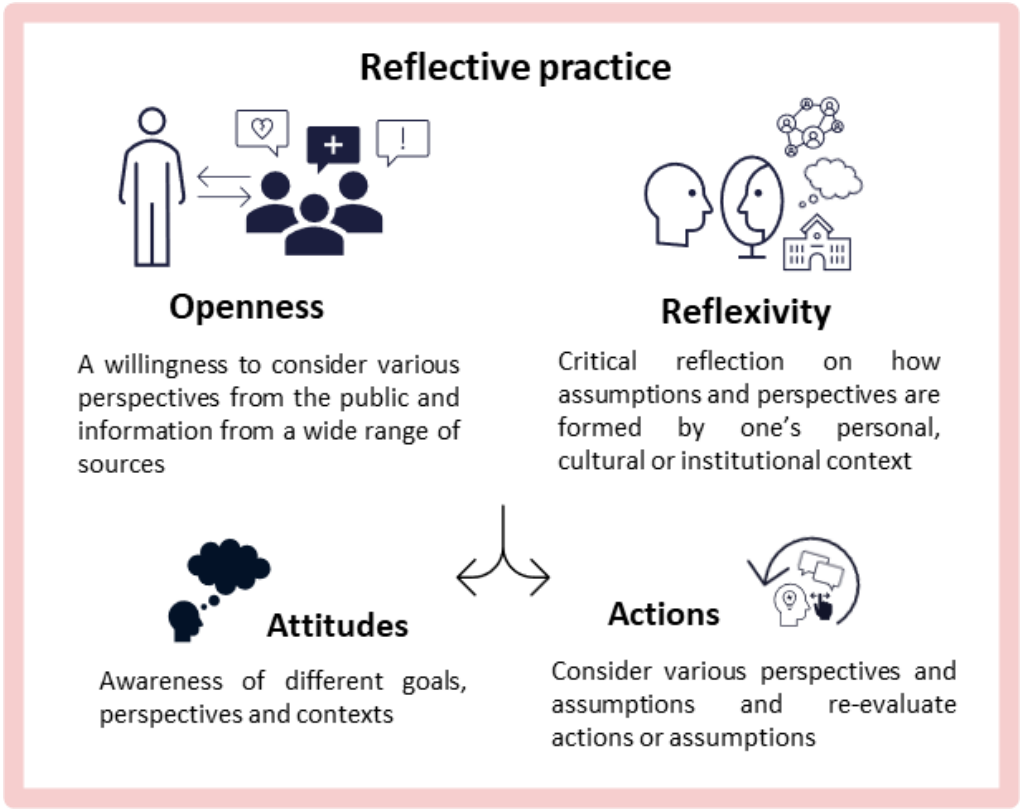

Figure 1: The conceptual framework of this study, where reflective practice comprises both openness and reflexivity. For either openness and reflexivity, one can derive attitudes and actions that are characteristic to these practices. *Figure credits: E. Raamaker.*

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2.2 REFLEXIVITY

For science communication activities to be attuned to the changing society and the wide diversity of sense-making practices of citizens, science communicators have to adopt a reflective attitude. First of all, reflexivity involves critical reflection. Fook & Gardner (2007) elaborated on this, when they wrote: "critical reflection involves the unsettling and examination of fundamental (socially dominant and often hidden) individually held assumptions about the social world, in order to enable a reworking of these, and associated actions" (Fook & Gardner, 2007, p21). Furthermore, they wrote that reflexivity is the ability to recognise that all aspects of ourselves and our contexts influence our actions, and as such is linked to the way we create knowledge (Fook & Gardner, 2007). This involves gaining insights into your own assumptions and the way in which perspectives shape the activities practitioners undertake (Chilvers, 2012; Fook & Askeland, 2006, p. 45; Ridgeway et al., 2020). This can be formal and systemic, or daily and unarticulated to make sense of surroundings. Reflexivity therefore means being aware of all the ways in which we create or influence the type of knowledge we use.

How we interpret and select information is influenced by our physical states and social positions, our particular being and experience, the tools and processes we use, and historical and structural contexts (Fook, 2007). In short, reflexivity means three things: (1) critical reflection of one's thoughts, assumptions, feelings, beliefs, motivations, and how these relate to one's actions, (2) reflecting about the consequences of these actions, how they influence and are experienced by others, and (3), based on these reflections, (potentially) adjusting one's thoughts, beliefs, actions. This means that besides being aware that all our personal aspects influence the way we interpret and communicate information, it also means this process differs for everyone and all individuals have their own way of interpreting information. This connects well to the research on sensemaking practices, which highlighted the wide diversity of personal situations and social contexts that lay to the basis of citizen's sensemaking practices (Rerimassie et al., 2020). Lastly, the perspective science communicators take on their own role in science-society interactions, has implications for the activities they undertake, the audiences they address and the (type of) interactions they have with these audiences (Roedema et al., 2021). As such, having awareness of one's own values, worldview and context, and how this influences interaction patterns with 'the other', are crucial in science communication processes. These aspects are crucial in case we wish to understand how to tailor our science communication practices along with the trends, changes and challenges in society as described in the previous chapters.

Ridgeway et al. (2020) distinguished some components of reflexivity in relation to science communication. Firstly, it involves examining and trying to understand how one's own assumptions and perspectives have derived from personal, emotional, social, cultural, historical, and political influences and how they are embedded in one's science-communication actions and experiences.

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Furthermore, it involves acknowledging that and reflecting on how one's actions influence the knowledge and perspectives of the audience (closely related to openness). Finally, reflexivity means to, based on these reflections, potentially change one's beliefs as well as science communication practices. In addition to the points of Ridgeway et al. (2020), one should consider their audience's personal situations (incl. emotions, values, wordviews, etc.) and broader social and cultural context in order to understand their perspectives. Lastly, science communication practitioners should consider how their audience views them in order to be better able to form constructive science communication interactions. These aspects to reflexivity are summarised in table 1.

2.3 OPENNESS

When practicing science communication, next to reflexivity also openness awareness and actions are required in order to connect to the various sensemaking practices of citizens. Openness is "the dispositional willingness to seek out and thoughtfully engage with new and even threatening information" (Carpenter et al., 2018). Baron (1993) introduced the idea of Actively Open-Minded Thinking, which includes efforts to search for reasons why an initial conclusion might be wrong (Baron, 1993). Ridgeway et al. (2020) further elaborated on openness in relation to sensemaking practices of citizens and describes that openness involves the following components: a) awareness of others' goals and perspectives; b) being open to and respectful of a wide range of evidence, new information, and perspectives, and; c) consciously considering adjustment and a willingness to change one's own mind. Furthermore, an openness means accepting ambiguity and uncertainty (Carpenter et al., 2018).

Openness as an attitude means it is more than just an open mentality, it means it is manifested in one's science-communication activities. Firstly, open science communication means considering the audience's personal situation and social context, including one's worldview, values and emotions in relation to what the science communicator tries to communicate. Furthermore, practitioners may have to (temporarily) side-line their own worldview, values and perspectives, and put effort in understanding other points of view – with the recognition that one's own stance might not be universally held. For example, instead of trying to convince a sceptic to use face masks with the scientific facts and numbers that clarify how face masks prevent the spread of COVID-19 through aerosols; science communicators could facilitate a constructive discussion by a shared exploration on the underlying values and emotions that may lie to the basis of their behaviour. In this way, science communicators may become facilitators of constructive public discussions of science, by opening-up the various ways in which citizens make sense of science. As such, from a science communication perspective, openness refers to the ability to take into consideration other perspectives and think about how these perspectives shape the public taking part in the interaction on science. More, openness refers to the ability to temporarily put aside one's own perspective in order to be able to take an open look towards the perspective of 'the other'.

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In conclusion, to operationalize an open practice for science communicators, similar to reflexivity, we adopt the openness attitudes and openness actions of Ridgway et al. (2020), as shown in Table 1. For science communicators, an openness attitude is described as the awareness that other perspectives exist as well. Moreover, science communicators should be able to include a wider range of perspectives, information and evidence in their communication activities. Openness actions as described above can apply directly to science communicators: they mean to take a broad range of perspectives of the public they communicate with into account, consider information and evidence from a wide range of sources in their communication and be prepared to revise their own perspectives.

Table 1: Reflexivity and openness attitudes and actions.

Reflective practice		
Openness		
Attitudes	Aware of goals and perspectives	Being aware of other people's goals and perspectives
	Open-minded thinking	The dispositional willingness to seek out and thoughtfully and respectfully engage with new and even threatening information, perspectives, values and emotions
	Considering adjustment	Consciously considering adjustment and being willing to change your mind when presented with new insights
Actions	Taking broad range of perspectives into account	Taking a broad range of perspectives into account in science communication practice, with the preparedness to display the range of perspectives in scicomm activities
	Open-minded acting	Considering and actively seeking out information, evidence, values and emotions from a wide range of sources, some of which may counter your perspective
	Prepared to revise own perspectives	Being prepared to revise your perspectives and actions based on newly presented information and evidence
Reflexivity		
Attitudes	Aware that contexts influence interpretation	Awareness that all aspects of people and their context influences the information people find and how they interpret it, and thus that a particular interpretation of an issue may not be universally held
	Everybody has own assumptions and perspectives	Awareness that we all have our own assumptions and perspectives derived from personal situations and social contexts; which include, emotional, social, cultural, historical and political influences
	Aware that actions influence knowledge of others	Awareness that your actions influence the knowledge and perspective of others, and that these actions may in turn be judged through individual perspectives

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Actions	Re-evaluating how contexts influence interpretation	A preparedness to re-evaluate how your own and other people's context influences the information you and others find and how they interpret it; and potentially change practices on based of these insights
	Considering the influences on assumptions and perspectives	Considering the personal, emotional, social, cultural, historical and political influences on our and other's assumptions and perspectives; and adopting these insights into science communication practice
	Critically analysing underlying assumptions	Critically analysing underlying assumptions, expectations and positions embedded within your actions and experiences
May lead to:		
Reflection-in-action	The process of reflecting about an action and adjusting science communication practices in the moment of executing that practice	
Double-loop learning	The modification of strategies so that when similar situations arise a new approach is employed	

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3. METHODOLOGY

The RETHINK project has now entered its second phase: "develop & experiment". Therefore, the main aim of this research is to develop and experiment with strategies that enable a reflective practice for science communicators. Herewith, this research aims to contribute to a practice that opens-up and connects with the various sensemaking practices of citizens. To this end, the RETHINK project has asked science communication practitioners to together with the researchers of this study develop new approaches to science communication and experiment how these approaches work out in the practice of science communicators. Small-scaled experiments have been designed together with participants of this research, which were executed over the course of several weeks. This chapter details the methods used to develop and experiment with strategies to open-up sensemaking practices of citizens.

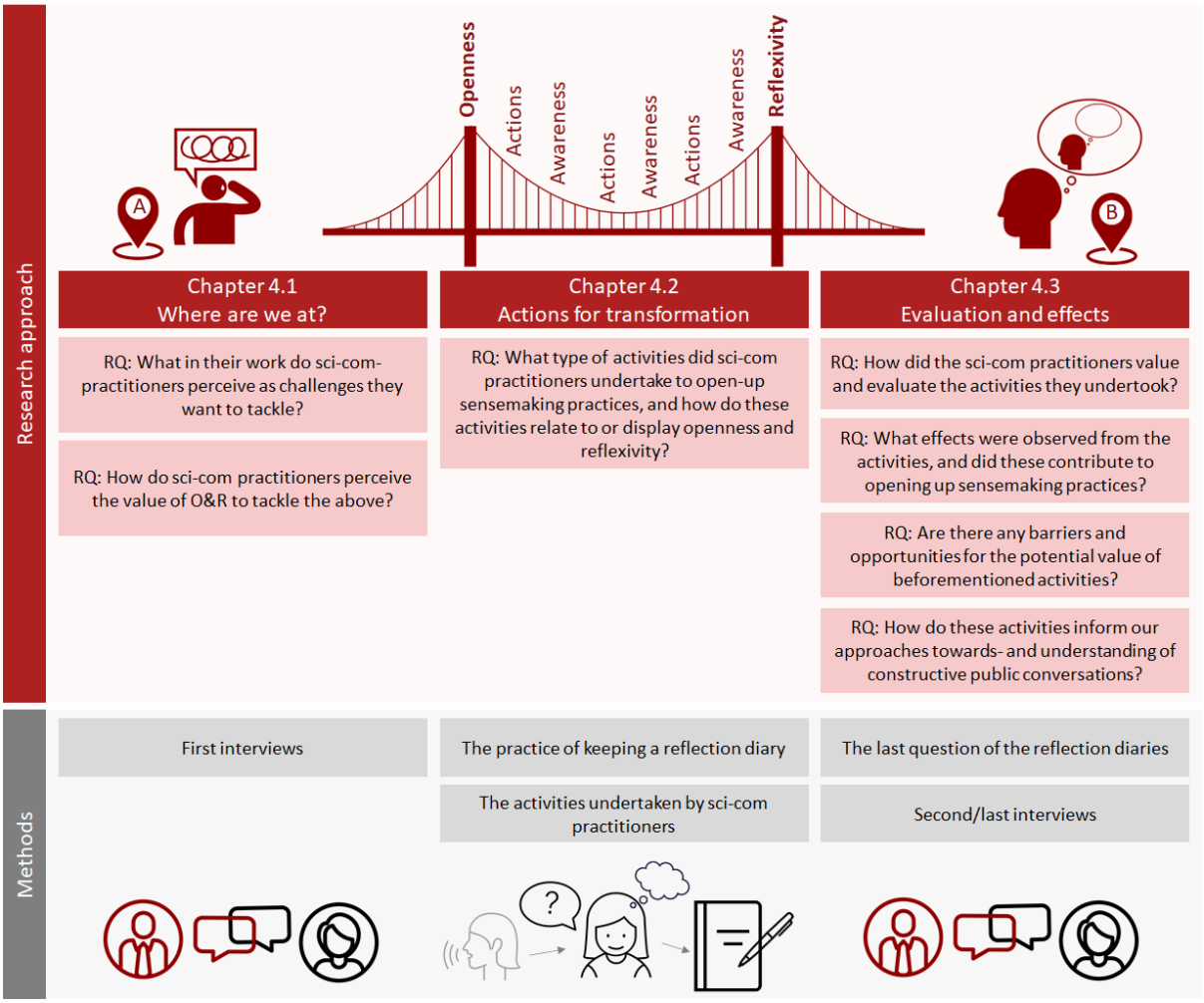

Figure 2: Overview of research questions, methods and corresponding result-sections.

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3.1 ACTION RESEARCH

This study will use an action research approach. Action research combines theory with practice and researchers with practitioners: research is performed simultaneously whilst taking action to tackle the problem that is at hand (Avison et al., 1999). As such, it is an iterative process consisting of multiple cycles of problem statement, performing an action and reflecting on that action and its effect on the initial problem (Avison et al., 1999). The action research approach can be seen in figure 2, in which the different stages of action research are visualized in an action research spiral (Kemmis & McTaggert, 1988; Peters, 2015).

3.1.1 ACTION RESEARCH PHASES

First, the reconnaissance takes place, in which a broad view of the issues and its characteristics is obtained prior to planning and implementation of interventions (Peters, 2015). Following the reconnaissance, a plan is designed by integrating and prioritizing the problem perceptions, opinions and ideas of different stakeholders. This action plan then is executed by stakeholders. Reflection on this action will then lead to a new plan and action - after which a new cycle will start (Peters, 2015). An action research approach is useful when the focus is on the practice of the study population in focus (Avison et al., 1999). The work of RETHINK focuses on developing new strategies for science communication practitioners to open-up sensemaking practices of citizens. In order to connect to the context and working practices of science communication practitioners, and to continuously adapt the scope of the research to the needs recognised in practice, an action research approach is helpful. Through continuous conversations and 'Rethinkerspace' workshops, these thematic concerns were discussed - i.e., the reconnaissance phase - where possible plans to deal with these thematic concerns were discussed. In the current RETHINK phase, i.e., the 'develop and experiment phase', we proceed to work out these plans and put them into action. Therefore, we now progress further through the action research spiral, as we: 1) address the thematic concerns; 2) discuss them together with science communication practitioners to come to reconnaissance; 3) together develop a plan for action for the practitioner to deal with the identified thematic concerns; 4) experiment with the developed plan; 4) observe how this plan works out in practice, and 5) reflect on what we can learn from the experience and revise the plan accordingly.

3.1.2 COMMUNITIES OF PRACTICE

In the RETHINK project, we have established seven communities of practice, with whom the action research is undertaken. These are the so-called 'Rethinkerspaces', which are established in seven European countries: Italy, the Netherlands, Poland, Portugal, Serbia, Sweden and the United Kingdom. Each Rethinkerspace consists of a heterogeneous group of approximately ten to fifteen participants,

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varying from science communicators, to science journalists, communicating scientists, policy makers and science enablers such as members of funding bodies. Herewith, the Rethinkerspaces act as testbeds and validation mechanisms for the strategies with regards to adopting openness and reflexivity in the practice of science communication - which makes them especially useful in the context of this study.

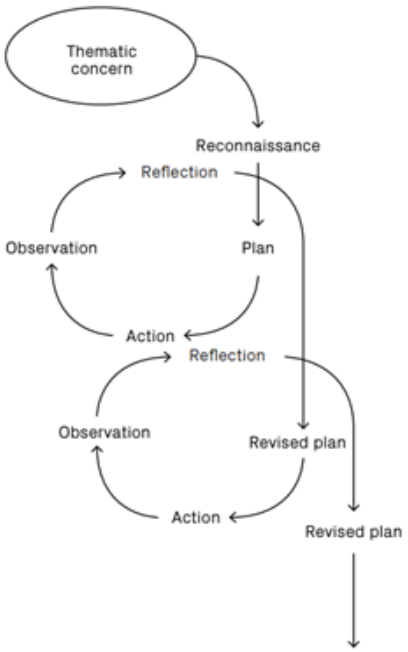

Figure 3: The action research spiral.

3.2 STUDY DESIGN

Previous research has identified several challenges for the practice of science communication. In this next phase, the RETHINK project aims to develop and experiment with strategies that address the identified challenges. In order to reach this, the VU research team, together with the Rethinkerspace members, first formulated the challenges that the 'experimenters' would like to address and secondly formulated a strategy that addresses the identified challenges, incorporating the idea of openness and reflexivity. Then, the Rethinkerspace member put the plan into practice to see how the developed strategy actually works out in practice. For this, we held an *open-ended interview* with Rethinkerspace members. Herein, challenges were identified, the idea of openness and reflexivity to deal with challenges were introduced, and a preliminary strategy was formed. Then, we asked Rethinkerspace members to experiment and fill in a *reflection diary* to keep track of the workings of the developed plan in practice. After the experimentations, we held a *second interview*, to draw out the value of openness and reflexivity for science communication practice and lessons learned. The details of this study design are further described here below.

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3.2.1 OPEN-STRUCTURED INTERVIEW: DEVELOPING STRATEGIES

With 24 Rethinkerspace members, in interview 1 we first discussed their science communication activities, their perspective on how they perceive their role as science communicator, and the challenges they encounter in their work. Secondly, we explored the value of openness and reflexivity for the practice of science communication. We did this by very briefly presenting the concepts of openness and reflexivity, and discussed if the Rethinkerspace member recognized these concepts in their work or maybe already practiced aspects of it. Subsequently, together with the members we explored ways to become reflective practitioners. We did this by introducing the reflection diary, and discussed with the Rethinkerspace member if they could think of communication activities they could undertake and reflect upon.

3.2.2 REFLECTION DIARY

During the two-week experimental phase, science communicators, including science journalists and communicating scientists, were asked to keep a reflection diary. Keeping a diary permits the examination of experiences in their natural, spontaneous context, thereby providing information complementary to that derived from interviews (Reis, 1994). Besides, diaries have a higher recall accuracy, as the minimum amount of time between an experience and the recall of it reduces the amount of retrospection (Bartlett, 1932). By reflecting on experiences in a diary, gaps between theory and practice can be addressed (Fonteyn & Cahill, 1998; Hancock, 1999). Moreover, transferring thoughts onto paper helps examining and analysing situations in a more objective way (Redfern, 1995). Lastly, constructing sentences to write down in the journal gives a certain degree of structure and accuracy to thoughts and recollections of events.

Participants kept a diary for a period of approximately 10 working days, wherein they could regularly reflect on their communication practices and interactions with their audience. Participants were asked to reflect and experiment with new communication practices for at least 6 hours. They also reflected on the experiment that has been constructed together with the researcher, and how this affects their practice. The diaries provide a permanent record of professional practice, which can be used to gain further insight at a later moment in the study. This helps collect well-considered and in-depth data (Travers, 2011). In the current research, Gibbs' (1988) model for critical reflection that has been described in the theoretical background was used as a basis for the reflection diaries. For each step questions have been formulated that fit the practice of science communicators. An overview of the questions in the reflection diaries can be found in Annex A.

In the first interview participants discussed with the researchers what challenge in their science communication practice they would like to face. If participants could not think of such a challenge,

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Rethinkerspace members were asked to reflect on past science communication activities they deemed meaningful or remarkable. For example, members may have seen a talk show on TV or read a news article that made them think about how science communication could or should be practiced. Lastly, participants were asked to reflect on science communication activities they had undertaken themselves that did not work out the way they expected. For these items together an approach or activity was designed that would include adopting openness and reflexivity in their science communication practice. With this, the reflection diary followed the framework of Gibbs (1988), which includes a cycle of six key stages: (1) describing what happened, (2) examining feelings and thoughts related to this, (3) evaluating positive and negative aspects of the situation, (4) analysing to make sense of it, (5) drawing conclusions about what else can be done, and (6) developing a personal action plan. In this study, science communicators went through these six stages by filling in reflection diaries. Doing so allowed them to reflect on their science communication practices and interactions with citizens.

3.2.3 SECOND OPEN-ENDED INTERVIEW

In this meeting, we discussed the experiences of Rethinkerspace members with filling in the reflection diary. Next, we discussed their ideas on the potential value of openness and reflexivity for their practice. Lastly, we asked for feedback on the reflection diary activity. This gave insights into the workings of the reflection diary, and the value of a reflective practice accordingly to the participants.

3.3 REFLECTIVE PRACTICE PARTICIPANTS

The goal of this study is to develop and experiment with strategies to open-up sensemaking practices. Because this research focuses on experimenting with new practices of science communication, it was important to include participants who felt motivated and capable to experiment and reflect for a minimum of six hours on their science communication practice. Therefore, we put out an open call for Rethinkerspace members to participant and experiment with us in this endeavour. Participants received a small remuneration for their experiments. Many different practitioners have many different ways in which they undertake science communication activities or hold many different perspectives on what practices work or work not in different situations and contexts. Therefore, it was important to gather as many different and diverse ways in which science communication practitioners experience their practice and see ways in which they could open-up sensemaking. This is why a wide diversity - and not representability - of participants was also strived after. A total of 24 participants were eventually included in this study, of which 6 were communicating scientists, 9 science journalists and 9 science communicators. An overview of included participants can be found in table 2. Participants were interviewed and conducted small-scaled experiments in the months of April, May and June 2021. 24 participants were interviewed in the first round of interviews. Three participants indicated they did not

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have time to continue to the experimenting phase, which means that 21 participants continued with experimenting with reflective practice and noted their thoughts on their small-scaled experiments in the reflection diary. Participants filled in multiple reflection diary entries, which led to a total of 79 science communication situations and activities on which participants reflected. The 21 participants who filled in a reflection diary were invited for a second interview, to reflect on their experiment and the use of the reflection diary. This led to a total of 45 conducted interviews of approximately one hour.

Table 2: Overview of participants.

#	Stakeholder category	Job description	Country	Gender
1	Communicating scientist	PhD student	UK	F
2	Communicating scientist	Senior researcher	PL	F
3	Communicating scientist	Associate professor	PL	F
4	Communicating scientist	PhD student	IT	F
5	Communicating scientist	Post-doc	PT	F
6	Communicating scientist	PhD student	PL	M
7	Science journalist	Freelancer	NL	M
8	Science journalist	Freelancer	SB	F
9	Science journalist	Freelancer	SB	F
10	Science journalist	Online magazine	SB	F
11	Science journalist	Freelancer	IT	M
12	Science journalist	Online magazine	PL	F
13	Science journalist	Freelancer	NL	M
14	Science journalist	Freelancer	PT	F
15	Science journalist	Magazine	PT	F
16	Science communicator	Community engagement officer	SE	F
17	Science communicator	Assistant press officer	UK	F

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18	Science communicator	Senior adviser external relations	SE	F
19	Science communicator	Senior communications manager	SE	F
20	Science communicator	Public relations officer	PL	F
21	Science communicator	Museum	NL	M
22	Science communicator	Museum	NL	M
23	Science communicator	Trainer workshops, R&D consultant	IT	F
24	Science communicator	Digital content creator	UK	F

3.4 DATA ANALYSIS

In total, 24 participants were included in this study. All participants filled in a reflection diary with multiple entries. All interviews were held via online video conferencing tools, audio recorded and transcribed verbatim. Interviews were conducted in English and lasted approximately 45 minutes. Transcripts of the interviews and reflection diaries were coded with the use of data analysis software ATLAS.ti. The data was first coded by using open codes and then further analysed by axial and selective coding. Axial coding was based on a coding book constructed with help of the theoretical framework as described in chapter 2.

3.5 ETHICAL CONSIDERATIONS

Prior to performing interviews, informed consent for data sharing and long-term preservation were asked to be filled in by participants. The informed consent form includes a section on the collection and storage of personal data in databases, a statement regarding the period of storage of data and possible use for future research. Furthermore, participants were informed that they may request data to be deleted when it has not already been used in publications. Moreover, it was made clear to participants that they are not subjects, but co-researchers, and that they can withdraw from the research at any time. Participants have the freedom to contact the interviewer for questions, concerns and remarks. No information that is confidential or sensitive in nature will be revealed, unless prior permission is obtained. The privacy of participants is protected by means of restricted access to the data and exclusions of personal and organisational details regarding their identities (data will be anonymised). These details are only known to the researchers of this project.

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4. RESULTS

This section will follow the same structure as described in the method section - with the aim to display the results in such a way that they highlight the transformational set-up of this research. Firstly, this section will detail "how participants came in"; i.e., what they view as constructive conversations at the onset of their small-scaled experiments, how they may already implement openness and reflexivity in their practice, and what challenges they encounter in their work to which openness and reflexivity may provide assistance. Secondly, this section describes the 'small-scaled experiments', or reflections on the science communication activities that participants undertook during this study, and their experiences with the use of reflection diaries to track the thoughts and reflections of participants. The last section provides the experiences of participants with adopting openness and reflexivity in their science communication practice to open-up sensemaking practices. In that section, the value of openness and reflexivity according to participants of this study are detailed and an overview of barriers, opportunities and future needs to adopt a reflective practice in the field of science communication is given.

4.1 "WHERE ARE WE AT?" OPENNESS AND REFLEXIVITY AT ONSET OF SMALL-SCALED EXPERIMENTS

Participants and researchers of this study met in a first interview to discuss the challenges that science communication practitioners experience – and what they deem important to tackle through openness and reflexivity. This initial insight of the science communication practitioners is influential for the further course of the experiences by participants. Therefore, the results below describe the openness and reflexivity of practitioners at the onset of the small-scaled experiments, or: "where is our science communication community at?". First, it details the experiences of science communication practitioners in facilitating constructive conversations. Secondly, it gives an insight into the perspective of practitioners on the possible use of openness and reflexivity in their practice.

4.1.1 SCIENCE COMMUNICATORS' PERSPECTIVE ON CONSTRUCTIVE CONVERSATIONS

Most participants agreed that in a constructive conversation both sides should be allowed to share their perspectives. Multiple participants explicitly mentioned that it is important to take the feelings and emotions of others into consideration. Participants mentioned that in constructive conversations you have to come to some conclusion together. With this, they stated that people do not have to agree, as long as one acknowledges that there are differences and make the differences explicit. For example, participant 11 mentioned that the science communicator should allow the person they are interacting with to express themselves as much as possible. Participants also found it important to find common ground to base the discussion on. Participant 12, a science journalist, jokingly mentioned that a

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constructive conversation is where she gets what she wants – therewith indicating that the perspectives and goals of the other should also be taken into account in constructive conversations. For example, participant 13 described that he prefers interactions wherein 'the other' respects his opinion.

> *"People do not need to take over my main message. But, I need to confess that in a constructive conversation I like it when someone takes my opinion seriously. Because, I have the feeling that on some topics I know more than others."* – Participant 13, freelance science journalist.

This participant added to be aware that 'the other' often is more focused on the emotional aspect rather than the informational aspect – and that this was often the basis of misunderstandings and, subsequently, less constructive conversations. However, most participants concluded that a constructive conversation is not about trying to *convince* the other of your own opinion, but rather about a pleasant *experience* for all participants in the interaction to find common ground. For example, some participants mentioned that a conversation is constructive when you learn something from it or it brings you insights - and that this goes for all participating in the interaction. This does not necessarily have to be knowledge. For example, participant 11 mentioned:

> *"It means that when you communicate, you do not only give, but you also receive. And sometimes it is this door, the receiving door, that is closed. That's when the conversation is not constructive."* – participant 11, science writer and journalist.

To this end, multiple participants expressed constructive conversations to have a two-way mode of science communication. Some participants expressed this as trying to understand what the other person wants or needs and what their goals are – in order to understand what 'the other' has to offer. Interestingly, most participants found it important, but also difficult, to find ways in which they can have meaningful interactions with their audiences.

> *"I thought that I was talking to my audience, but it turns out I'm not talking enough. I should ask more questions about what they want, and what they need from me and from my work."* – Participant 3, communicating scientist.

The reasons for the participants to (want to) seek two-way interactions were in most cases twofold: on the one hand, they found it important to better understand their audience and to give them the chance to interact and, on the other hand, the participants were very aware of how crucial it is to interact with their audience in order to improve their own science-communication activities. Therefore, they mentioned to actively seek for the value 'the other' can bring into the interaction. Yet, several also concluded that their science-communication activities normally remain in the domain of one-way communication and that they did not always know how to be really open to 'the other'. This was

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something that most participants indicated they wanted to address in their reflective practice experiments.

4.1.2 SCIENCE COMMUNICATORS' DISPLAYED OPENNESS AND REFLEXIVITY

The way in which participants talked about their perspective on constructive conversations highlighted that many participants already displayed openness and reflexivity *awareness* at the onset of the small-scaled experiments. For example, participants mentioned the importance of 'knowing your audience' and attributed two-way characteristics to constructive conversations. Only some participants mentioned they were aware of the knowledge of their audiences on topics involving science. For example, participant 9 mentioned to have noticed that *"audiences in Serbia are becoming more aware of the air, water and land pollution"* in their country – a topic this science journalist writes on frequently. Other participants took this a step further, when they mentioned being aware of audiences' goals, perspectives and stances in conversations about science. This indicated that participants were reflective towards their own perspective or stance as well as those of their audiences at the onset of this study.

Next to reflexivity awareness, also openness awareness was displayed by participants. For example, participants indicated that conspiracy theories are important to address in order to stop the spread of misinformation. Another participant mentioned that openness was important for mutual respect, for she mentioned:

> *"Openness means being open to each person. Some of those people in the audience are totally anti-science. And they are not easy to talk to. Though, I feel that being open is to ask questions to those groups and address their questions as well. Because they are representatives of society. They do have a right to ask."* – Participant 3, communicating scientist.

To this end, some participants mentioned to include information from a wide range of sources into science communication. Openness and reflexivity were perceived as valuable feedback mechanisms by participants in this study. For example, participants mentioned that by doing openness and reflexivity, they could gain more insights into their audience, and their values or ideas with regards to science communication outputs. However, participant 7 mentioned he accepted that he will not reach a substantial proportion of people, for he would not be able to comply with all individuals' perspectives or stances on scientific topics. This indicated that participants display open and reflective *awareness* with regards to the sensemaking practices of citizens, but did not feel they could always connect to audiences on basis of open and reflective *actions*. In conclusion, multiple participants indicated in the first interview that they reflect on their own work and their audience frequently, did not always know how to adjust their activities accordingly.

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4.2 ACTIVITIES UNDERTAKEN BY SCIENCE COMMUNICATORS

At the end of the first interview, the researchers of this study set-up small-scaled experiments together with participants. These experiments were tailor made to the situation, local context, challenges experienced by and interest of each of the participants – in order to see how openness and reflexivity works out in many different science communication practices and contexts. First, an overview of small-scaled experiments by participants is given. Secondly, the experiences of participants with the use of the reflection diary are described.

4.2.1 ACTIVITIES UNDERTAKEN BY SCIENCE COMMUNICATORS

Analysis of the activities undertaken by participants showed that participants thought of their activities to address practical insights into science-communication activities aimed at larger audiences as well as activities on a more personal level. Moreover, participants undertook different approaches or strategies to implementing openness and reflexivity in their practice. Participants undertook activities in roughly two categories: 1) specifically to find out more about their audience, with the aim to have more constructive or interactive interactions, by collecting feedback or input from audiences, and; 2) mentioned several conversational tactics that they explored through their small-scaled activities. These activities are presented in an overview in table 3.

COLLECT INPUT FROM AUDIENCE

Most participants felt feedback mechanisms for checking the science communicator's assumptions about their audience were lacking. Reasons for this were mentioned to be time constraints, an aspect of science communicator that practitioners simply would not focus on in their daily work, and the nature of the platform or dynamics on that platform would not allow for extensive interactions between practitioner and audiences. As such, participants wanted to focus on checking assumptions and finding out more about their audience in their small-scaled activity. One participant sent a questionnaire to the listeners of her radio show.

> *"I created a short questionnaire to better understand each listener's point of view on science, coronavirus and vaccines."; "My sister is worried about these things. So, from conversations with her I am able to kind of get that other perspective that often is not accessible to science communicators."* – Participant 1, communicating scientist, UK.

Other participants also actively asked for feedback on their science communication output and found this a good alternative when interactions online were lacking depth. Participant 8, a science journalist from Serbia, who wanted to include the opinions of her listeners when composing questions for the guests in her podcast. She therefore announced the topics and guests of the coming podcasts on its

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Table 3: Overview of conducted small-scaled experiments and reflection diary entries.

#	**Openness & Reflexivity activity**	**Reflection diary entries (example/illustration of reflection)**
1	Sent out questionnaire to podcast-audience for feedback, actively started conversations about sensitive scientific topics	Reflected on the insights and hidden assumptions that became apparent through the questionnaire on conversations
2	Engaged in online scicomm on a daily basis	Reflected on inclusivity of columns in academia, simplification of scicomm content to attract audience, and general reflection on scicomm practice.
3	Thought experiment	Reflected on speech and explored online tools to further quality
4	Practiced conversational strategies: (1) making explicit goals and objectives of communication instances; (2) preparing on potential emotions at play during future conversation	N.A.
5	Attended a scicomm event with the sole purpose to listen and recognize the value of that.	Reflected on the value of diversifying the communication media and general reflection on scicomm practices.
6	Conducted a TV interview on fake news & wrote a personal letter to a science sceptic person who responded to a social media post.	Reflected on an instance where a science communicator actively became a ‘person’ alongside their audience
7	N.A.	N.A.
8	Asked audience for input and questions for the next podcast	Reflected on the way their audience reacted to the request for participation.
9	Explored the value of openness and reflexivity through several activities, both conversational and in writing	Reflected on conversations with friends with opposing ideas on intelligence of women and vaccines, and on their own behaviour in that conversation, wrote an article on misinformation and explored mechanisms of conspiracy theories
10	Intended to write article with expert to address the most common sceptical comments	Reflected on conversation with friend who doubts vaccines, understood other perspectives and the value of asking questions.
11	Thought experiment	Reflected on the role of emotions in a Facebook conversation on toxic masculinity, and a surprising conversation about an experience of COVID recovery.
12	Intended to suspend judgement and interact with negative comments she usually ignored.	Reflected on the accidental publishing of an article with fake news, on a speech she gave where she purposefully acknowledged to not have studied science, and a

		conversation with editor on writing about climate.
13	Thought experiment	Reflected on conversation with partner, a Facebook conversation with a friend on coronavirus sources, and other conversations. Concluded that open and reflective should be her default mindset in conversations going forward.
14	Wanted to organise a debate about what a science communicator is	Reflected on potential of knowledge from different disciplines for scicomm.
15	Did the opposite of what she'd normally do: add personal perspective to communications, and talked to friends she'd usually avoid.	Reflected on different conversations she'd usually not have had, and valued the ability to have these conservations and their quality.
16	Thought experiment	Reflected on live tweeting during virtual conferences, on a conversation about the participants organisation, and on a career choice.
17	N.A.	N.A.
18	Thought experiment	Reflected on a professional interaction related to funding of scicomm activities, a meeting on delays in a project, a moderation role and value of reflection.
19	Thought experiment	Reflected on difference between live and online interaction for scicomm theatre, the difficulty of getting approval for scicomm endeavours in a specific experience, and the value of listening and effects of bias in experiences throughout scicomm work.
20	Thought experiment	Reflected on an unpleasant experience where the participant was accused of lying, and the reactions and emotions of scientists in a post on Facebook
21	N.A.	N.A.
22	Thought experiment	Reflected on a role he had to take in a workshop, and how his expectation of his role and the process in the session did not align with the participants.
23	Conducted workshops with lay people, doing hands-on and two-way communication and science experiments together with them.	Reflected how discussions about science should more often be contextualized with historical/sociological perspectives.
24	Asked early career scientists questions who follow her on Instagram	Reflected on the outcomes of the experiment to explore the openness of scientists

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Instagram page, openly asked if her audience had questions for her. Participant 24, a science communicator from the UK, set-up a small-scaled experiment into the willingness of scientists to be more personal about themselves, and how she could assist scientists to become more open. She asked her 10,000 early career scientists followers on Instagram about the level of openness they display in their communication activities. She also asked for feedback on the type of content her followers would like to see. Participant 9, a Serbian science journalist, wrote an article on how conspiracy theories are spread and why people believe them – and tried to include the concepts of openness and reflexivity in the process. Furthermore, participants mentioned that asking questions can be a way to understand how the audience makes sense of what is being communicated – for in this way feedback on outputs is received. As such, to many participants openness and reflexivity in the practice of science communication was perceived as an important way to check whether the assumptions made about audiences are correct. Also, it was viewed to function as a tool to get audiences engaged in the story and to connect the science-communication content to the audience's context.

CONVERSATIONAL TACTICS

Next to small-scaled experiments that focused on feedback mechanisms from audiences to the science communication practitioner, many participants experimented with openness and reflexivity by reflecting on previous conversations about science. These participants were interested to reflect upon their interaction pattern with audiences, and wanted to experiment with new ways in which they could have a conversation about science. Almost all participants reflected at least once on a conversation they had with family, friends or acquaintances, often about COVID-19 or the vaccine. Other topics that came up were the relationship between a Star Wars character and toxic masculinity, genome sequencing, whether women can be geniuses, and who 'holds the truth'. In this, participants reflected on the value that openness and reflexivity could bring in such conversations about science. For example, participant 13, a Dutch science journalist, included a telephone call with a 'citizen scientist' – and reflected on how he would have liked to have reacted now. Participant 12, a Polish science journalist, reflected on a moment when the website she works for accidentally published an article that included fake news. She also reflected on conversations she had with her editor about how to approach writing about climate change. Next to this were examples of participants who experimented with new forms of conversations, such as participant 9, a Serbian science journalist, who offered the audience the opportunity to ask questions during livestreams with experts and addressed the most common comments by climate sceptics in an article. Participant 10, a Polish science journalist reflected on a rubric regarding topics sensitive scientific topics, by asking the same questions to two academics with opposite opinions.

Participants mentioned they experimented with concrete conversational or writing tactics. For example, listening was mentioned. One participant participated in a science communication event with the intention to focus only on listening.

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> *"I participated as an observer. […] And I was like, well, this is one of the first times I'm hearing people. I'm not talking to them; I am hearing what they think. And it's really enlightening. […] And that was really an aha-moment for me, because I was like: OK, I'm listening to them and learning more about what they know and don't know. And perhaps this is one of the fundamental steps of communication."* – Participant 5, communicating scientist, PT.

With this, participant 5 indicated trough the small-scaled experiment they had learned more about their audience. Another example was provided by participant 9, a Serbian science journalist, who reflected on three different conversations with friends. After each reflection, she mentioned she got progressively more open to their perspectives and values. The first conversation she reflected regarded a discussion with friends, wherein one male friend agreed with the message of a book that women cannot be geniuses – therewith heavily upsetting the participant of this study. In the reflection, participant 9 realised that her anger may have affected the conversation for this had prevented an open and constructive conversation. In the future, she wrote, participant 9 wanted to be calmer in order to make space for understanding the stance of 'the other'. Participant 1 also tried to experiment with opening-up the conversation on difficult scientific topics, and specifically focused on the role of emotions in this, for she stated the following:

> *"I think that I have tried to change my approach when I introduced a vaccine-related topic [in my podcast] that debunks misinformation. I did this by first addressing where the hesitancy comes from, or the valid reasons why this could concern people, and only then going on to debunk the misinformation. Then, I tried to explain the science. I feel that people will be far more receptive to science if they feel as if their emotions are being acknowledged too."* - Participant 1, communicating scientist, UK.

Reflecting on such communication situations made participants realise that they are not always as approachable as they thought. For example, participant 9 mentioned this experience provided her with the opportunity to clarify to others that she is learning to be open to new information, hearing different points of view, and that she is considerate of their opinions and feelings. As such, some participants connected the act of listening and opening-up to new perspectives, with the ability to inhibit automatic reactions. It also shows that the reflection diaries enabled participants to not only reflect-on-action, but also reflect-in-action.

4.2.2 EXPERIENCES WITH THE USE OF REFLECTION DIARIES

All participants made use of a reflection diary to keep track of the small-scaled experiments they undertook in the context of this research. Some participants described their perspective on the value of

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using the reflection diary for their science communication practice. For example, participants indicated that taking notes of interactions or thoughts they had during the creation of science communication activities really helped to structure their thoughts and to get insights into their audiences.

> *"Sometimes I have the feeling that something is completely obvious, but it's starting to be obvious only after you write it down. So, writing in this journal made me see this stuff in a different light."* – Participant 2, communicating scientist, PL.

Some participants noticed that as they filled in more entries in the reflection diary, they also started to reflect more *during* science communication activities. For example, participants mentioned that the reflection diary facilitated active reflective thinking, which helped them to listen and take opinions that were different from their own into consideration. Other participants mentioned they reflected more in the moment, for example when they remembered the reflection diary questions and were able to bring these into the conversation. Participants 10 described this as follows:

> *"The reflection diary helped me to think one step further. I had to consciously think about what happens on a daily basis in the interactions that I have through work. It showed me that we are poorly informed and disabled by our own thoughts and emotions about topics and people."* – Participant 10, science journalist, PL.

However, not all participants found the reflection diary useful, for they felt it took too much time or because they had not encountered noteworthy science communication interactions to reflect on. The level of depth induced by the reflection diary also differed. For example, as participants still displayed assumptions about their audiences, the reflection diary was not always successful in challenging those. As such, it was found that even though participants reflected a lot on their activities, and some even in the moment of the communication activity, it still proved hard to get to the underlying assumptions, stances or worldviews that lay to the basis of the misunderstanding or conflict in the science communication situation.

4.3 EVALUATION AND EFFECTS: THE POTENTIAL OF OPENNESS AND REFLEXIVITY IN OPENING-UP SENSEMAKING PRACTICES

This last section aims to address the experiences of practitioners in becoming reflective practitioners and tries to draw a link between the small-scaled experiments undertaken by practitioners in opening-up sensemaking practices. This section focuses in on the overall evaluation of participants on taking part in this research, what they learned from reflecting on their science communication practice, and what facilitates or hampers becoming a reflective practitioner. It details the experiences of science communicators in opening-up sensemaking practices of citizens and the workings of openness and

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reflexivity herein. Lastly, this section describes future needs and advises that participants of this study have indicated to the researchers.

4.3.1 VALUE OF A REFLECTIVE PRACTICE FOR SCIENCE COMMUNICATORS

In the second interview phase, participants described their reflections on the value of openness and reflexivity for the practice of science communication. Participants mentioned they engaged in activities and behaviour patterns of which they were previously unaware – and did so by temporarily postponing their 'usual' science communication objective. By filling out the reflection diaries, most participants started to see the reactions from their audiences in a different light, which participants said to have previously been taking for granted or assumed to be true. For example, communicating scientist from the UK wrote in her reflection diary the following:

> *"These conversations have been really challenging but have helped me to improve my patience in communicating divisive topics in science. It has taught me to not be too defensive and to listen to people's points before responding. […] It gave me a better insight into the types of myths that are being communicated to cynics. This has allowed me to adapt my own practice and to better understand what could appeal to those tricky audiences."* – Participant 1, communicating scientist, UK.

As such, participants indicated that the reflective practice enables science communicators to navigate through difficult topics, by recognising their own stance whilst also giving space to other opinions and perspectives. For example, participant 11, an Italian science journalist, realised that science communicators often think they have the right ideas and perspective in mind. As such, in the second interview he was convinced that people who communicate about science should be prepared to revise their own perspectives, for the reflective practice gave him new insights into his own stance and those of his audiences – which made him see that his own stance was not always universally held. Still, he indicated that whilst he was very aware of emotions being an important part of conversations, in his personal conversation he found it difficult to involve these while keeping to the facts. Related to emotions was the reflection of participant 1, who mentioned the reflective practice assisted in dealing with emotions. She reflected on the period before the corona pandemic and compared this to her reflection on her science communication practice now, after having done the small-scaled experiments.

> "*I try to acknowledge [emotions] before telling people all the information. For example, previously I acknowledged there's an infertility anti-vax rumour going around, but that there is no evidence [to support that]. Now I realise that to those women that is terrifying. So, now I try to not go straight to the scientific information and first acknowledge that fear, and talk about why people are scared of this. And then the*

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> *reasons how and why this conspiracy about vaccines and infertility has come about. (…) I could have easily been dismissive of vaccine hesitant people and let my emotions lead the discussion, whereas now I always try to approach with empathy. (...) The frustration that many scientists and science communicators feel bleeds out into the interaction, and I think that risks further alienating the audience from science*". – Participant 1, communicating scientist, UK.

This participant mentioned that the reflective practice enabled her to see the people behind the hesitancy, and by keeping an open mind (empathy, emotions) whilst also reflecting on her own stance (scientific perspective, ratio) she was able to navigate through this difficult interaction. Other participants also mentioned reflective practice can help science communication practitioners to facilitate constructive conversations about science. For example, participants mentioned how finding common ground, through adopting openness and reflexivity, had helped them in facilitating constructive conversations on science. Connecting to the sensemaking practices of citizens was an important aspect in this regard – as is illustrated by the following quote:

> *"I think it's not a good thing that I was disappointed to see him vent his doubts. I would associate such doubts with conspiracy thinking. But those doubts don't make him a conspiracy theorist. I realised he was being vulnerable and open to input, and that made my perspective change. (…)Maybe the assumption I had was not strange, but it wasn't productive either."* – Participant 2, science journalist, PL.

In this quote, participant 2 explains that once he realised 'the other' in the interaction was actually vulnerable in expressing his doubts, and open to input, they could understand each other more – which made them have a positive experience. It meant that the interaction was no longer on disputing the facts, but on the underlying emotions and values that were present in each of them. Another participant also mentioned connecting to the underlying values and emotions, which see saw as the starting point for a constructive conversation:

> *"I know that parents who don't want to vaccinate their children are not bad parents. They are scared that something will happen. So, for me, the baseline here will be that we all want to have healthy children. We agree on this. And when we have this agreement, it's easier to start the conversation. And then I think the next step is to ask questions."* – Participant 2, communicating scientist, PL.

Related to this, multiple participants mentioned that the personalised approach that a reflective practice brings, empowers the communicator to tailor-fit their science communication activities to audiences. Other participants mentioned that the reflective practice experiments helped participants find topics to write about and suitable ways to approach those topics. This was connected to being more open to the

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perspective of audiences, for there would be more space for mutually asking and answering questions. One participant said it can even help scientist communicators to better understand their own thinking and feeling as well. Thus, it much better allows for mutual understanding of how both science communicators make sense of the issue at hand.

> *"It's much easier when you can debate with someone else what you are thinking about or feeling, because I feel when I have the chance to check [my ideas or feelings] with someone it is more enriched."* – Participant 14, science journalist, PT.

The participants are often mentioned to have encountered people that propound falsehoods, fake news, conspiracy theories or misinformation. It appeared that it is much more effective to deal with this during a conversation than through communication channels aimed at larger audiences. It was emphasised by multiple participants that one shouldn't immediately attack or contradict false claims, for people always have their reasons to believe something. Hence, it was perceived to be more constructive by participants to inquire about *why* their audience believe that, what values and emotions lay to the basis, and next, to take those reflections as the starting point of a conversation. For example, participant 13 described this as follows:

> *"What I could adopt for future encounters is the idea that being open and reflective should be the default mindset. It helps to shed a light on the personality behind the doubts and questions, instead of all the associated characteristics that may or may not be present in someone."* – Participant 13, science journalist, NL.

Additionally, the reflective practice experiments did seem to lead to reflection-in-action and double-loop learning of participants. For example, participant 1 actively thought about his audience's feelings and changed his actions based on that (reflection-in-action), for she mentioned:

> *"The whole reflection process is really helpful for thinking about what I could do better, or find ways to adapt my practice"; "I think I was able to approach people in a way that made them feel they could really tell me the truth."* – Participant 1, communicating scientist, UK.

With this, participants highlighted that reflective practice helps in connecting to audience's underlying values and emotions; and not only base one's perspective on audiences on assumptions which sometimes are hard to check. As such, it became clear that participants, with help of the reflection diary and experimenting with openness and reflexivity, were better able to view their own science communication activities in relation to their role – and therewith connect to the various ways in which citizens make sense of science.

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4.3.2 FACILITATORS AND BARRIERS TO BECOME A REFLECTIVE PRACTITIONER

Many participants expressed they liked doing the reflective practice assignment and found it helpful – although challenges were also mentioned. For example, actively thinking about and nothing down reflections on science communication activities was sometimes perceived as challenging. Many participants mentioned that it took a lot of work to fill in the reflection diary, especially as they felt some of the questions in the diary were similar. Time constraints were therefore mentioned as the largest barrier to deploying a reflective practice in their science communication activities. On top of that, scientists are often active as science communicators in their free time. This means they already barely have the time to engage in the communication itself, as participant 4 mentions:

> *"I find myself moving from one meeting to another without the time to even think about what we just said. The [academic] system does not give us the time to think about what we did and how we communicate."* – Participant 4, communicating scientist, IT.

This seemed to be mostly related to the academic system, for more communicating scientists mentioned their organisations do not value the communication activities they engage in. Often, it is not part of their job description nor daily work, and they are seldom remunerated for their communication activities. Lastly, participants frequently expressed that it is difficult to motivate the audience to engage with their science communication output, or to respond to requests for interaction. Moreover, one participant said that even when some of audiences responded, the responses were too diverse. This made it nearly impossible to actually integrate all responses into the communication activity in a satisfying manner, for he mentioned:

> *"The answers of four people [to questions posted on social media] were completely different. So, it is also not easy to combine them together and to create one coherent answer. Therefore, I think it is really difficult to be specific for some audience's needs in articles that you are creating for a wider audience."* – Participant 2, communicating scientist, PL.

Facilitators that stimulated openness and reflexivity included that both persons involved in the conversation should feel comfortable or relaxed. Herein, participants indicated that it may help to adopt openness and reflexivity when people just start with these concepts when the people interacting are acquainted. Having had earlier conversation with that person about the same topic before as well as knowing the other person is open to your opinion also stimulated openness and reflexivity – for people indicated to already know *"where the other person is coming from"*. Furthermore, the right environment, setting, and starting point of the conversation also helped in adopting a reflective practice. Lastly, things that contribute to reflective practice are actively trying to be more approachable and experiencing reciprocity of openness and reflexivity in the interaction.

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4.3.3 DEVELOPING A REFLECTIVE PRACTICE FOR SCIENCE COMMUNICATORS

The findings also note how some participants have specific requests and ideas for future insights in order to help to pursue the exploration of how to facilitate constructive public conversations on science. Some participants mentioned it is important to make people who communicate about science aware that they should learn how to be more patient, listen to the other side without being judgmental, and try to understand the background that person comes from. This will also help them to better explain themselves while being respectful of others' beliefs and experiences, being careful with what they bring and in providing evidence. Specifically, participant 12 stated that:

> *(…) science journalists could use a lot less antagonism. We should force ourselves to be humbler and keep the perspective of 'a normal person'."* – Participant 12, science journalist, Pl.

Participants mentioned reflective practice should be frequently implemented, for example, by once a year taking a day where science journalists meet with colleagues, talk about situations that occurred (possibly kept in a diary) and discuss how others would have dealt with it. Participant 11, an Italian science journalist, said that in the future he would probably not always ask himself exactly the same questions as in the reflection diary, but would prepare three or four points to break down a communication situation. This would allow him to more easily see if he still has the same opinion as before.

Other ideas for implementing reflective practice concerned training and education. For example, participant 8 elaborated on some ideas to train people who communicate about science in dealing with opposing opinions. One of these was setting up virtual safe spaces in which people can share their views anonymously, as this makes them more willing to share their opinions. Exercises could be performed there, for instance: letting two people debate and afterwards write about the other's standpoints to see if they understood their perspective. Role play and use of actors was also mentioned. To this end, participant 13 emphasised that it is important to learn how to induce openness and reflexivity in the person you are talking to, as the outcome of the conversation also depends on them. According to him, this could be done by a sharp way of interviewing and by asking if someone is willing to adapt their point of view given the newly brought-up information. It was mentioned that changes in the education system could help people better understand science and the communication about it. Lastly, with reflective practice, participants saw opportunities for people who communicate about science to sometimes step out of their role as a communicator and talk more from their own perspective as a human being when trying to reach their public.

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5. DISCUSSION

The overarching aim of this research was to find strategies that would enable science communicators to open-up sensemaking practices of citizens, in order to facilitate constructive public discussions on science. This research sought to engage science communicating participants in experiments where they explored ways to adopt reflexivity and openness in their communication practices. This research aimed to answer the main research question: *How can the nurturing of openness and reflexivity in the practice of science communication enable practitioners to open-up sensemaking practices of citizens?* In the following section, we will describe strategies to a reflective practice for science communication in an attempt to open-up sensemaking practices of citizens and discuss these in the context of the wider science communication system. Lastly, we will conclude by providing some implications for the practice of science communication and our ideas for future research.

5.1 DISTILLING STRATEGIES TO OPEN-UP SENSEMAKING PRACTICES

Throughout this research, we learned that the participants displayed open attitudes and actions to a large extend, such as the being aware of the importance to listen carefully to 'the other's' perspective and including multiple perspectives in their science communication practices. Likewise, they displayed a level of reflexivity, for practitioners already explored and thought about their science communication activities, and sought for ways to improve their practice. Participants mentioned that constructive interactions entail science communicators to listen, respect, have a focus on two-way mode to science communication and should try to understand where 'the other' is coming from. With this, participants displayed openness and reflexivity *attitudes* at the onset of this study. One critical note that can be placed with regards to the double-loop learning displayed by practitioners is that there is a difference between the *espoused* versus the *enacted* openness and reflexivity awareness and actions displayed by practitioners. In other words, participants may have thought they were very aware of and accordingly openly and reflectively acted upon their underlying values, emotions and perspective with regards to the interactions they had with audiences; but in reality, these might not have been deployed or executed in the same way. For example, participants mentioned at the onset of this study to already engage in dialogue and highly value activities focused at two-way modes of communication. On multiple occasions they indicated to be aware of the need of and value appointed to the shift away from deficit-thinking and towards more interactive modes of science communication. In reality, in some occasions, there were indications that practitioners acted upon previously acquired thoughts about their audiences and one-way perspective with regards to science communication. This can be explained by the fact that practitioners actively sought to engage in the small-scaled experiments with openness and reflexivity after the researchers put-up a call for participants – and therefore already had a pre-existing idea with regards to the value of these concepts. Moreover, the participants in this study are Rethinkerspace

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members, meaning they are engaged in the RETHINK project for over two years and as such already know the terminology used and narratives with regards to desired science communication modes in public discussions on science deployed in this project.

In the first interview, participants indicated it is challenging to receive feedback on their science communication output from audiences. Naturally, knowing your audience is crucial if you want to be open to their values or perspective and adapt your science communication practice accordingly. As such, participants described they found it hard to deploy open and reflective *actions*. Therefore, many participants mentioned they wanted to get to know the values, perspectives, emotions and ideas present in their audiences in more detail, and designed reflective practice experiments that would provide these insights. Roughly two categories of small-scaled experiments were deployed: 1) seeking feedback from audiences on science communication outputs, and; 2) trying-out conversational tactics that involved openness and reflexivity. Small-scaled experiments mostly involved receiving feedback from their audience – for example in the form of an open conversation or conducting a questionnaire. Moreover, they involved several conversational tactics, such as focussing on listening to the other whilst postponing one's own judgement, and the incorporation of emotions in addition to facts into interactions about science. The reflection diary was mentioned to be very valuable in keeping track of and structure the progress and learning opportunities during these small-scaled experiments.

The activities that participants undertook to enhance their openness and reflexivity, were evaluated to be valuable to the practice of science communication in general as well as benefitted individual practitioners. For instance, the reflection diaries and small-scaled experiments helped practitioners to become more aware of their own underlying assumptions and feelings at the root of communication practices. Participants mentioned to have a better understanding of the perspective and emotions of audiences, knew better how to adapt their science communication activities accordingly, and found new inspiration for activities or topics to explore in their future practice. In this, participants mentioned explicitly to have learned to listen better, postpone their judgments about 'the other' and to find underlying values and emotions present in interaction partners in order to find common ground.

This research identified strategies that open-up sensemaking practices with the help of openness and reflexivity. Firstly, participants found that with reflective practice *the topic of the conversation can be shifted from the statements or scientific facts where a controversy arises, towards a search for common grounds or conversation about the underlying values or emotions involved in the interaction.* Here, it is important to note that interactions not only concerned dialogues or face-to-face interactions, but also includes one-way or dissemination activities. This was for example seen when participants experimented with open and reflective ways of writing or conversing about science, wherein they aimed to open-up the black box regarding emotions and underlying values which practitioners found present in their audiences. Secondly, and with regards to opening-up sensemaking practices and facilitating

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constructive public discussions on science, another thing mentioned by practitioners was that *connections between practitioners and audiences were intensified and experienced as more constructive*. For example, practitioners mentioned a reflective practice proved valuable to gain insights into one's own values and emotions as well as those of audiences, which gave practitioners the insight they often had similar feelings or were capable to show empathy to the audiences they intend to reach. As such, they felt reflective practice was valuable in bridging or blurring the boundary between science and society, by complementing their 'voice of the scientist' with the 'voice of the citizen'. This enhanced a proximity to 'the other' person or audience, a proximity that was found to alleviate certain obstructive effects encountered in discussions on science. Lastly, *the small-experiments helped practitioners not only reflect on their science communication activities, but also assisted practitioners in becoming reflective practitioners in the moment of interactions.* With this, this study contributed to reflection-in-action and double-loop learning. Multiple participants indicated this enabled them to reflect on their own stance and that of 'the other' and accordingly could adapt their activity or interaction whilst it happened – another attribute of the small-scaled experiments that likely contributed to practitioners connecting to and opening-up sensemaking practices of citizens.

5.2 KEY OBSERVATIONS

THE VALUE OF A REFLECTIVE PRACTICE FOR SCIENCE COMMUNICATORS

The science communication ecosystem has become fragmented and complex, for example by the increase in new players involved in the public discussion on science – all with their own values, emotions and worldview when it comes to scientific information, knowledge and expertise (Roedema et al., 2020; Wynne, 2006). Science communicators play an essential role in providing society with scientific information and moderating public discussions on science. Yet, due to challenges present in the current science communication ecosystem it is increasingly difficult for practitioners to facilitate a constructive conversation about science. For example, science communication practitioners need to check and gatekeep the quality of scientific information that enters society in an ecosystem where misinformation is spread, people reside in their own 'echo-chambers', and scientific expertise is publicly questioned (DelVicario, Bessi, Zollo, Petroni, Scala, Caldarelli & Quattrociocchi, 2016). In addition, this asks from science communication practitioners to focus on public engagement with science in which practitioners not only report on scientific facts; but offer syntheses, contextualise knowledge to the personal situation and social context of citizens and assist individuals in their sensemaking process on science. In other words, in the complex and fragmented science communication ecosystem and due to the wide variety in which citizens make sense of science, it is important that science communicators find ways to open-up the conversation about science and strengthen the conversations that already take place in society.

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In public discussions on complex problems where multiple scientific, political, economic, cultural and ethical disciplines are involved, controversies often do not arise due to a disagreement on the (scientific) facts. However, in public discussions on science and in the field of science communication, it is still observed that many times the experts restate the facts – mimicking the well-known habit of deficit-thinking. Simis et al. (2016) discussed several reasons for this phenomenon. One important factor might be that rational and objective thinking are inseparable from academia and scientific practice. Scientist are trained to deal with information in a rational way, and in such a system, knowledge seems to stand above other emotional or relational manners to process information or certain issues (Simis, Madden, Cacciatore & Yeo, 2016). This might also explain why most practitioners found it easier to define what other science communicators need to do, rather than what they themselves need to do. Besides that, if they do intend to connect, the "lure of rationality", as Simis et al. (2016) call the risk of falling back into deficit-thinking, might also be an explanation for the imbalance between scientists intended role in science communication, and their subsequent repertoire, as described by Roedema et al. (2021).

Yet, aligning one's role, perspective on science-society interactions and subsequent repertoire might enable more constructive conversations about science (Roedema et al., 2021). Thus, as this study has shown, there seems to be a collective call and recognition of the need to engage in cross-perspective connection, besides perspective persuasion. It is our belief that science communication should move away from public conversations about the scientific facts *only*, and instead *include* or add a conversation about the values, sensemaking practices, worldviews and emotions that often lay to the basis of misunderstandings or disagreement. A reflective practice is essential in this sense, for reflexivity is described as "holding-up a mirror to one's own activities, commitments and assumptions, being aware of the limits of knowledge and being mindful that a particular framing of an issue might not be universally held" (Chilvers, 2013). This study proved to be highly valuable in its aim to experiment together with science communicators practitioners on *how* such a reflective practice could look like for the field of science communication, and the value hereof for public discussions on science.

The biggest advantage practitioners mentioned was that a reflective practice enabled them to feel better equipped in connecting to the underlying values and emotions of their audiences, for the focus on openness and reflexivity gave in-depth insights into the perspective citizens had on science communication activities and output. Through experimenting with openness and reflexivity, practitioners seemed to open-up the sensemaking practices of citizens and contributed to positive experiences and constructive conversations about science. Two aspects of the small-scaled experiments and reflection diaries seemed to have induced this effect: 1) Double-loop learning gave practitioners an awareness of their own underlying perspective, values and emotions regarding science-society interactions, therewith enabling practitioners to adapt their practice accordingly to what was desired by citizens, and; 2) reflection-in-action gave practitioners the chance to reflect in the moment of science

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communication activities, which led to the opportunity to immediate experiment and implement a newly thought-of practice. As mentioned by practitioners, often they got new ideas for science communication outputs or activities, and practitioners indicated to have received positive responses from their audiences – which gave both parties the feeling they connected to their audiences in new and constructive ways.

UNLOCKING THE POTENTIAL OF REFLECTIVE PRACTICES

With this, this study observed that science communication practitioners experienced the value of second-order thinking and double-loop learning. However, practitioners also indicated that experimenting with openness and reflexivity led to new worries. For example, some practitioners mentioned it was challenging to protect their and scientists' expertise in moments when they actively tried to open-up to the ideas and insights of citizens. In some occasions, for example, citizens would not agree with scientific facts of which the science communicator knew they were valid. It was in those moments that science communicators mentioned to feel the need to defend science and scientific expertise, in order to prevent the scientific value of their output to go to waste. Here, the types of learning and thinking by practitioners play an important role. For example, beyond seeking what actions can be altered to improve the results (which is a rough description of single loop learning), it's sought after what assumptions cause these actions to take place and to explore whether these assumptions may require revision as well (i.e., double-loop learning). Single-loop learning would mean exploring whether listening more often in communication efforts would make a positive change, and if proven right, the practice of listening would be enhanced. In double loop learning, this reflection would be complemented with the questioning of why one did not intuitively listen in the first place; what assumptions or perspectives are the root causes of that signalled behaviour, what other behaviours stem from those assumptions, and should I see whether those assumptions still hold true? In this study, practitioners extensively experimented with structuring thoughts and assumptions about themselves and audiences, therewith experimenting with double-loop learning and second-order thinking in their practice.

Yet, even when practitioners realised that their differing opinions or disagreement on the scientific facts could originate from different sensemaking practices, personal situation, or social context; still, they did not always feel capable to deploy a new strategy nor did they know what direction or focus such a strategy should have. This points to the need for third-order thinking and triple-loop learning (Irwin, 2013). In such a framework, practitioners could ask themselves the question: "Do I use the appropriate science communication model to accompany for goals that I have set, the perspective on science-society that I have, and the activities that I undertake? Do I ask the right questions? And how can I find out?"

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5.3 IMPLICATIONS AND FUTURE RESEARCH

Opening up sensemaking practices is a process of importance in the current complexity of the world. During this research a high variety of activities were initiated and analysed, and in this deliverable we made an early start of describing how these activities combine into the strategies that open up sensemaking practices. What's more, the reflective practice and exploration of openness was evaluated as significantly valuable by the participating science communicators. Participants stated their efforts during this research had beneficial effects on their communication activities and in connecting with their audiences in a more profound way, and many shared that they would like to continue with experimenting with reflective practice. Therefore, in order to help out science communicators in these efforts, more tools and exemplary practices can be created, and are requested by the science communication community. This contribution is what the last phases of the RETHINK project will strive to work for.

A specific focus may be laid upon seeking ways to, together with practitioners, develop best-practices that enable single, double and triple-loop learning. It should be noted that these types of reflection take a lengthier process of change, and therefore also requires more structural changes within the practitioner as well as the science communication system. Moreover, it was observed that these types of questions often did not come to mind in participants of this study during filling in the reflection diaries but on some occasions were asked during the interviews. This indicates that in order to come to third-order thinking more easily or frequently, it might help to discuss and brainstorm over such questions with colleagues, friends, or science communicator's audiences. In conclusion, in our work with the RETHINK project and in trainings or workshops aimed at science communicators, perhaps the discussion of what we aim to achieve through science communication, and asking ourselves if we ask the right questions, should take a more central stage in our reflective practices together. When one truly wants to connect to and open-up sensemaking practices, we need to find ways to help these practitioners reflect and review their intuitions, assumptions and habits, and see how these dimensions link to activities deployed. This is a lengthy and ongoing process. It is therefore that we highly recommend to start experimenting with becoming a reflective practitioner yourself – and you can do so by keeping track of your ideas and learning points for the future in the reflection diary provided in Annex A.

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RETHINK #scicomm

Reflection diary

Personal information

Name:

Country:

Profession:

Instructions

Please use this reflection diary during the two weeks that follow our first meeting. You can either print it out or fill it out digitally.

This diary is intended to encourage you to reflect on your science communication activities and enable you to make in-action adjustments to those activities in the future. Furthermore, it is a tool to keep track of your experiences with facilitating openness and reflexivity of public dialogues on science. *Your entries in this diary will be processed as anonymised data and analysed for the purposes of the RETHINK project*. For this, you have provided us with your written consent.

We kindly ask you to fill out this diary at moments when you are engaging in a common, interesting, or otherwise relevant science communication activity, or whenever a notable situation occurs that you think might be relevant. We have created eight entries, each consisting of six different questions. If you need more, you can create new entries yourself. If you don't need all eight, that is fine as well.

Please take your time to answer the questions with attention. This may take some effort, as critically reflecting on your own actions and assumptions is not always easy and may even be confronting. However, please know that **there are no wrong answers!** The main questions in **bold** should be answered in detail; the questions in *italic* are intended to guide your reflection.

If you have any questions or experience difficulties, please don't hesitate to reach out to us.

Thank you for your time and effort.

On behalf of the RETHINK team,

[redacted]

Reflection diary entry #1

1. Describe the communication situation.
What happened? What communication activity were you doing and why? What was the topic? What medium did you use? Who was the audience and what did they do? What was the outcome of the situation? What went right? What went wrong? You may add any screenshot, picture, drawing etc. that helps you better describe the situation that you found yourself in.

2. What were your feelings and thoughts during this situation?
What did you feel before, during and after the situation? What do you think other people involved in the situation were feeling? What did you think during and after the

3. Why do you think you experienced these feelings and thoughts?
What was positive and/or negative about these feelings and thoughts? Why did you experience these as positive or negative? What assumptions and expectations did you

4. How could your feelings, thoughts and assumptions have influenced the situation?
Were there thoughts, feelings or assumptions that affected your actions? How did your expectations influence the situation and your actions? Were there thoughts or assumptions you came to find were not (totally) accurate?

5. What could you have done differently? Or: did applying the new approach help you move past the situation?
What helped you? What didn't?

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6. Describe how you would approach a similar situation in the future.

Would you use the same approach or is there something you would do something differently? Does the approach need to be adapted? If yes, how?

Additional comments

Any additional thoughts or revelations can be written down here.

5

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