

***Mutual learning on opinion-forming activities aimed at public engagement in synthetic biology***

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# *Mutual learning on opinion-forming activities aimed at public engagement in synthetic biology*

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## **Abstract**

Synthetic biology (Synbio) is an upcoming techno-scientific field in which new biological systems can be designed and created by humans. This new field is prone to become a socio-scientific issue about which stakeholders and the public should engage in a dialogue. To have a meaningful dialogue all participants need to have access to factual and personal information (i.e. the values and underlying notions that frame the way a person looks at an issue). Frame reflection can help a person explore their own and others' underlying values and notions. In a workshop initiated by the EU participants were trained in the techniques of frame reflection. This research evaluates that workshop. Frame reflection seems to be a lengthy process but even in a 2 hour workshop steps can be made by having participants ask each other follow up and digging deeper questions in small group settings. It is important that the participants are thoroughly guided through concrete examples of types of questions they could ask.

## **Introduction**

Synthetic biology (Synbio) is an upcoming techno-scientific field in which new biological systems, such as proteins or even complete organisms, can be designed and created by humans (Venter, 2008) . Where in Genetic Modification (GM) the basis of a new biological system always laid in an existing biological systems, in Synbio one can design any biological system from scratch, giving rise to endless possibilities and applications (Garrett, 2013). This new practice however is not without controversy. As with GM researchers, policymakers and the public will need to decide, together, what will and will not be allowed in this field.

The experience in the GM debate tells us that this is not so easily done. Public reactions towards GM have at times been hostile. Scientists concerned attributed this to a lack of understanding in the public when it comes to the science of GM and the concept of risk. Government and scientists therefore concluded they needed to communicate more, and more clearly to the public, which they interpreted as 'explain' more to the public (Cook, Pierri and Robbins, 2004). This strategy has clearly not worked as well as they had hoped.

Consensus now is that to decide boundaries in how to apply Synbio all stakeholders will need to come together and have a dialogue concerning the desirability of various applications of Synbio. In this dialogue scientists will not only explain their work but also listen to the wishes and concerns of members of the public.

To enable a constructive public dialogue all stakeholders need to be informed. This means the public must have access to all the factual information concerning Synbio, but also means the public must have access to their ‘personal information’, i.e. emotions and values, concerning Synbio. When people experience strong emotions it might be a sign that their personal beliefs or values are compromised. Roeser (2011) claims that these emotions are a valuable, essential, tool in discerning what matters most to us and help us in making decisions based on moral judgments. Moreover, personal beliefs and values a person holds can unconsciously influence how someone perceives factual information. This is called ‘framing’ (See figure 1.). This means that to have access to personal information members of the public must be able to clarify and reflect on their own emotions and values and understand how they are influencing their opinion of the topic. To truly understand their own feelings towards an issue like Synbio participants in the public debate need to look at the values they have and the way they frame a problem.

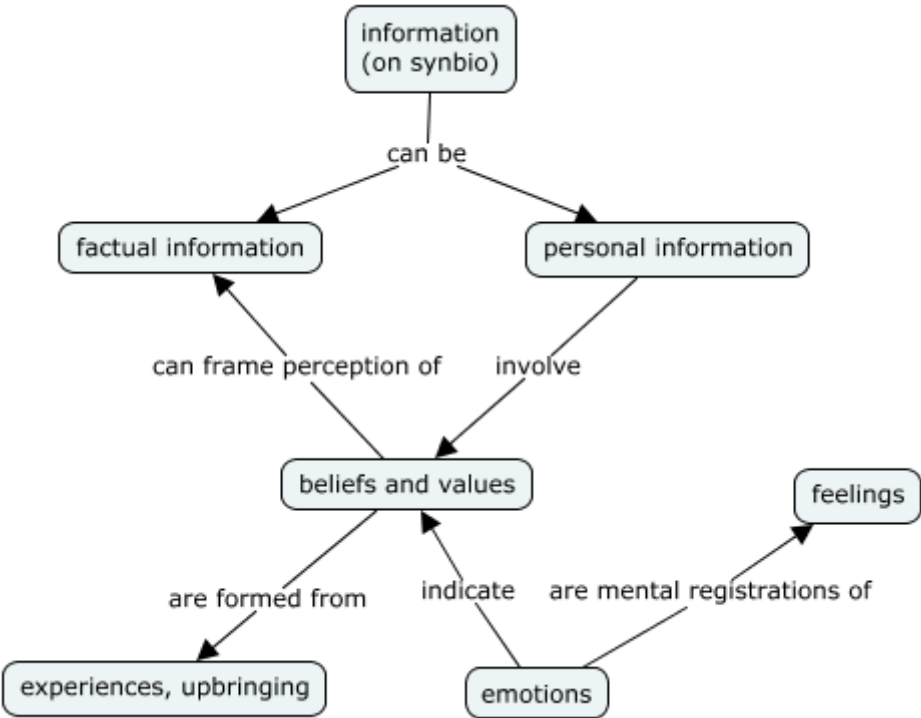


figure 1: correlation between concepts used in this report

Therefore, in the public dialogue, attention needs to be paid to personal values and ways of framing. Science centres could play a role in such a public debate. They could present the public with activities that would allow them to reflect on their values and frames. However, little is known about how to effectively work with these types of activities in informal educational settings. Trench and Bucchi call in their 2010 review for a coherent theoretical framework for science communication. They describe the field as fragmented and under theorised and feel that more research could help the field mature. This means there is, as of yet, no cookie-cutter approach to steering the public debate to a more value oriented form.

The EU now supports activities that empower stakeholders in the public debate on Synbio to contribute in an engaging way. The EU has started a project, SYN-ENERGENE, which aims to be “initiating and fostering public dialogue on synthetic biology and mutual learning processes among a wide variety of stakeholders from science, industry, civil society, education, art and other fields [...] At the same time, it will stimulate reflection on novel approaches to inclusive governance frameworks capable of fostering responsible research and innovation (RRI).”

As a part of this project the Freudenthal Institute, Utrecht University and the Athena institute, Amsterdam (VU) have offered a workshop for partners in the SYNENERGENE project ([http://cordis.europa.eu/projects/rcn/108718\\_en.html](http://cordis.europa.eu/projects/rcn/108718_en.html)) on April 8-9 2014, held in Brussels. This workshop was aimed at mutual learning on the topic of dealing with socio-scientific issues related to synthetic biology. The workshop addressed the interaction of emotions, values and facts in public debate. Ultimately the workshop was meant to empower involved science teachers and communicators to design and enact public engagement activities. Through collaborative frame reflection and reframing activities, sparked by Synbio-related techno-moral vignettes, it was aimed at critical reflection on their roles in value-laden dialogues.

The aim of the current study is to evaluate the design, execution and outcome of this workshop, adding to the theoretical framework on the guidelines to the practical sides of frame reflection and reframing activities.

## **Theoretical framework**

### **Synbio as a socio-scientific issue**

The aim of the Synenergene project (of which the workshop was part) is to spark a dialogue on the topic of synthetic biology (Synbio). Synbio, the practice of creating new biological systems, is a socio-scientific issue *pure sang*. Socio-scientific issues are complications and dilemma's related to science (Zeidler & Keefer, 2003). They often deal with new technologies that can have a range of soft and hard impacts on lives. Soft impacts, as opposed to hard impacts, are effects on the quality of human life that cannot be quantified. They are correlated with values like justice and equality. They can be contrasted with hard impacts,

which are effects that are measurable and objective, like the number of deaths a poison will cause or the reduce in cost of production by a new technology. Values impacted by hard impacts are, for example, values related to health and environment. Soft impacts affect psychological aspects like emotions, perceptions and motivation (van der Burg, 2009).

Examples of hard impacts Synbio might have are diverse. Thanks to Synbio techniques artemisinin, a crucial substance in malaria medication, can be made faster and cheaper (Paddon and Keasling, 2014). Some researchers are recreating the 1918 Spanish flu virus for research purposes. Though benefits can come from such research, the risk of dangerous organisms falling into the wrong hands is also real. The problem of 'dual research of concern' (Garrett, 2013). Soft impacts of Synbio include the way we think about life. With scientists creating living organisms from scratch in a laboratory, in any way they desire, the definition of life might be shifting (Garett, 2013). Since these impacts may affect so many parts of life it is important for the public to be informed and have their say on the topic.

### **Talking about socio-scientific issues**

For years science communicators adhered to the deficit model in their practices. The deficit model refers to the widely held belief in the scientific community that the public just does not know enough of science; science is difficult and the public needs someone to explain it to them. Learning more about scientific discoveries would also make the public more in favour of them. This is where science communicators come in. By informing the public, often in a form of one-way communication, the deficit could be recovered and public approval of science would rise.

At the turn of the century policy makers began to feel that a top down approach to science communication was no longer appropriate to the wider agenda that science communication is now addressing (Bucchi, 2008). Now, policy discourse in science communication has shifted from using words like 'popularization' to words like 'dialogue' 'engagement' and 'participation' (Trench & Bucchi, 2010).

That engaging the public is beneficial to a science community or technological company as well as to the general public is a shared belief among many. Torgersen & Schmidt, 2013, have described three approaches why experts think [a public] debate might help in mitigating a conflict.

*Instrumental:* to save the research community from obstacles resulting from a possibly negative public opinion was a main concern, and early dialogue was seen as an appropriate means to this end.

*Normative:* Public deliberation: Deliberation is the process of weighing all the options carefully and seriously. This can be an interior process or take the form of a debate

(Dortmans, K. *Deliberatieve democratie in actie*, [PowerPoint slides]. may 22<sup>nd</sup> 2012). As the US Presidential Commission for the Study of Bioethical Issues, 2010 (p. 152) says:

“public deliberation is particularly valuable while the field is still young, as there is a unique opportunity to shape its development in ways most likely to promote the public good while assuring safety and security.”

*Substantive:* Lay or stakeholder participation as well as an open debate over potential implications at an early stage should influence the technology in a socially beneficial way when it is still possible.

Science communication is now more about inviting the public to voice their opinions and questions on science and technology issues. Scientists now actively ask the public to take part in decision-making on issues. This is especially the case in technologies that have the possibility of drastically changing peoples' lives, and are likely to give rise to socio-scientific issues.

### **Mutual learning and dialogical learning**

One way to invite stakeholders to voice their opinions and questions is to encourage a dialogue between these stakeholders. In a dialogue participants learn about each other's perspectives. This is also referred to as dialogical learning. The learning through a dialogue is decentred and takes place in the social interaction as opposed to in the head of a single learner (Koschmann, 1999). It is cooperative in its nature. In a dialogue people should not feel forced to defend their points of view (van der Zande, 2012). The focus should be on understanding. It is described as dynamic and process-based. The content of what is to be learned is therefore determined in the process, and can be described as emergent, nondeterministic and contingent (Koschmann, 1999).

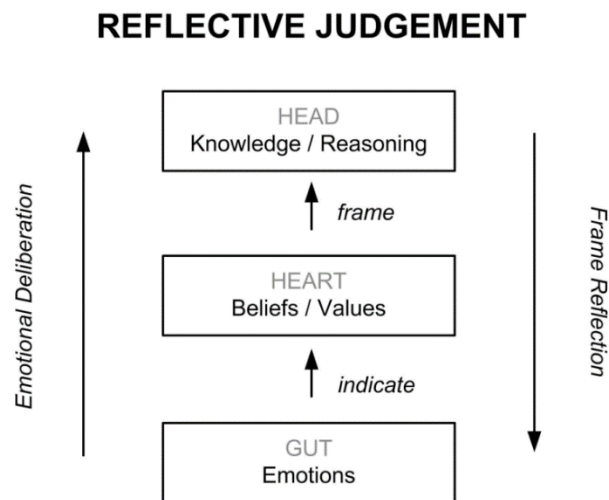
Such a dialogue is one of the objectives of the EU project. Synenergene aims to have experts from different fields contribute to a common framework on public engagement in Synbio. In other words: Synenergene wants the stakeholders in the project to learn from each other and with each other. Within the project this is referred to as 'mutual learning'.

There is little known about what factors lead to effective mutual learning. What is clear however is that it involves mutual understanding between participants. This mutual understanding would be greatly helped if participants could understand and make explicit what frames and values underlie their opinions and vocabulary. This making explicit of frames and values is the aim of frame reflection. Acknowledging one's emotions can help in this frame reflection.



## Emotional deliberation

A person's values and beliefs determine how he frames his knowledge and perception of the world around him. The values and beliefs show themselves through emotions and feelings. When a person's values are compromised this will lead to him experiencing strong emotions (see figure 2).



**Figure 2: relationship between emotional deliberation/frame reflection and emotions, values and framing. (Waarlo, A.J., personal communication, 2013)**

These emotions are often seen as standing in the way of rational decision making (Roeser and Pesch, 2016). Roeser, (2011) warns against ignoring emotions, often done because they are perceived as irrational, which she calls the technocratic pitfall. This leads to listening only to experts and exclusion of the public. Another pitfall she warns against, the populist pitfall might be to not have a public debate at all and just avoid upsetting the public by not implementing some potential useful technologies.

Rationalist models of moral judgement state that moral judgement and moral knowledge is primarily reached through a process of reasoning and reflection, causing scientists to up the information flow to the public in order to remedy a lack of information.

More recent studies however show the process to be the reverse. When presented with a story describing a moral reasoning dilemma (such as consensual incest between two adult siblings) people immediately formed an opinion and only then tried to come up with rational arguments. The dilemmas however were carefully written to be harmless to all actors in the story. Even when no rational arguments could be found participants stuck to their original opinion (Haidt 2001, Haidt, Bjorklund and Murphy, 2000). This shows that ignoring emotions or trying to remedy irrationality by providing more factual information does not necessarily improve moral judgement.

Roeser (2011, 2012) claims that emotions should be seen as a valuable, essential, tool in discerning what matters most to us and making decisions based on moral judgments. She proposes starting a dialogue on new technologies from the emotions, this is called emotional deliberation. It can turn out that the emotions are irrational and that people should be educated more. But it can also turn out that these emotions reflect when a genuine value is being compromised. When the emotions of people are taken more seriously, people will also be more open to new information and other people's point of view (Roeser, 2011).

Synthetic biology is a field that can lead to many socio-scientific issues that might end up having a lot of soft impacts on daily life. People are bound to have strong emotions about the risks and possibilities involved. Therefore it might work well to start from emotions when discussing this new technology and from there to uncover values and beliefs. First steps towards this approach have been made in an educational setting and results showed that students were able to make values they and others held more explicit (Ripken, 2015).

### **The need for Value oriented discussion for opinion forming - reflective judgement**

Not only a person's emotions, his beliefs and values may also influence how he considers a topic or factual information. A person's values and beliefs determine how he *frames* his knowledge and perception of the world around him (see figure 2). Frames (or 'the ways a person frames') are powerful organization principles of individual perceptions and interpretations that have an important function for humans, they help them deal with complex real life situations. When people come across a complex situation or issue they try to make it comprehensible by a process of naming and framing.

The way a person frames an issue can determine how a he defines and perceives an issue. It determines what arguments are reasonable to him. It is as if a person sees the world through a frame that is formed by experiences and can change according to the context we live in (Schön and Rein, 1995). Aspects of the situation are selected for attention and named in a way that they fit a frame constructed for the situation. This allows people to define a problem. Frames provide a common discursive basis for a debate (Schön & Rein, 1995).

An example of a frame is the economical frame. Someone perceiving an issue through an economical frame will pay most attention to arguments concerning economic progress and disregard any arguments concerning for example ethical complications. How he defines an issue in turn is indicative for how they feel the issue should be dealt with. When an aspect of a problem is not given much attention this aspect will also not be solved (Schön & Rein, 1995). When people have different frames regarding the same problem, they will often call for different solutions.

Every debate is subject to a dominant frame. This frame is necessary to come to a common understanding of what is considered relevant and which form of debate should be used. In debates on emerging technologies, such as synthetic biology, a dominant frame is not automatically established as the properties and consequences are still not clear. But dominant frames have already set the tone for debates on comparable new technologies. One such example was the debate on genetic modification in which the risk frame (emphasis on potential risks) led to adverse public perception in some countries. The development of a particular frame in the debate on Synbio could determine the direction of this debate. Many researchers agree that public perception of GM technology harmed the development of a democratic debate and should be avoided in a debate on synthetic biology (Torgersen and Schmidt, 2013)

The variety of frames in a society has more implications. Since frames can determine how a person perceives issues and what arguments are reasonable to him, they are a big factor in the way a debate will develop. Frames determine what arguments are reasonable to a person. How he defines an issue in turn is indicative for how they feel the issue should be dealt with. When an aspect of a problem is not given much attention this aspect will also not be solved (Schön & Rein, 1995). When people who have different frames regard the same problem, they will often call for different solutions.

The problem with frames is that there is no neutral, independent way of determining the best one since this would require an objective judge. No one is free of frames and therefore no one is completely objective (Schön & Rein, 1995). Each individual has a different set of frames. In any society there is a diversity of frames. This makes it difficult for debates to take place since not all individuals in society see eye to eye on the issues and the arguments.

Through framing meanings and significances in socio-scientific issues are embedded in values and worldviews. Conflicting values can spark debates on these issues that are not merely about whether the science is right or wrong. In these debates it is therefore beneficial to recognize and make explicit that there are subjective, qualitative dimensions to the topic that are of importance to individuals and cultures (O'Brien and Wolf, 2010). Such a values based approach could help people decide on what regulations should be implemented to secure what individuals and society value.

### **Frame reflection and reframing**

It can help participants of a debate or dialogue to reflect on the frames influencing it (see figure 2). Before one can reflect on his frames he must become aware of them. For this we must construct them from the language and actions of the participants. This may be problematic for a number of reasons (Schön & Rein, 1995). People may for example present frames in their rhetoric different from the frames underlying their actions. Also, there is no person who can objectively construct frames since no person is without frames of his own.

If the frames influencing the debate have been mapped the participants these can be discussed/reflected on and this may result in reframing. This might be helpful since it provides understanding of the conflict dynamics (Kaufman, Elliott and Shmeulli, 2003).

One way of mapping the frames in a debate is interviewing the participants on their perceptions and interpretations. The results can then be presented to all participants to trigger exploration of the meaning and impact of these frames. Reframing can be difficult for participants. In reframing activities tension should be reduced and other perspectives considered. It may help participants to move away from the discussion at hand and explore common grounds or to consider each other's point of view. (Kaufman, Elliott & Shmeulli, 2003). In the case of synthetic biology, public dialogue can function as a clarifying tool in frame mapping and reframing.

The mapping of frames described by Kaufman, Elliott and Shmeulli, 2003, is similar to the practical work of Kupper (2009) on frame reflection. In his 'value lab' he had people reflect in a dialogue on their associations on animal welfare related topics. Through this reflecting he uncovered the frames people used. Kupper's methodology was used in the workshop on the value based approach to public debate.

Since synthetic biology is expected to have an effect on many parts of society, and a public dialogue on Synbio should take place, there may be a role for public places, such as science centers in frame reflection and emotional deliberation. A large part of the workshop should therefore deal with these topics and in its aim to help participants understand what they can do to contribute a democratic discussion.

A workshop has been developed for the Synnergene participants, considering emotions and focusing on frame reflection by means of dialogue. The workshop aimed at getting the participants to help each other, through dialogue, to become aware of and articulate their own frames and that of others. The design of the workshop was based on guidelines on emotional deliberation and frame reflection articulated by experts such as Roeser and Kupper. The current study will evaluate to what extent these guidelines are in fact implemented in the workshop, to what extent the workshop is executed as planned and to what extent the participants reach the learning goals as set by the designers.

The research question in this report will therefore be:

*To what extent does the 'frame reflection workshop' contribute to value oriented opinion forming in synthetic biology-related socio-scientific issues?*

## **Methods**

### **Outline of research**

The goal of this study is to evaluate the workshop on frame reflection (given in Brussels on the 8<sup>th</sup> of April 2014), by looking at the implementation of guidelines set by experts and by determining to what extent the workshop helped the participant to reach the learning goals. Experts were interviewed to get a view of their pre-existing knowledge on frame reflection. This led to guidelines used in designing the workshop. The designers' workshop design was retrospectively made explicit in a hypothetical learning trajectory (STAGE A). The outcome and implementation of the workshop was assessed by observations, questionnaires, learning reports and interviews (STAGE B).

### **The process of designing the workshop (STAGE A)**

As part of workpackage 2 of the Synenergene project a two-day training seminar has been organized in order to foster "Knowledge sharing and mutual learning between the research community, science communication practitioners, policy makers and representatives of civil society". The workshop under evaluation in this research was part of this seminar, and has been developed and executed by Prof. A.J. Waarlo, Freudenthal Institute and Dr. F. Kupper, Athena Institute.

In a first step of the design process two experts have been interviewed:

A face-to-face interview has been conducted with an expert on emotional deliberation to get her views on conceptualizing, and the practical sides of operationalizing, reframing and emotional deliberation. The 1.40 hour lasting interview was semi-structured so as to leave the interviewee plenty of room to get her thoughts in but still cover all of the necessary topics.

A second interview has been conducted with an expert on frame reflection and co-designer of the workshop. This designer has worked with the value lab, the practical application of frame reflection. The interview was mostly meant to make explicit the practical necessities of frame reflection. The interview lasted 1.50 hour and was semi-structured. The main topics included background information on frames, frame reflection and mostly his experiences with the practicalities of his value lab.

Both interviews were transcribed verbatim and analyzed looking for concrete guidelines to be used in designing the workshop.

Based on observations of the meetings in which the designers discussed the preparation of the workshop and the PowerPoint presentation used during the workshop, a HLT was drawn

up retrospectively. To evaluate how much of the requirements for frame reflection as stated by experts were incorporated in the design of the workshop this HLT was compared with guidelines for frame reflection derived from the interviews.

### **Participants of the workshop**

The conference in which the workshop was given had 66 participants listed to attend. This included leaders of the workshop (2) and the researcher (1). It was not kept track of if all of these participants actually partook in the workshop, if they did, a total of 63 participants attended the workshop. 36 of these were male, 27 were female. The background of these participants varied. Most came from various European countries, some from outside the EU. Though they all had some link to Synbio, the nature of that link varied greatly. Some were participants in the iGem competition, others were scientific researchers in Synbio, worked in science centers, or in science education. The designers of the workshop took care to have a mix in backgrounds in each workshop group as this was one of the prerequisites of the methods used.

### **Data-sources and analysis**

In order to assess to what extend the participants reached the learning goals four different data-sources were used:

#### *Observations*

During the workshop video recordings of four workgroups were made. One of these was closely observed and relevant observations and quotes were transcribed. This group contained 6 members, 3 male and 3 female. To aid in these observations all post its and worksheets produced by the participants were kept and recorded. The observations done during the workshop were described and evaluated for signs of reaching learning goals and the overall execution of the tasks assigned by workshop leaders (i.e. To what degree did the participants understand and execute the tasks?)

#### *Questionnaires*

After the workshop 41 participants filled in short questionnaires in which they rated the perceived effectiveness of the workshop on a 5-point Likert-scale. The questions asked were the following:

- It is clear to me how I frame Synbio
- It is clear to me how other people frame Synbio
- It is clear to me how framing in Synbio can influence the way I communicate about the topic.

To these questions the following options could be answered: Strongly agree – Agree – Neutral – Disagree – Strongly disagree – I prefer not to comment. The answers to the Likert-scale questionnaires were analyzed by occurrence of answers.

### *Learner reports*

Participants were invited to write learner reports based on completion sentences at the end of the workshop (see Appendix 7). This led to 37 usable learner reports. A learner report is a way of letting learners themselves report on their own progress. A learner himself knows best what new skills, knowledge and experiences he has gained (van Kesteren, 1993). Because what participants get from the workshop can be described as an 'educational encounter' without pre-specified learning objectives (i.e. 'expressive objectives'<sup>1</sup>) and were highly personal in nature, the use of learner reports seemed to be most effective to measure the learning output from the learner's point of view.

Answers to the learner reports were coded into categories of similar answers that emerge from the data, and presented to show the frequency in which they occurred.

### *Interview with stakeholders*

After the workshop a focus group interview was held with seven stakeholders. This included the leaders/designers of the workshop. One stakeholder was an expert on science communication. Another was an expert on biology education. Two stakeholders worked with the Rathenau institute and were involved with the writing of the technomoral vignettes. These technomoral vignettes were adapted to form the short stories used in the workshop. One stakeholder worked with one of the designers as a PhD student. Goal was to get their view on the success of the workshop. Topics included to what extent did the participants execute the assignments of the workshop and to what extent did they reach their learning goals. This 16 minute interview was videotaped and analyzed by transcribing it.

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<sup>1</sup>Expressive objectives deal with educational encounters: experiences that allow a learner to be engaged in a situation from which he can learn. As opposed to learning objectives, an expressive objective does not specify what it is that a student should have learned from this encounter. They describe the nature of the experience at hand and are mostly meant to be inspiring and help diversify students' behavior (Eisner, 1978). The expressive objectives for the workshop are not yet set.

## **Results**

### **Requirements and guidelines for the frame reflection workshop as conceived by experts in the field (Stage A)**

Two experts on value oriented dialogue, have been interviewed to get an insight in guidelines for the design of the workshop. From their work on value oriented dialogue guidelines and advice can be derived on the practicalities of organizing such a workshop. The expert advice derived from the interviews is summarized below. These guidelines can then be compared to the HLT.

#### **Expert 1 - Emotional deliberation**

One way of getting to the core of how people feel about a topic is the emotional deliberation coined by this expert. Where the value lab asks people to tell stories and associate, emotional deliberation asks people to consider their emotion deeper. She proposes taking an emotion seriously and then continue by digging deeper through follow up questions.

The theory of emotional deliberation is still fairly abstract and that practical applications are needed. Although not yet published she has been busy formulating how reflection on emotions should roughly be done.

#### **Expert 2 – The Value lab**

Expert 2 has had some firsthand experience with the reframing process. According to him reframing must always start with realizing your present way of framing. For this you need frame reflection.

In his practical application, the value lab, participants were asked to come to an articulation of how they frame the concept 'animal', as it was a study in the field of animal welfare. The methodology of the value lab can also be used in clearing up other socio-scientific issues and will therefore be the main guidelines and requirements.



Guidelines and requirements from these two experts are summarized in the following section:

Methodology	<ul style="list-style-type: none"> <li>- First provoke: Let participants start by telling anything that comes to mind when provoked by a word or a short story. Expert 2 warns for the multifaceted aspect of such a story. A story should be neutral, unambiguous and contain no problem definition</li> <li>- Then follow up: After this the facilitator needs to help participants dig deeper. Ask follow up questions on what these stories mean to people, this will get you to the level of values and assumptions. Do structured exercises to examine these values and assumptions.</li> <li>- Start from emotions, follow up with questions such as: ‘why are you afraid?’ ‘can you elaborate on that?’. Since emotions can be an indicator of conflicting values this might help to get to the core of the problem.</li> <li>- Use emotions in the reflection on emotions. You can for example ask people to imagine themselves in someone else’s shoes, which takes emotion to do so.</li> </ul>
Groups	<ul style="list-style-type: none"> <li>- Groups should be small. You need time and attention spent on the step from intuitions or values. Each table should have a trained facilitator or if not available, a very clear worksheet.</li> <li>- Groups should also be homogenous so that participants do not spend too much time disagreeing with each other. This would happen if conflicting values and ideals would be present.</li> </ul>
Facilitators	<ul style="list-style-type: none"> <li>- Facilitators must keep focus on dialogical element by repeatedly asking ‘why’ questions.</li> <li>- They must create a trustworthy and non-threatening environment in which participants feel at ease and open to freely express their thoughts and beliefs. (Greenbaum, 2000 as cited Kupper,2009, p. 72)</li> <li>- They have to maintain a continuous balance between structure and freedom, both by being an empathic, active listener and presenting him or herself as the authority on the process (Greenbaum, 2000 &amp; Vaughn, Schumm, &amp; Sinagub, 1996, as cited in Kupper, 2009 p. 72)</li> <li>- Facilitators should not pretend not to have an opinion of their own. Each facilitator must realize his own values and default ways of framing.</li> <li>- They should respect emotions and take them seriously. They are indicators of something deeper.</li> </ul>
Participants	<ul style="list-style-type: none"> <li>- Participants should respect each other as equal.</li> <li>- They should be willing to revise their own views.</li> <li>- They cannot use to their future advantage anything that is said in the experimental setting.</li> <li>- They should be addressed as individual citizens, not as representatives. (Habermas, 1984, as cited in Kupper, 2009)</li> </ul>

## Overall guidelines

All experts agree on the importance of follow up questions, following on an emotional reaction to a problem or on an association provoked by a word or a story. These follow up questions are vital to getting to the underlying frames and values. In order to get the most out of the follow up questions they need to be personally tailored to the participant, thus groups must be as small as possible. A trained facilitator should be present, or in the very least, detailed instructions for the participants on how to act as a facilitator.

## Implementation of the guidelines in the intended workshop (Stage A)

### Learning goals of the workshop

The designers of the workshop expressed that the ultimate goal was to focus on framing of an inevitable process that colors both your own ideas but also the way a science communicator interacts with his target audience.

With this in mind the designers of the workshop got to work designing.

In the program of the day the workshop had the title *“How to clarify and reflect on frames in the deliberation of techno-moral vignettes*

*“Being able to ...*

- *recognize, articulate and deliberate own and others beliefs, values and assumptions related to applications and implications of synthetic biology*
- *identify patterns: coherent constellations of beliefs, values and assumptions and relate these to frames that consistently appear across public debates on emerging science and technology*
- *critically reflect on how to deal professionally with framing processes when designing and implementing public engagement and participation activities in SYNENERGENE”*

Since these are the goals as communicated with the participants these will be the goals reviewed in this research.

### Hypothetical Learning Trajectory (HLT)

The following HLT has been drawn up retrospectively and is based on the observation of the process of designing the workshop, the PowerPoint presentation made by the designers and the lesson plan also made by the designers.

Note: statements indicated with '\*' are directly taken from designers' notes.

Activity	Hypothesized learning result	Learning functions
Introduction on theory, given by facilitators	<ol style="list-style-type: none"> <li>1. Understand theory behind workshop</li> <li>2. Learn key terms used in workshop</li> <li>3. Introduce participants to the logic of the workshop*</li> </ol>	<ol style="list-style-type: none"> <li>1. Regulative: orienting on learning task</li> <li>2. Idem 1</li> <li>3. Affective: motivate</li> </ol>
Reading case descriptions*	<ol style="list-style-type: none"> <li>1. Prompt feelings, questions</li> </ol>	
Write down first intuitive associations on separate post-its*	<ol style="list-style-type: none"> <li>1. identify own notions, believes, emotions</li> </ol>	<ol style="list-style-type: none"> <li>1. Processing: verbalize</li> </ol>
Neighboring participants interview each other about their associations* /underlying notions -> write them on post it	<ol style="list-style-type: none"> <li>1. Reconstruct underlying value concepts together*</li> <li>2. Clarify the reasoning</li> </ol>	<ol style="list-style-type: none"> <li>1. Processing: Interpret, verbalize, analyze</li> </ol>
Table of participants groups value concepts together according to a structured frameworks*: <ol style="list-style-type: none"> <li>1. Into analytical categories</li> <li>2. Into frame of meaning</li> </ol>	<ol style="list-style-type: none"> <li>1. Identify patterns in value concepts (such as: 'problem definitions' 'empirical believes' and 'moral values')</li> </ol>	<ol style="list-style-type: none"> <li>1. Processing: Structure, analyze</li> </ol>
Compare the reconstructed frame to several available conceptualizations in literature*	<ol style="list-style-type: none"> <li>1. Compare the reconstructed frame to several available conceptualizations in literature*</li> </ol>	<ol style="list-style-type: none"> <li>1. Processing: compare</li> </ol>
Reflect on steps taken and yielded benefits*- plenary	<ol style="list-style-type: none"> <li>1. Reflect on steps taken and yielded benefits*</li> </ol>	<ol style="list-style-type: none"> <li>1. Processing: reflection</li> </ol>
Reflection on own framing and influence of own framing on public engagement designer - Table discussion group	<ol style="list-style-type: none"> <li>1. Understanding own frames and getting insight into diversity of frames in others</li> </ol>	<ol style="list-style-type: none"> <li>1. Processing: reflection, compare</li> </ol>
Social capital game	<ol style="list-style-type: none"> <li>1. Meet others who can help you in your frame induced blindness</li> </ol>	<ol style="list-style-type: none"> <li>1. Regulative?</li> </ol>

From the observation of the process of designing the workshop it is clear that the designers intent to assign participants tables as to ensure a favorable composition of the teams and intent to take the participants through the process step by step by giving a short explanation, with examples, with each step.

### **To what extend does the design of the workshop meet the requirements/guidelines for value oriented opinion forming as set by current scientific ideas on the topic?**

When looking at the HLT the structure of first provoking and then digging deeper with follow up questions, such as is used in the value lab, is clearly visible. The most striking difference however is the lack of an facilitator. As the designers discussed, there was a large group and little time to work with. Hence the choice to give the participants instructions to facilitate themselves. While discussing the design the designers discussed the use of examples. They indeed included some example questions to be asked.

Another guideline, that of small groups was implemented by the design team. The list of participants was requested ahead of time and participants were assigned to small tables. Interestingly the designers assigned participants in such a way that direct colleagues would not be in the same group, making the groups heterogeneous with scientists, communicators etc. in the same group. This is remarkable because one of the designers himself came up with the guideline that groups should be homogeneous in order to prevent time wasted on discussions.

Since there were no facilitators, these guidelines would be difficult to implement. Other than the example questions, there were no directions for the participant-facilitators on how to act in the presentation or in the lesson plan.

As for the participants, they should be addressed as individuals and not as a group. In the case of this workshop this might be a problem: The people attending the workshop are all people who have been involved professionally with Synbio before. This may cause them to come up with associations that are not purely their own. The designers suggests doing a warm-up exercise in which participants are asked to leave behind their professional identity. This could be as simple as asking them to take of a lab coat.

## To what extent is the workshop executed as intended?

### Is the workshop executed as intended by the workshop leaders/designers?

Looking at the HLT, the designers expressed an intent to explain the reason ‘the logic’ behind the workshop. The observations show that indeed the workshop leaders address this:

*“if you work in Synenergene and you do public engagement and participation activities, it’s very important to know what are your own values beliefs and assumptions because it may influence the way you communicate with people: if you are persuading people in a hidden way or if you are just helping people to clarify their own things.”*

As was planned the workshop leaders start with the theory behind the workshop. There was some mix-up in vocabulary in the workshop. While one workshop leader preferred to talk about beliefs values and assumptions and makes a side note that these are also called “*the second order ones*”, the other workshop leader on the other hand talks primarily about first and second order notions.

Not mentioned in the HLT but witnessed in the observation is the making explicit what the nature of the upcoming assignment is: initial and personal.

*“So what we want from you, what we ask from you is just to quickly come up with ideas in a brainstorm fashion. Of course we ask you to think about that deeply but also to explore as many ideas as you can, without waiting for the definite definition of things [.....] It is your personal view so we’re not asking you about all the things that you know about synthetic biology, we’re asking you your personal perspective.”*

Since there was no facilitator for each small group the designers of the workshop felt they should be very clear on what was expected of the participants. In the process of designing they decided examples of ‘digging deeper’ should be given. The observations show that they indeed gave examples of what these types of questions.

*“ask each other questions like: ‘what do you mean by... The thing that is on the post-it.’ ‘what is important to you?’ ‘what is at stake here?’ ‘what are your concerns here?’. So these are questions of clarification and then, suggest notions. So suggest: ‘are you saying... safety?’ in my example. Or ‘is this about... the uncertainty of the world?’ ‘Do you mean that... tinkering becomes uncontrollable?’. So try to catch the clarification in one word, or two words if that is absolutely not possible, and write down the keyword on a separate post-it that has a different color.”*

At the end of the session there turns out to be too little time to do last parts of the workshop: the 'reflection on own framing and influence of own framing on public engagement designer' step was not discussed at the table, but touched upon plenary directly after the discussion of the reflections. The social capital game that was planned was skipped altogether.

### Is the workshop executed as intended by the participants?

The observations show that the participants follow the steps willingly. However for some participants the step of finding the underlying notions seems to be difficult. Looking at the post-it's the participants produced we see a varying degree of reflection. The first post it (figure 3) remains superficial and sticks with 'high quality of life' as a underlying notion for 'good idea'. The second post it (figure 4) comes up with modesty as a underlying value for 'playing God'.

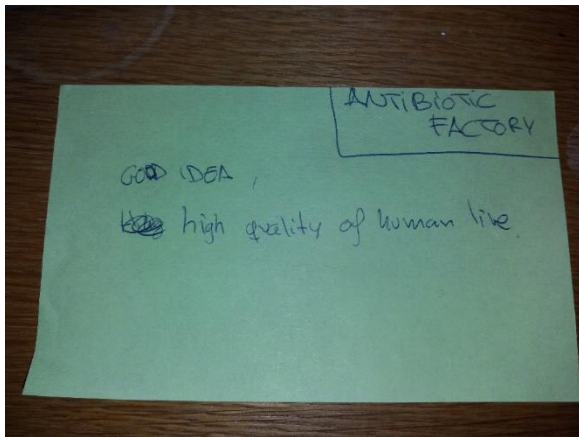


Figure 3: product of table 1

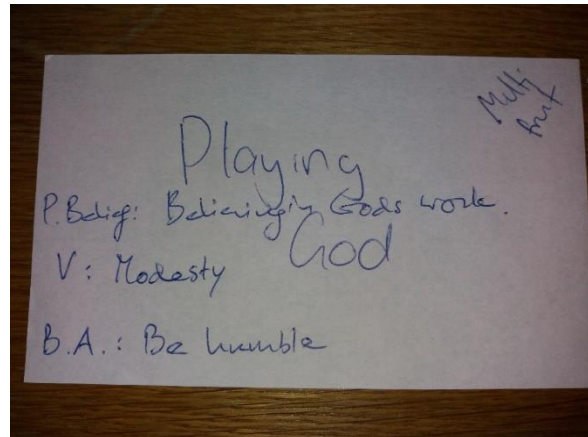


Figure 4: product of table 1

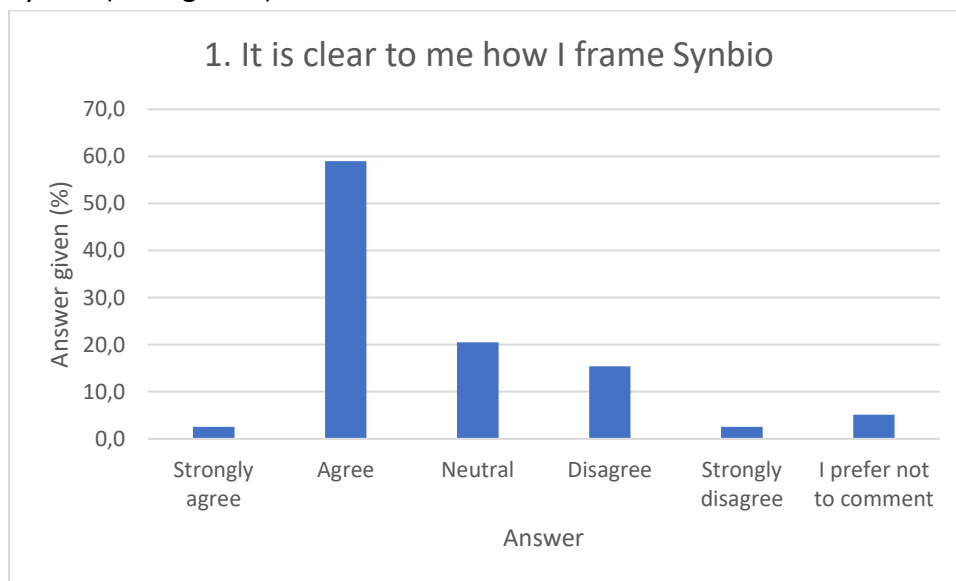
One of the stakeholders interviewed after the workshop noticed how some of her teammates did not reflect on their own frames but more on the way of communicating the story. Striking is how these participants did not seem to notice how they did not follow the assigned exercise:

*“En het was wel een hele interessante observatie dat bij een van de cases waar een wetenschapster aan werkte, die zijn met z'n tweeën heel erg gaan reflecteren op hoe het gecommuniceerd werd, en niet op de inhoud. En daar kon ik ze ook niet toe bewegen om dan nog wat te zeggen over wat vind je van het idee. Dus puur over 'ja ik vind dat ze een oude manier van communiceren hebben genomen, en dat is eigenlijk heel risicovol, en het is helemaal niet zo eerlijk zoals ze dat portretteren...' en dat is een hele andere....”*

## To what extent do the participants meet the learning goals as set by the workshop designers?

The first goal of the workshop was to be able to recognize, articulate and deliberate own and others beliefs, values and assumptions related to applications and implications of synthetic biology.

When asked in this questionnaire most participants (59% agreed + 2,6% strongly agreed = 61.6%, n = 39) answered that they felt that it was clear to them how they themselves framed Synbio (see figure 5).



**Figure 5: answers to questionnaire statement: 1. It is clear to me how I frame Synbio (n=39)**

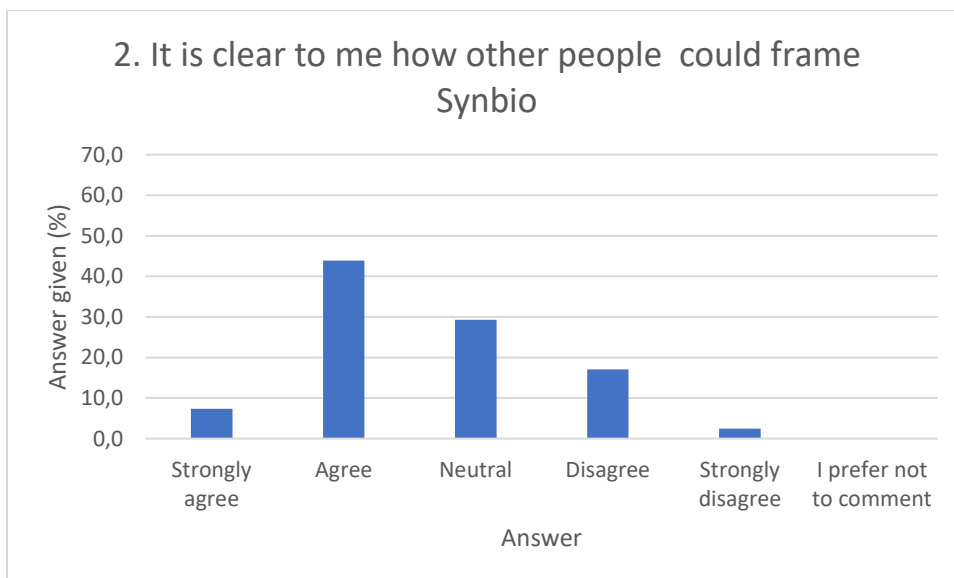
When looking at the observations this is partly backed up: many participants did move from intuitive associations to deeper notions:

*“P2: I don’t mistrust these people. I think they might not be aware of the consequences of the work they do. (Taps the handout with his pen) This is quite an ideal way of how things are going. Very nice in situations. But I’m not sure you will achieve that and end up there. P1: I’m looking for a word for your position. Probably it’s prudence.. P2: Yeah, yeah, could be. P1: just.. take care. P2: (acknowledging) aha.. know what you’re doing. Don’t do what you don’t know. Could be. P1: could be. P2: so I can write down prudence?”*

Some critical notes need to be made here. There seems to be a fine line between exploring frames/values and exploring/articulating your own opinion, and not all participants notice this and try to move to a deeper level of reflection, especially without expert facilitator.

“P1: And then I thought it was better to invest in alternatives. They exist, but they were neglected. And so my second keyword is alternatives. But... (makes a troubled face) P2: With alternatives you mean not (inaudible) P1: not antibiotics. P2: so not alternatives to research protocols that are now implemented. P1: other research approaches that are now neglected but... P2: that should be part of a.. because also within scientific research there are also priorities that are set.... P1: Yes, can also be synthetic biology but I don't believe in this project. P2: so also you think that also. You (emphasized) don't believe in this project? Within the scientific... (breaks of sentence)”

When it comes to their knowledge about frames of others the participants were still positive. When asked in the questionnaire about their understanding of other people's frames this number drops slightly compared to the first question but is still quite high: 43.9% agreed + 7.3% strongly agreed = 51.2 % (n=41) (see figure 6).



**Figure 6: answers to questionnaire statement: 2. It is clear to me how other people could frame Synbio (n=41)**

The stakeholders however noticed that participants were much more willing to explore/voice their own frames and were less willing to reflect on the frames of others.

“IF: was er uiteindelijk frame reflection? Hebben jullie het idee dat er echt dingen geleerd... Nee?

Stakeholder 1: nee.

Stakeholder 2: ik heb iemand anders z'n frame helemaal... [maakt omarmend gebaar]... omhelst. Maar hij was met mijn frame helemaal.. [maakt wegduwend gebaar] No way. Maar hij had ook al meer ervaring.. maar ik weet niet, was het nou frame reflection? Maar iedereen staat er wel anders in, sommige zijn meer open, anderen wat minder. Maar ze reflecteerde in ieder geval wel waar ze stonden.



Each stakeholder was assigned to a table and, being more experienced in topic of frame reflection than the average participant, noticed some aspects of the frame reflection process in their assigned teammates. Besides the openness of the participants to explore other peoples' frames the stakeholders felt that some participants were not able to dig deep enough. The stakeholders suggested that this might be due to the inexperience of the participants. Some of the stakeholders for example noticed how participants got stuck on the terminology, which turns out to be so complex that even stakeholder had difficulty working with the terms:

*“Stakeholder 1: We hebben het er later nog met Arend Jan erover gehad. Ik denk van, ja weet je, wat nou een personal believe is en wat nou een basic assumption is...*

*Stakeholder 2: maar dat was nou bij ons juist, daar kwam ik ook heel lastig uit, dat we waren naar onze uitspraken te kijken en dat ik dacht van is dit nou een assumption of moet hier nou nog wat onder zitten? Of wat is dan de value? Dus ik kreeg zelf heel erg de behoefte aan..*

*Stakeholder 1: steun, sturing?*

*Stakeholder 2: ja steun inderdaad.*

The idea that participants did not always grasp the meaning of the theory is backed up by the observations as can be seen in the following extract of round four, in which the participants were asked to identify 'Believes', 'Values' and 'Basic assumptions'. It shows the misconception that a belief is always something spiritual.

*“what do you think about it?” P2: “I think it is mainly a basic assumption.” P1: [nodding] “it is very, very low level. You’re right.” P2: “and it is not questioned in a way. It is also not a belief related to something spiritual.”*

One of the workshop designers/leaders himself comes up with a possible solution to this problem: give examples.

*“ dus we moeten in de instructie nog een oefening, een heel alledaags voorbeeld, inbouwen. Dat ze even geoefend hebben. Want dan komen de vragen voor af hè. Ja is het nou dit of is het dan dat? Ik kreeg verschillende vragen, nu ook van mensen van de theorie van assumpties”*

The question is whether or not this focus on theory is absolutely necessary. As the other workshop leader points out in the following abstract, the discussion is part of the frame reflection process.

*“ alhoewel het dan ook een deel van het, maar is dan te weinig ruimte voor in deze opzet, maar deel van het gesprek is, dat je jezelf afvraagt van wat is dit dan nu eigenlijk, het gevoel dat ik hierbij heb. Is dit nou iets dat ik belangrijk vind...”*

The stakeholders agree that a moderator per small group, pushing the participants to dig deeper and explain key terms, would be the best solution and that unfortunately this was in this setting not possible.

As for the second learning goal: being able to identify patterns: coherent constellations of beliefs, values and assumptions and relate these to frames that consistently appear across public debates on emerging science and technology, the participants showed in their learner reports that they saw the complexity of the subject:

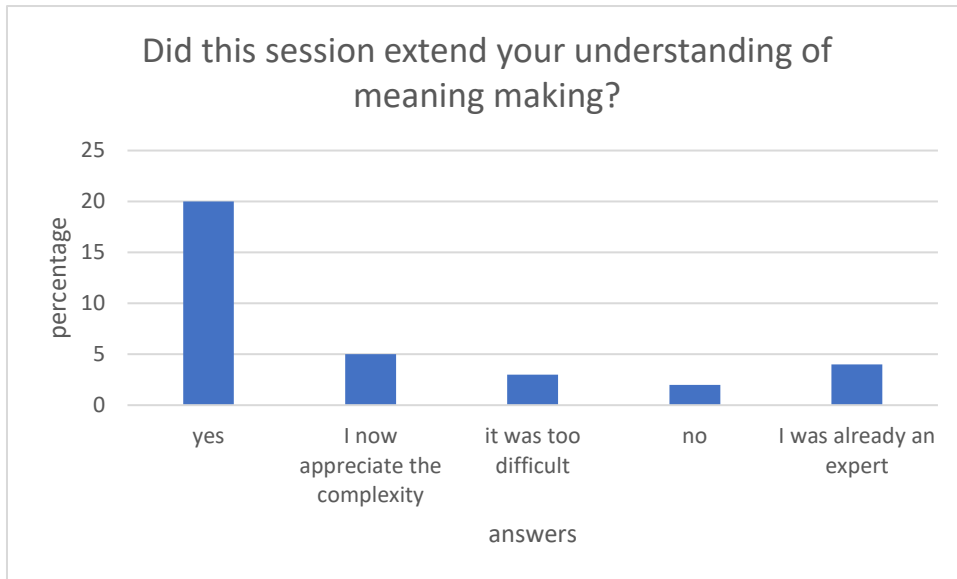
*“It is difficult to categorize your ideas or opinions into categories and reflect on how you have developed these thoughts. This workshop tried to do that for us.”*

As the stakeholders too had noticed, the answers to the learner reports showed the need for everyday examples:

*“I think I learned that I understand little about the process of meaning making the opening presentation on framing was difficult for me to understand without many concrete examples. Basically I only learned that I must learn more on the subject”*

Even though the topic was complex most participants felt that they had increased their knowledge. When asked in the learner reports: ‘Did this session extend your understanding of meaning making?’, the majority (59%) answered that it did (see: figure 7). Such as this participant:

*‘Yes it did, consciously asking questions for clarification and trying to find underlying values and assumptions makes in a more structured way is a way that contribute to my process of meaning making – reflect personally – reflect on others ’.*



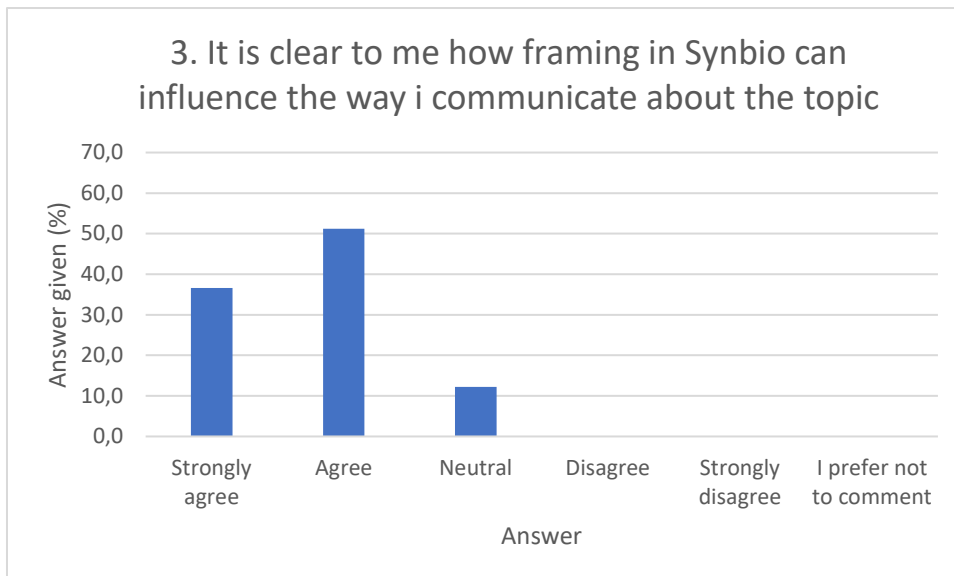
**Figure 7: answers from learner report question 2: Did this session extend your understanding of meaning making?**

Those who had answered some form of 'no' gave reasons concerning the time in which the topic was covered:

*'I'm afraid that this theory of meaning making was a bit opaque for me – we had a lot of new concepts imposed on us in a short amount of time.'*

The third learning goal, being able to critically reflect on how to deal professionally with framing processes when designing and implementing public engagement and participation activities in SYNENERGENE, was not explicitly covered by the workshop. Yet many participants felt that they had an idea of how frames could be of influence in their professional life.

There was strong agreement with the questionnaire statement that the participants understood how their frames could influence the way they communicate about Synbio: 51.2% agreed and 36.6% strongly agreed, together 87.8% (n=41), see figure 8).



**Figure 8: answers to questionnaire statement: 3. It is clear to me how framing in Synbio can influence the way i communicate about the topic (n=41).**

Some participants echoed this sentiment in the statements made in the learner reports:

*'Meaning making is still different between social & exact sciences & general public. We must work harder to find common ground.'*

And:

*'I want to empower iGem teams who do public outreach to use explicit notions of framing and to go beyond "Synbio is good!" or "do you have a favorable view of Synbio?"'*

## Overall

The first goal of the workshop was to be able to recognize, articulate and deliberate own and others beliefs, values and assumptions related to applications and implications of synthetic biology. When it comes to their own frames both the participants and the stakeholders felt that it was sufficiently explored. We can see some participants getting stuck on opinions and not explore the frames behind them, but we can also see some underlying notions identified by participants. When it comes to other people's frames participants felt less like they understood what they needed to understand. The stakeholders too felt some participants were more focused on their own frame than on someone else's

With regard to the second learning goal, being able to identify patterns: coherent constellations of beliefs, values and assumptions and relate these to frames that consistently appear across public debates on emerging science and technology, we see some difficulty.

Both participants and stakeholders blame this on the complexity of the topic and the short time span to cover it in.

The third learning goal, being able to critically reflect on how to deal professionally with framing processes when designing and implementing public engagement and participation activities in SYNENERGENE, was not explicitly addressed in the workshop and yet an overwhelming majority felt they understood how framing could influence their communication activities on Synbio.

## **Conclusion and recommendations**

*To what extent does the 'frame reflection workshop' contribute to value oriented opinion forming in synthetic biology-related socio-scientific issues?*

To paraphrase the creators of the workshop: The workshop went well, considering time and set up. Frame reflection is a lengthy process. It needs time, which was limited in this two hour introductory workshop. In an ideal situation there would have been a facilitator present for each group. The fact that this was not possible in this particular situation meant that the leaders of the workshop needed to pay extra attention to explaining the theory well and making sure all instructors use the same vocabulary. Working with concrete examples, for example after the first round, worked well. In the second round, where the second order notions needed to be categorized, some more examples could be given, since here there were some misconceptions to be found. The workshop leaders could also consider preparing the large sheets used for distilling patterns and separating categories. It prevents confusion and make sheets less messy.

Especially when exploring the frames behind intuitive reactions participants need the concrete examples of what type of questions to ask each other. Even though steps towards an understanding were made, most participants did not get to full frame reflection. Often participants felt they were done too quickly. The workshop leaders could emphasize that *all* partners understand and agree to an underlying notion. This is an ongoing process. A asks B about initial ideas and comes up with an conclusion. B gives his view on this conclusion (A asks more details) A and B come up with better conclusion. Etc. An underlying notion is not a diagnosis someone else gives you. It is a clarification two people work tentatively towards.

As the stakeholders mentioned not every participant was as willing to listen to and explore their partners underlying frames. The workshop leaders could consider pairing the groups up in three. Not everyone is reflectively gifted and knows how to ask clarifying or reflective questions. Some people are quickly satisfied with a notions while others will dig deeper.

Making groups of three increases the chance to have at least one very reflective member and still provides the safe environment of a small group.

Even though the goal of gaining insight how frames could influence the participants professional life was mentioned on multiple occasions there was no preset moment in the workshop where this was covered. To pay more explicit attention to this goal the workshop leaders could make a slide with this goal of the workshop, a how-to for frame reflection and possible pitfalls.

Overall, the workshop was not perfect but steps towards frame reflection were made. Feedback from the participants showed they had gained insight in their own frames and how frames can affect their work in science communication. This realization of the impact of frames was after all the main goal of the workshop.

## Discussion

Some comments are to be made on the reliability of the research. Some of the arguments made in this report are supported by extracts from the focus group interview with the stakeholders or extracts from the filmed and transcribed observations of the workshop participants. One has to note however that this sort of evidence is always biased since the process of selecting extracts involves a level of judgement on the part of the researcher (Denscombe, 2007, p.199). The extracts are also inherently presented out of context which makes it more likely for the reader to misinterpret their true meaning.

As for the validity of the research, here some improvements can be made. Even though the questionnaire was meant to measure the impact of the workshop, the questions were formulated to measure all knowledge on framing in Synbio, pre-existing knowledge and knowledge gained from the workshop. One of the statements in the questionnaire was: 'It is clear to me how other people could frame Synbio'. One can expect that experts would already agree with this statement before the session even started. Since there were in fact some experts among the participants (for example: the stakeholders) one can expect the results in the questionnaire to be skewed in the favor of the effectiveness of the workshop.

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