CHAPTER 1

Introduction
1. INTRODUCTION

Research and innovation (R&I) within emerging fields, like nanotechnology, synthetic biology and information technology, have great potential to generate solutions that can tackle important societal challenges concerning health, food, energy, transport, the climate, education, equality and security. While the R&I-generated solutions, like new applications, are often intended to have desirable and predictable impacts, they can also have unintended, undesirable and unpredictable impacts on society (Owen et al., 2012). To understand the variety of impacts, scholars often distinguish between hard impacts and soft impacts (e.g., Boerwinkel et al., 2014). Hard impacts concern the risks of R&I applications and their implications for health, safety and the environment. Soft impacts concern more intangible matters, including social consequences arising from R&I applications, such as changes in the way we think, act and organize our lives and societies.

To guide the impacts of R&I in directions that have societal benefits, R&I require structures or principles that ensure responsible development. In response, numerous scholars conceptualized approaches to support this development, such as post-normal science (Functowicz & Ravetz, 1993), transdisciplinary research (Thompson Klein, 2001), mode-2 knowledge production (Nowotny et al., 2001), constructive technology assessment (Rip et al., 1995), participatory technology assessment (e.g., Loeber et al., 2011), and ELSA, which is research into the ethical, legal and social aspects of emerging sciences and technology (e.g., Zwart et al., 2014). In the last decade, a new policy narrative emerged for the governing of R&I, named Responsible Research and Innovation (RRI) (Owen et al., 2012; Von Schomberg, 2013; Kupper et al., 2015). RRI is a form of anticipatory governance (Guston, 2014), involving a shift from individual to collective responsibility to ensure positive outcomes of R&I in the future (Von Schomberg, 2013).

A well-known definition of RRI is “a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)” (Von Schomberg, 2013, p. 69). According to Owen et al. (2012), such a collective responsibility requires the active participation of diverse groups of individuals who are involved in or impacted by R&I (i.e., actors) in integrated processes of anticipation, reflection and inclusive deliberation concerning R&I, its outcomes, impacts and governance.

Within RRI, collective responsibility is required throughout all processes of R&I, rather than based solely on the impacts of R&I (Stilgoe et al., 2013). To realize this, Stilgoe et al. have distinguished four process dimensions that become important in the context of RRI (2013, p. 1570-1572):

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• Inclusion, referring to “small-group processes of public dialogue”, and “multi-stakeholder partnerships, forums, the inclusion of lay members on scientific advisory committees, and other hybrid mechanisms that attempt to diversify the inputs to and delivery of governance”.

• Anticipation, comprising of “systematic thinking aimed at increasing resilience, while revealing new opportunities for innovation and the shaping of agendas for socially-robust risk research”.

• Reflexivity, meaning “holding a mirror up 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 may not be universally held”.

• Responsiveness, involving “responding to new knowledge as this emerges and to emerging perspectives, views and norms”.

These four process dimensions are integrated within existing processes of scientific inquiry.

In addition to these various conceptualizations of RRI, Kupper et al. (2015) have distinguished three RRI outcomes. See Figure 1.1 for a depiction of the relationships between these three RRI outcomes. The first, overall RRI outcome concerns the delivery of R&I-based solutions to societal challenges, meaning that R&I ideally, eventually, contribute to the tackling of issues in health, food, energy, transport, the climate, education, equality and security. The second RRI outcome is the generation of ethically acceptable, sustainable and socially desirable impacts. The third RRI outcome has three components - i.e. learning outcomes: ‘responsible actors’, ‘engaged publics’, and ‘responsible institutions’ (Kupper et al., 2015, p. 18). As can be seen in Figure 1.1, these learning outcomes are of major influence for the realization of the other RRI outcomes.

Of the three RRI learning outcomes, ‘responsible actors’ refers to R&I practitioners, e.g. scientists and technology developers, who take responsibility in being responsive to societal perspectives by aligning their practices with (contemporary) societal needs, concerns, dreams, values, and world views (e.g., see in Stemerding, 2015). This responsiveness can be realized by means of continuous reflection on R&I practices (e.g. see in Schuurbiers, 2011). Table 1.1, adopted from Stilgoe et al. (2013, p. 1570), displays questions that are relevant for such reflection. This reflection-in-practice can help to develop, but also requires reflective practitioner skills (cf. Schön, 1983; 1987). In RRI context, these skills imply the capability of looking at (one’s own) R&I practices from a meta-perspective, which supports R&I practitioners in the continuation of being a ‘responsible actor’.

The RRI learning outcome ‘engaged publics’ refers to non-R&I actors, such as stakeholders and citizens, who take responsibility in being responsive to R&I (Owen et al., 2012). Non-R&I actors can engage in various levels of responsiveness. A relatively low-threshold, first level, is when non-R&I actors engage in continuous self-informing about developments in R&I (Jennings, 2004). A deeper level of responsiveness is when these actors continuously and frequently engage in societal debates and deliberative reflection on R&I (Stilgoe et al., 2014).
Figure 1.1: a depiction of the relationships between the three RRI outcomes.
Table 1.1: questions one could ask concerning R&I (adopted from Stilgoe et al., 2013).

Table 1.1

<table>
<thead>
<tr>
<th>Product questions</th>
<th>Process questions</th>
<th>Purpose questions</th>
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<tbody>
<tr>
<td>How will the risks and benefits be distributed?</td>
<td>How should standards be drawn up and applied?</td>
<td>Why are researchers doing it?</td>
</tr>
<tr>
<td>What other impacts can we anticipate?</td>
<td>How should risks and benefits be defined and measured?</td>
<td>Are these motivations transparent and in the public interest?</td>
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<tr>
<td>How might these change in the future?</td>
<td>Who is in control?</td>
<td>Who will benefit?</td>
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<tr>
<td>What don’t we know about?</td>
<td>Who is taking part?</td>
<td>What are they going to gain?</td>
</tr>
<tr>
<td>What might we never know about?</td>
<td>Who will take responsibility if things go wrong?</td>
<td>What are the alternatives?</td>
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<td>How do we know we are right?</td>
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While the engagement of actors can (in)directly make R&I responsive to societal perspectives (Boerwinkel et al., 2014), it also helps these actors to advance their scientific citizenship skills (Horst & Michael, 2011; Bandelli & Konijn, 2015). These citizenship skills include making sense of contemporary techno-scientific developments, feeling comfortable to discuss them with others, and making well-considered R&I-related choices in line with own principles, needs and concerns (cf. Boerwinkel et al., 2014). Examples of these R&I-related choices are the decision to invest in particular products, to use particular treatments in healthcare, and to vote for certain political parties (van der Meij, 2015). Importantly, by developing such skills, non-R&I actors are more inclined to remain engaged with R&I (Nisbet & Markowitz, 2014).

The RRI outcome ‘responsible institutions’ refers to the structures and organizations that give R&I practitioners opportunities and support to be responsive to societal and non-R&I actors, and vice versa (Kupper et al., 2015). By scaffolding this mutual responsiveness, structures and organizations at the ‘meso’-level (see Figure 1.1) take the responsibility to make the learning outcomes at the ‘micro’-level possible, which in turn can help to make institutions more responsible again, and thereby achieve the other RRI outcomes at the ‘macro-level’.

Although a growing body of literature focuses on the conceptualization of RRI (Wilford, 2015), the practical realization of the RRI process dimensions and outcomes is less investigated. In RRI-conceptualizations, a recurring but little investigated aspect is the reflection on R&I in which RRI process dimensions ‘inclusion’, ‘anticipation’, ‘reflexivity’, and ‘responsiveness’ are employed. To operationalize such reflection, Stilgoe et al. (2014) assign an important role to Science Communication (SC), since practices in this field have increasingly professionalized the facilitation of reflection on R&I between and among various R&I and non-R&I actor groups (see e.g., Bucchi & Trench, 2008). Stilgoe et al. (2014) distinguish between policy-motivated initiatives, more formally organized and aimed at the direct or eventual informing of R&I policy, and policy-free initiatives, which are generally more informally organized by ‘bottom-up’ initiatives. The former is often referred to as ‘participation’; the latter
is often gathered under the term ‘engagement’ (Stilgoe et al., 2014). Both practices can concern the reflection among societal actors, between R&I and non-R&I actors, or between R&I actors (i.e. ‘within R&I’). In this thesis, we gather the various existing and the desired RRI-specific initiatives for the facilitation of reflection on R&I under the umbrella term RRI-reflection.

If we translate previous investigations into facilitating reflection on R&I to the context of RRI, we can derive that the challenges of designing and facilitating RRI-reflection are manifold. Firstly, the realization of process criterion ‘inclusion’ means that a (often-unpredictable) diversity of people can participate. When emerging and potentially controversial R&I are discussed, all participants may put legitimate perspectives to the fore. The diverse natures of these perspectives can make it complex to compare them (Wynne, 2001). As a result, misunderstandings can arise, discussions can polarize, and minority viewpoints can be overlooked (Carpini et al., 2004). Therefore, strong conversational facilitation structures are needed to guarantee equality, fairness and respect (Rowe and Frewer, 2000; 2005).

Secondly, conversing about R&I can be complex for people (Felt et al., 2014). This challenge especially complicates the realization of RRI-criterion ‘anticipation’. For some people it is hard to imagine what emerging R&I and potential applications or implications may look like (Rowe & Watermeyer, 2013). Others even refrain from imagining potential applications; adhering to the idea that one should abstain from speculative ethics (cf. Nordmann, 2007). These are logical consequences if emerging technologies are in a very conceptual stage (Felt et al., 2014), but ideally, these abstractions, complexities, and uncertainties surrounding R&I are to be embraced.

Thirdly, the realization of ‘reflexivity’ as defined by Stilgoe et al. (2013) can be a challenge in RRI-reflection too. The talking about facts related to R&I is for many people a rather common activity these days, the conversing about deeper notions such as values is less common (Dietz, 2013). As a result, people can feel insecure in talking about deeper notions when reflecting on R&I, as it is rather unfamiliar to them (Kupper & De Cock Buning, 2011; Broerse & de Cock Buning, 2011).

Last, realizing ‘responsiveness’ is challenging for it asks people to change or act. It can be hard for R&I actors to act responsive if societal reflections do not deliver (personalized) operationalization perspectives, especially since “existing, internal responsibilities often take precedence over a researcher’s broader social responsibilities” (Schuurbiers, 2011, p. 285). On the side of non-R&I actors, the engagement in reflection on R&I hardly has so much (long-term) impact that a person permanently continues to reflect on- and engage in R&I (Felt et al., 2014), especially if a person feels no direct or personal relevance or importance to do that.

2. Although the term ‘reflection’ may seem similar to Stilgoe et al.’s dimension ‘reflexivity’, we see ‘RRI-reflection’ as a means to realize each of the RRI process dimensions (individually or combined).
Considering the multidimensional challenges of RRI-reflection as described above, we could argue that RRI-reflection needs to be designed in such a way that it helps participants to adopt an attitude that is motivated to open-up for diversity, complexity, uncertainty and ambiguity. Playfulness is such an attitude; it implies a judgment-free, intellectually curious and flexible consideration of a topic or situation (Dewey, 1910). Publications on playful learning show that the use of playful tools and formats can make children and adults at ease in coping with complex topics or issues (e.g., Gaver, 2002; Fisher et al., 2013; Jacobs & Heracleous, 2007; Poplin, 2012; Triantafyllakos, et al., 2010; 2011). Playful learning can support people in expressing their thoughts, negotiating viewpoints in a respectful manner, and thinking of new ideas (e.g., Jacobs & Heracleous, 2007; Poplin, 2012; Triantafyllakos, et al., 2010; 2011). With these benefits of playfulness in mind, we argue that playful RRI-reflection methods could support participants to cope with the complexities, uncertainties and ambiguities of R&I, the diversity of participants and their viewpoints, and in the realization of ‘depth’ in RRI-reflection.

A handful of scholars conducted research into the facilitation of playful reflection on R&I. For example, Cox et al. (2009) and Wieringa et al. (2011) investigated theatre as a method for reflection on biotechnology, while Felt et al. (2011) studied an interactive card-based format for Public Engagement in nanotechnology. Bradburne (2000), Allen (2004), and Bandelli & Konijn (2009) explored frameworks for hands-on activities and events in science centers and museums that can facilitate reflection on R&I, while more practical examples of exhibits can be found in Delicado, (2009), Yaneva et al. (2009), Horst & Michael (2011), Kerbe and Schmidt (2013) and (Skydsgaard et al., 2016). Furthermore, Schmidt et al. (2015) and Lucivero (2016) investigated reflection by means of narratives, while Davies et al. investigated a variety of formats (2009; 2012). All these investigations concluded that the tools, formats or methods evoked rich (forms of) reflection among participants that engaged in the processes or spaces.

Although these studies into the facilitation of playful reflection on R&I could be an inspiring base for new playful RRI-reflection method design, current studies hardly conceptualize the tools, formats or methods as playful. More generally, according to Felt et al. (2014), few studies put emphasis on the ‘materiality’, being the design ingredients and designs of tools that are used in the reflection on R&I. Furthermore, many scholars merely seem to use tools and formats as a means to gain insight into the public perceptions regarding R&I (e.g., Cox et al., 2009; Wieringa et al., 2011; Kerbe & Schmidt, 2013). Also, studies hardly investigate the exact reflection that causes people to develop their R&I perspectives. As a result, there seems to be a lack of systematic investigation into RRI-reflection method designs with a focus on playfulness in relation to the reflection among actors that occurs as a result of these designs.
In this thesis, therefore, I aim to provide a breeding ground for the systematic designing of playful RRI-reflection methods, by investigating various RRI-reflection methods that exploratively practiced the realization of the RRI process dimensions ‘reflexivity’, ‘inclusion’, ‘anticipation’, and ‘responsiveness’ (cf. Stilgoe et al., 2013), or a combination thereof, in relation to reflection on R&I, among various people, in various settings. We seek an answer to the following main question:

**How can playful tools and formats contribute to RRI-reflection?**

To answer this question, we conducted a narrative literature review first, which yielded playfulness design principles. Then we used these principles to exploratively design and evaluate five playful RRI-reflection methods. All five methods were meant to evoke playfulness among participants, helping them to cope with the diversity, complexities, unknowns, uncertainties and unfamiliarities surrounding RRI-reflection. In our explorations we focused on policy-free reflection methods (cf. Stilgoe et al., 2014). Furthermore, our RRI-reflection methods focused on facilitating reflection among homogeneous groups of R&I actors and societal actors (separately), for the (eventual) practical realization of RRI learning outcomes ‘engaged publics’ and, to a lesser extent, ‘responsible actors’ (cf. Kupper et al., 2015). The next chapter conceptualizes reflection on R&I, playfulness and reflection environments, which serves as a base for the studies that are part of this thesis.
CHAPTER 2

Theoretical framework
2. THEORETICAL FRAMEWORK

As described above, RRI is characterized by an interplay between reflection and R&I governance. Therefore, this thesis uses a framework for reflection built on several models for learning and reflection in R&I practices and policy-making. This chapter proceeds to describe these models, followed by a conceptualization of the design elements for RRI-reflection methods, and in particular playfulness design elements that can support RRI-reflection.

2.1 From learning in- to reflection on R&I

People that engage in innovation, often experience new situations in which they have never engaged before. Therefore, they learn through experiencing the innovation practices (Regeer, 2009; Sol et al., 2013). Kolb proposed a cyclic process for experiential learning: (1) observe and reflect, (2) form concepts and generalize, (3) test concepts in new situations, and (4) experience concretely (1976). In experiential learning people ideally move through all learning phases, in any possible order, while they often have a preferred starting point (ibid). Going through all phases helps people to successfully apply the obtained knowledge in other (new) contexts too (Kolb, 1976; Tsai & Lee, 2006). Tsai and Lee (2006) added that going through Kolb’s learning cycle, produces ‘know what’, ‘know how’, ‘care why’ and ‘know why’ insights. The sum of these insights helps people to define whether things could be improved (ibid).

When direct R&I experiences are not readily available to somebody, e.g., among people novice to R&I, learning from vicarious experiences can be a good alternative (Bandura, 1977). It means that the ‘novices’, in this thesis stakeholders who are not directly involved in the R&I practice itself, learn from (stories about) experiences of others who engaged in the practices more closely or earlier (Myers et al, 2012). Following Tsai and Lee (2006), such vicarious learning could also make learners knowledgeable about R&I practices, and how this can be optimized.

Knowledge gained from experiences is often tacit, meaning that it hides in the context in which it was obtained (Regeer, 2009). The elicitation of this tacit knowledge, e.g., through the sharing of experiences, can support people in learning in and about innovation (Sol et al., 2013). In other words, learning within and about R&I happens through interactions with others.

For the context of learning in multi-stakeholder R&I practices, Gordijn and Helder assign an important role to reflection (2013, p. 33):

“Reflection is a process that promotes deeper learning as it involves consciously thinking about and analysing an experience. It enables learners to activate prior knowledge and to construct, deconstruct and reconstruct their own knowledge. Reflective learning involves stepping back from an
event or experience to analyse it from different perspectives in order to make sense of it, and to improve future performance”.

Taking this as outline, RRI-reflection that takes place among R&I actors, could be considered as a process of looking (back) at the full learning cycle of Kolb, the insights this yielded and the exploration of insights that other people gained from engaging in (the same or comparable) R&I, in order to make sense of the R&I practices, and to improve further actions.

Looking at the questions concerning R&I that are at stake in RRI contexts (see Table 1.1), we could link this to (vicarious) reflection on insights gained from experiences as follows:

- Reflection on what the R&I, its products, and the R&I system are or could be, link to reflection on ‘know what’.
- Reflection on how R&I happen or should be practiced, especially in terms of people, safety, responsibilities, transparency and control, link to reflection on ‘know how’.
- Reflection on benefits and stakes that various people have or should have with regard to the R&I, link to reflection on ‘care why’.
- Reflection on current and desired R&I purposes or motives, link to reflection on ‘know why’.

Therefore, we consider RRI-reflection within R&I as the reflection on the what’s, how’s, benefits, stakes, purposes and motivations concerning own R&I practices, and that this is aimed at identifying ‘what is’ and defining ‘what should be’.

In RRI contexts, however, reflection on R&I opens up to people from outside R&I too, such as citizens or stakeholders that are not directly ‘doing R&I’ but could affect or be affected by R&I (Owen et al., 2012; Kupper et al., 2015). In that case, the reflection addresses (emerging) R&I that is ‘done’ by others, in relation to global challenges. As a result, the reflection as described above may not suffice. Firstly, developments in R&I can change society, e.g., by generating new applications that bump into the boundaries of lifestyles and world views; old norms and values may not suffice anymore, new norms and values may emerge or become important (see Swierstra & Rip, 2007). As a result, one could say that ways of defining ‘what is’ and ‘what should be’ R&I in relation to its societal context need explicit (re-) consideration. Secondly, the world views, norms and values of various actors can be very different or even conflicting due to their very diverse backgrounds (Broerse & De Cock Buning, 2011). When people encounter others and discuss viewpoints, they often cannot develop mutual understanding when the rationales behind their viewpoints remain un-addressed (McKee, 2003). As a result, RRI-reflection processes that do not explicitly address the rationales behind viewpoints, such as norms and values, may lead to a deadlock.
2.2 Frame reflection

A strategy to (make people) address, rethink and reconsider rationales behind thinking and doing, could be found in a process that Schön and Rein call ‘frame reflection’ (1994). Frames are “structures of belief, perception, and appreciation” (Schön & Rein, 1994, p. 23), which determine a person’s stance towards a topic. They are (re-)constructed through a process called framing, mostly by interacting with others, in which new situations are considered and compared to what is already known (Ibid; Cornelissen & Werner, 2014; Dewulf & Bouwen, 2012; van Hulst & Yanow, 2014). Schön and Rein (1994) describe that this interactive process of assigning meaning to a new issue or situation at hand, ideally also focuses on the elicitation and reflection on the structures of belief, perception and appreciation. They argue that such frame reflection can lead to looking at the topic or issue more freely, and if occurring in an inter-personal setting, this can eventually lead to mutual understanding of diverse viewpoints. In that sense, frame reflection could be considered as a crucial reflection process to prevent that incommensurable viewpoints lead RRI-reflection to an impasse.

2.3 First, second and third order reflection

In addition to frame reflection, a complementary strategy can be derived from Grin and van der Graaf’s conceptualization of reflection for policy making (1996). They distinguished between first and second order reflection. First order reflection comprises activities such as problem defining, evaluation of effectiveness, effects and side effects, and the weighing of various alternative solutions that can solve the problem at stake (Grin & van der Graaf, 1996). Translating this to RRI-reflection context, first order reflection means the careful analysis of problems, benefits, effects, and solutions in relation to R&I practices, which is rather similar to the reflection described in Section 2.1.

However, in order to lead to better mutual understanding among people argumentation underlying the opinions, such as underlying values and assumptions, should be reflected on as well (Grin & van der Graaf, 1996). This is called second order reflection (ibid). Translating this to RRI-reflection context means that second order reflection comprises the discovery and elicitation of values and assumptions that underlie first order reflection on R&I.

In addition to first and second order reflection, Yuthas et al. (2004) described one other form of reflection that they call deutero-learning, in which “the learning becomes intentional as the learner turns attention toward reflecting on the process of learning itself” (p. 238). It makes people look at learning processes from a meta-perspective, and increases the likeliness that learning becomes a continued process.

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1. As Grin and van der Graaf do not describe the exact meaning of ‘values’ and ‘assumptions’, I derive their definitions from different authors. Values refer to situation-transcending concepts or beliefs that guide a person’s evaluation of actions in certain order of importance (Dietz, 2013). Assumptions are technical, social or political world views that people adhere to (Irwin, 2001). Both values as well as assumptions determine how a person forms a view of science or technology (Irwin, 2001; Dietz, 2013).
(ibid). We consider deutero-learning as desirable especially to the continuation of reflection on R&I beyond organized RRI-reflection events and processes. In this thesis, we refer to it as third order reflection. Figure 2.1 depicts conceptually summarizes the reflection orders as described in this section.

When facilitated in an interactive setting, first, second and third order reflection could be linked to frame reflection (See Figure 2.2).

**Figure 2.1:** schematic overview of learning in R&I practice (right), the first order reflection on R&I (2nd from right), the second order reflection (2nd from left), and third order reflection (left).

**Figure 2.2:** a schematic visualization of frame reflection in relation to various orders of reflection. Legend: P stands for problems, S for solutions, V for values and A for assumptions. The bigger dotted circles represent people’s minds.
Imagine that the big circle of Figure 2.2 represents a person’s mind. When encountering a new issue or situation, first order notions about problems and solutions around that issue are being formulated (the small circles with ‘P’ and ‘S’). These first order notions are consciously or unconsciously linked to one another and/or to second order notions (‘V’ and ‘A’, representing values and assumptions). In interaction with the outside world, with other people and their perspectives during a reflection process, the notions are being (re-)considered, (re-)connected, broadened, demarcated, and (re-)constructed (see e.g., in Dewulf and Bouwen, 2012). Third order reflection then would involve a person’s capability to describe and reflect on this full process.

2.4 RRI-reflection methods

To describe our interpretation of the umbrella-term ‘RRI-reflection method’, this thesis builds upon various science communication formats that have been developed for multi-stakeholder and public interaction, learning and reflection on science and technology:

- Public dialogue (e.g., see Davies et al., 2009; Davies, 2011).
- (Upstream) Public Engagement (e.g., see in Wilsdon & Willis, 2004; Rowe & Frewer, 2005; Broerse & De Cock Buning, 2011; Felt et al., 2014; Krabbenborg & Mulder, 2015).
- Public Participation (e.g., see Rowe & Frewer, 2000; 2004).
- Public deliberation (e.g., see in Davies et al., 2012; Korthals, 2011).
- Exhibit(ion)s about controversial science or technologies in science centers or museums (e.g., Delicado, 2009; Skydsgaard et al., 2016; Stocklmayer, 2005; Yaneva et al., 2009; Horst & Michael, 2011).
- Formal reflection on R&I in classrooms (e.g., Knippels et al., 2009; Boerwinkel et al., 2014).

First, when looking at these formats, they generally comprise physical spaces (see Figure 2.3), in which people voluntarily engage. Although online deliberation has been explored (see e.g., in Delborne et al., 2011; Coleman & Moss, 2012), direct, face-to-face interaction seems still considered as the most common form. Second, the reflection often employs a step-wise logic, in line with particular aims set beforehand. Some formats may facilitate more open conversations (see in Davies, 2011), but generally speaking, the format seems regularly designed with certain structure. Third, there are supportive tools embedded in the environment, either tangible tools, or in an online-offline combination (cf. Jones & Lau, 2010; Ahmed, 2010; Sherry & Gibson, 2002). Such hybrid formats can, consequently, comprise the use of online tools (e.g., videos or databases) in an offline workshop format, in which other tangible tools may be used as well.

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2. Dewulf and Bouwen (2012) described various strategies that people apply when interacting with others. If people deliberatively accommodate, connect, disconnect or oversee links between own and other people’s notions (the little circles and dots in Figure 2.2), the likeliness increases that conversations lead to mutual understanding.
Chapter 2

2.5 Playfulness for RRI-reflection

The realization of RRI-reflection could benefit, as briefly mentioned in Chapter 1, from well-designed RRI-reflection methods that pay attention to the triggering of playfulness among participants. This thesis presents a literature review that describes the design elements for reflection environments in RRI contexts that are needed in order to trigger playfulness (van der Meij et al., 2017a; see Chapter 4). As our research methodology largely depends on this framework, we provide a summarizing preview here.

In order to trigger playfulness among participants of RRI-reflection environments, their designs need to apply one or more of four playfulness activity principles (‘narration’, ‘imagination’, ‘action-reflection’, and ‘co-creation’) and three playfulness process conditions that make the activity principles functional (‘focus’, ‘experimentation space’, and ‘stimulating guidance’).
Activity principle narration refers to the use of stories, e.g., future or citizen-narratives about R&I, to trigger reflection. Narratives are mostly recognizably structured and personal, which makes them identifiable for the ‘receiver’. In case this receiver agrees with the content represented in the narrative, this can make him/her feel acknowledged, which can trigger him/her to actually share the own viewpoint as well. In case the narrative represents a viewpoint that differs from the receiver’s viewpoint, the identification power of narratives can help the receiver to step in the shoes of another person and its perspectives, which can eventually bring about understanding for other viewpoints too (e.g., Kangas, 2010; Laren et al., 2013).

Activity principle imagination comprises the use of ambiguous objects, visualizations, images, or other senses-stimulating triggers such as sounds during the reflection process. Ambiguity provides certain interpretation freedom, which helps participants to think of alternative ideas, perspectives, futures, dreams and concerns with regard to the R&I at stake in the process (e.g., Terrenghi et al. 2006; Jacobs and Heracleous 2007; Lindley et al. 2009).

Activity principle action-reflection comprises the immediate testing of particular thoughts in a safe reality, such as role-play, immediately followed by reflection on the action performed. Such activities help people to test ideas and (fore)see consequences of particular thoughts and actions (e.g., Price et al. 2003; Alcock 2010; Caci et al., 2013).

Activity principle co-creation means the collaborative creation of thoughts or objects. Through negotiation, the co-creators learn to understand each other viewpoints and, if necessary for the process, might reach certain alignment or even consensus in thinking (e.g., Kangas, 2010; Ferguson 2011; Poplin 2012).

The process condition focus means the application of small steps in the process of reflection, and demarcation of the topic at stake, an R&I field as a whole, to smaller subtopics such as specific applications of the field, or a focus on particular ethical considerations or societal dilemmas and implications. Such ‘focus’ assures that participants talk about the same, which makes them reflect more deeply, but also helps as a starting point around which diverse viewpoints can be explored (e.g., Jacobs and Heracleous 2007; Berkovski et al, 2012).

Process condition experimentation space involves the explicit stimulation of participants to eliminate judgment, be flexible, and take the time during their exploration of thoughts. This enhances the space for diversity during the process (e.g., Alcock, 2010; Kera, 2014).

Last, the process condition stimulating guidance comprises the guiding and active rewarding of participants throughout the process, resulting in larger engagement and thereby an effortless experience. This can be done by a facilitator or by the use of rules and principles by which participants stimulate one another (e.g., Triantafyllakos et al., 2010; 2011).
The playfulness activity principles can be combined or used in any sequence or combination in an RRI-reflection method, depending on the aims of the organizers or facilitators. The process conditions are, in contrast, preferably all applied in each method. Nevertheless, relatively little is known about the interplay between the elements and how they contribute to reflection in RRI-reflection practice (Van der Meij et al., 2017a). In the next chapter, we explain how the design principles have been applied in various RRI-reflection methods (practice) in order to investigate their interplay and contribution to reflection on R&I.
CHAPTER 3

Research design
3. RESEARCH DESIGN

To answer the main question on how playful tools and formats can contribute to RRI-reflection this thesis uses a case study methodology, so that insights from earlier cases could be adopted into new cases (George & Bennett, 2005; Siggelkow, 2007). The chosen approach builds on principles of Design-Based Research (hereafter DBR, cf. Edleson, 2002; Barab and Squire, 2004; Wang and Hannafin, 2005). Rooted in educational research, DBR is an approach in which educational practitioners act as education designers and researchers simultaneously (Wang and Hannafin, 2005). Through an iterative process, the practitioner develops theory for educational design, applies this in practice, and thereby evaluates and furthers the theory for new practical contexts (Edleson, 2002; Barab and Squire, 2004). Although the exact procedure of DBR varies, we adopted a DBR approach as described in Amiel and Reeves (2008), since their context of using new (technological) tools in educational settings shows similarities to the use of tools and facilitation for RRI-reflection that are at stake in this thesis. Amiel and Reeves described four steps for DBR: (1) the analysis of a practical problem, followed by the (2) development and (3) testing of solutions based on design principles identified in step 1, and (4) reflection on the development and testing in order to improve the design principles and practical solutions (2008). Inspired by this DBR approach, we conducted (1) an extensive analysis on playfulness and learning to identify a theoretical framework on playfulness design elements (Chapter 4), (2) applied and (3) tested various combinations of these elements in RRI-reflection methods in various contexts (Chapters 5-9), and (4) thereby gained new insights with regard to the design elements and for the designing of new playful RRI-reflection practices (Chapter 10, and see Figure 3.1). The researchers that performed the case studies played a major role in designing, applying and evaluating the reflection methods. This section proceeds to detail the study questions and steps that were taken.

Figure 3.1: the iterative DBR approach applied for this thesis.
3.1 Research questions and studies

3.1.1 Building a design framework for playfulness in RRI-reflection

Since the conceptualization of playfulness design elements in literature on learning and reflection is rather limited, the first study question we formulated for this thesis was:

1. What playfulness design elements for tools and formats could, according to state of the art literature, contribute to RRI-reflection?

To answer this question, we conducted a narrative literature review (cf. Sylvester et al., 2013). We investigated numerous scholarly publications on playful learning and reflection. This yielded seven design elements for the triggering of playfulness among people engaged in reflection, theoretically enabling them to cope well with the unknowns, uncertainties and unfamiliarities that come along with RRI-reflection. As briefly described in section 2.5 and elaborately presented in Chapter 4, the literature review divides the seven playfulness design principles in four activity principles, ‘narration’, ‘imagination’, ‘co-creation’ and ‘action-reflection’, and three process conditions: ‘focus’, ‘experimentation space’ and ‘stimulating guidance’.

The outcomes of the literature review were the foundation for the design of playful RRI-reflection methods that we investigated in five case studies, described in Chapters 5-9. We formulated three study questions to guide the case studies of this thesis:

2. How do various combinations of identified playfulness design elements lead to reflection in real-life RRI-reflection contexts?

3. What new contributions and limitations of the literature-based playfulness design elements arise in real-life RRI-reflection contexts?

4. What synergies and trade-offs between literature-based playfulness design elements arise in real-life RRI-reflection contexts?

In the next sections, we describe the five case studies conducted to answer these questions.
3.1.2 Heading towards playful reflection

The first opportunity to apply the playfulness framework was provided by a small responsible innovation network in the Netherlands called Regional Ateliers\(^1\) (hereafter RAs). RAs throughout the Netherlands function as communities for the realization of local, agricultural sustainable development. Each RA has a manager that incites innovation trajectories in rural areas by facilitating collaboration between local schools, research institutes, enterprises, NGOs, governmental organizations and citizens.

The RA managers and stakeholder involved in four of the twelve RAs in the Netherlands faced several issues in managing and implementing the sustainable development projects. For the facilitation of reflection among the people engaged in the RAs, we designed a video-narrative based reflection method called TransLearning. In the TransLearning method we did a careful attempt to apply the playfulness activity principle ‘narration’. A broad diversity of actors engaged in the RAs were invited for interviews, during which the interviewee and interviewer co-created narratives about authentic learning experiences of the actor’s engagement in sustainable development in the RA. These authentic narratives were video-recorded, cut into 3-minute clips and embedded in an online tool that allowed free browsing through the clips on the basis of keywords that represented their content.

In informal workshops, facilitated by the researchers, the RA stakeholders, who all actively collaborated in the sustainable development projects, were invited to browse through these clips in three rounds. Alternated with plenary reflection rounds, the insights gained from the browsing were collected and reflected on. We applied the playfulness process condition ‘experimentation space’ during the workshops by giving total freedom for participants during the browsing. The plenary workshop facilitators implemented playfulness process conditions ‘focus’ and ‘stimulating guidance’, as they gave clear instructions during the reflection and rewarded participants for sharing their reflections and newly gained insights.

The TransLearning video-narratives and the transcripts of the plenary workshop conversations were analyzed to identify patterns in the reflection that the narratives triggered during the TransLearning workshops. The TransLearning findings gave the insight that reflection by means of authentic video-narratives could incite certain playfulness among workshop participants, e.g., in behaving freely, openly and creatively, which in turn benefitted the reflection that took place during the workshops. Participants clearly combined and compared aspects of the video-narratives to construct their own stories in a creative manner, and the method sparked their thinking in unusual directions to develop innovative ideas for the improvement of their sustainable development trajectories. Yet, case study 1 also showed that inciting playfulness might require (1) less numerous and better designed narratives, and (2) additional means to structure and deepen the reflection. The case study is presented in Chapter 5.

\(^1\) Kenniswerkplaatsen in Dutch, see: http://www.kenniswerkplaats.eu/
3.1.3 Case context for case studies 2-5

Synenergene, a European consortium for RRI in synthetic biology\(^2\), provided opportunities to conduct four additional case studies into playful RRI-reflection methods. In these case studies, we could test the use of narratives in various ways and in addition apply several combinations of other playfulness design elements.

Synthetic biology (hereafter SB), the R&I field at stake in Synenergene, served as an interesting case for investigation into playful RRI-reflection methods. SB uses biotechnology to design and build new biological products and systems with specific preconceived functionalities (cf. Schmidt et al., 2009), in a more systematic way than the “trial and error” approach of genetic engineering (Boldt, 2016, p. 2). Ancillotti et al. (2016) concluded that many discussions on “biosafety and biosecurity, intellectual property rights, environmental consequences, and ethical and societal implications” are still uncovered and undecided (p. 309). Various scholars addressed SB as (potentially) controversial (Balmer & Martin, 2008; Torgersen & Schmidt, 2013). Furthermore, in so far, there are not many tangible applications of SB that could support thinking of potential impacts of the field (Rerimassie et al., 2016). This absence can make it hard for people to reflect on a field, especially if they are from outside R&I (Felt et al., 2014). Therefore, we argue that SB needs deliberation in the societal arena to ensure RRI in SB (e.g., Blümel, 2016; König et al, 2016; Piaggio et al., 2016), and we add to this that playful reflection methods can support people in sensing or envisaging and thereby reflecting on the field.

In case studies 2-4 (Chapters 6-8) we adopted the TransLearning idea of video-narratives for reflection, but modified the principles of the method in two ways. Firstly, the TransLearning approach showed that too many video-narratives blurred the reflection process. It challenged playfulness activity principle ‘focus’, as an abundance of videos made people less focused in their reflection. The large number of clips resulted in conversations about many different issues at the same time, thereby threatening the depth of the reflection. Therefore, the subsequent case studies were built upon the assumption that people can only process a limited amount of information (Mayer, 199; Mayer & Moreno, 2002). We decided restrict the number of narratives that would be provided in each reflection method of case studies 2, 3 and 4.

Secondly, in TransLearning, the use of authentic narratives seemed functional for the identification of viewers with the narrator as to support the reflection in this narrator’s viewpoints. However, the (relatively) low information density of authentic narratives seemed to hamper their relevance and effectiveness for reflection. Therefore, case studies 2, 3 and 4 applied a more scripted variant of narratives for reflection: ‘semi-scripted reality’ narratives. This type of narrative is usually applied in reality shows ‘behind the screen’ (DeAngelis, 2014), and basically comprises a mix of scripted and unscripted stories. To make scripts for the narratives we used a framework derived for Dutch citizen views on synthetic biology as conceptualized in Betten et al. (2017). The four viewpoints are visualized in Figure 3.2.

\(^2\) See: https://synenergene.eu/about
The left quadrants in Figure 3.2 represent viewpoints that consider humans and technology as opposite worlds, while the viewpoints of the right quadrants consider humans and technology as part of one, integrated world. Furthermore, the upper quadrants of Figure 3.2 represent viewpoints that consider human beings as dominant in steering technology, while the views represented by the bottom quadrants see technology as something that steers itself and cannot be steered by humans, with negative and positive consequences. Since the case studies were predominantly located in the Netherlands\(^3\), the Dutch citizen viewpoints of Betten et al. (2017) were assumed as representative for a cross section of our participants.

For a good ‘focus’, the workshop- as well as the narrative-design in case studies 2 and 3 followed our conceptualization of first and second order reflection (see Chapter 2). As a result, they covered three consecutive topics that could address one or more questions:

1. First order reflection: ‘what is synthetic biology?’ and ‘what will be the impact of synthetic biology on our future society?’
2. Second order reflection: ‘what is the relationship between human beings and technology?’
3. First order reflection (again): ‘what is the adequate ethical approach to synthetic biology?’

\(^3\) In case study 3 reflection sessions were done with Dutch high school and Master students, performed in the Netherlands, but also with international iGem students, which were performed in Boston.
3.1.4 Case study 2: Experiment with semi-scripted video-narratives

Case study 2 comprises a video-narrative based reflection method (hereafter VNBR). In the videos, improvisation actors narrate their stances to SB, in accordance to the four citizen-viewpoints as presented in Figure 3.2, and the three topics presented above. In contrast to case study 1, we engaged people from outside R&I to test the methods; we performed individual and group reflection sessions with citizens of various backgrounds and ages. By testing the method with people from outside R&I, we hoped to enable ourselves to unravel more insights into the design of playful reflection tools suitable for a variety of (societal) groups. The case study is presented in Chapter 6.

3.1.5 Case study 3: The Frame Reflection Lab

Case study 2 showed that especially the second order reflection, reflection on values and assumptions, was in need of more tools than only video-narratives. This resulted in the set-up of case study 3, which differed from case study 2 in several ways. First, case studies 1 and 2 had given us the idea that frame reflection could serve as an adequate direction for reflection on an emerging R&I field like synthetic biology. As a result, case study 3 was more explicitly focused on facilitating reflection on peoples’ various ways of framing synthetic biology (see Chapter 2), as opposed to facilitating reflection more generally, like in case studies 1 and 2.

Second, case study 3 comprised a playful reflection method in which we made use of the video-narratives on synthetic biology of case study 2, but also added other playfulness activity principles and process conditions. Baptized as the Frame Reflection Lab (hereafter FRL), the method comprised the viewing of the video-narratives in three rounds (in accordance to the three topics presented above), card- and canvas-based co-creation exercises in relation to these, and more explicit group conversation facilitation. The cards provided to support the FRL exercises were comparable to the cards used in Felt et al.’s Public Engagement format for nanotechnology (2014): they contained abstract visualizations and keywords, in our case about values or assumptions that can underlie a view of SB.

With these ‘value and assumption cards’, we hoped to trigger certain imagination: as the visualizations and keywords were multi-interpretable, they could provide a base for different perspectives to be elicited during the reflection. With the collaborative canvas exercises, we aimed to trigger scrutinizing of narratives and viewpoints of the participants themselves. We assumed that the sum of these tools, exercises and facilitation embedded in the FRL would give more insights in the application of playfulness activity principles ‘narration’, ‘imagination’ and ‘co-creation’, and playfulness process conditions ‘focus’, ‘experimentation space’ and ‘stimulating guidance’.
Third, we decided to diversify the groups of participants among which we would test the FRL method, to study whether one playful tool for reflection could possibly work for various people. As a result, we conducted test sessions with high school students, Master students, and students of the iGem competition, a competition in genetic engineering. The latter group could be considered as young researchers who are likely to become active in the SB. The high school students did Gymnasium (preparing for academic education in general). The Master students were enrolled in a Master program of Global Health and Management, Policy and Entrepreneurship (social sciences). The study is presented and discussed in Chapter 7.

3.1.6 Case study 4: The Opinion Lab

Inspired by the potential of the FRL to facilitate reflection on SB viewpoints among the variety of ages and backgrounds, we conducted more research into the facilitation of frame reflection within a different context, and with younger participants. At that time, science museum NEMO, Amsterdam, had just opened an R&D lab for researchers to test new formats for ‘science learning’. Considering that science centers have an increasing interest to play a role in RRI (Bandelli & Konijn, 2015), we developed an exhibit prototype aimed at triggering reflection on SB among the most evident visitor group of the NEMO science museum: children aged 8 to 12 years, and their parents. ‘Baptized’ with the name Opinion Lab (hereafter OL), we could test the prototype in NEMO’s R&D lab.

The OL exhibit prototype design applied design characteristics comparable to the FRL, albeit adjusted to a museum format. As a result the OL applied playfulness activity principles ‘narration’, ‘imagination’ and ‘co-creation’, and all playfulness process conditions of Chapter 4. The prototype comprised a puzzle to compose DNA, a digital interface in which the child could figure out what (fictitious) synthetic organism(s)he had created with the DNA composition, several audio-narratives that supported them in reflecting on their opinion with regard to this synthetic organism, and a drawing exercise to close the session. In the R&D lab, one child and one parent were allowed at a time, upon invitation of the researcher, who facilitated the conversations in the 20-minute test session.

A crucial difference between the FRL and OL method was the increased ‘focus’. The children, parents and facilitator just spoke about one synthetic organism, representing an SB application in sustainable development, health or food:

- A plastic eating bacteria (based on an iGem project).
- An illness-detecting bacteriophage (based on Budynek et al., 2010).
- Fruit plants that make a part of their own nutrients and therefore can easily grow in places with nutrient-poor soil (based on Lau et al., 2014).

4. See: http://igem.org/Main_Page
5. See: https://www.nemosciencemuseum.nl/nl/wat-is-er-te doen/activiteiten/nemo-research-development/
6. See: http://2012.igem.org/Team:UC_Davis/Project
As a result of this choice, we also applied playfulness design element ‘imagination’ more dominantly in the OL design. The synthetic biology applications at stake in the reflection sessions were based on applications that R&I are still working on (research phase). To make the SB applications imaginable, we added several fictitious elements to the description of each organism. Chapter 8 describes this fourth case study in detail.

3.1.7 Case study 5: Theatrical debate

One playfulness activity principle had not been explored in relation to reflection in the first four case studies: ‘action-reflection’. Therefore, one more case study was undertaken into a theatrical debate (hereafter TD) about SB. As the title reveals, this method for citizens-reflection on R&I combines theatre, in the form of semi-improvised sketches about futures with R&I, with facilitated debate (van de Poel et al., 2017). In other words, ‘narration’, ‘imagination’ and ‘action-reflection’ are combined with all playfulness process conditions. Based on previous experiences with this method on the emerging field of nanotechnology (ibid), we developed a comparable method on the field of SB and organized three TD events in the Netherlands.

The TD existed of four scenes, of which each comprised: (1) a sketch played by improvisation actors about a possible future with one particular synthetic biology application embedded in daily life, followed by (2) moderator-guided reflection debate among all visitors on the sketch at stake, after which (3) the actors re-played the sketch, and (4) a wrap-up. Like in the OL, the sketches had a ‘focus’ on one SB application in sustainable development, health or food, and the semi-improvised play focused on particular dilemmas surrounding these synthetic organisms. Data was gathered by means of (1) Learner Reports (cf. van Kesteren, 1993) handed-out at the end of the events, (2) after-event interviews with participants that visited the TD events, and (3) TD event transcripts. With this method we could unravel the reflection evoked by the TD format, and contributions of playfulness design elements that were applied in the TD, to this reflection. This final case study can be found in Chapter 9 of this thesis.

Table 3.1 provides a brief overview of the study questions, participants, and data gathering techniques of each study that is part of this thesis. The separate studies described in Chapters 4-9 elaborate more on the data gathering and analysis techniques that were applied.

3.2 Validity

In this section, we elaborate on how validity was considered in our methodological choices.
Table 3.1 Overview of studies embedded in this thesis and their basic characteristics.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study question(s) at stake</th>
<th>Data sources / Participants</th>
<th>Data gathering techniques</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Narrative literature review</strong></td>
<td>1. What playfulness design elements for tools and formats could, according to state of the art literature, contribute to RRI-reflection?</td>
<td>26 scholarly articles</td>
<td>Narrative literature review</td>
<td>Chapter 4</td>
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<tr>
<td>Playfulness framework</td>
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<tr>
<td><strong>Case study 1</strong></td>
<td>2. How do various combinations of identified playfulness design elements lead to reflection in real-life RRI-reflection contexts?</td>
<td>Three workshops with 31 stakeholders in total of two different sustainable development initiatives</td>
<td>Analysis of video-narrative content and audio-recorded workshop plenary conversations among participants</td>
<td>Chapter 5</td>
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<tr>
<td>TransLearning</td>
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<tr>
<td><strong>Case study 2</strong></td>
<td>3. What new contributions and limitations of the literature-based playfulness design elements arise in real-life RRI-reflection contexts?</td>
<td>Three workshops with 69 high school students in total</td>
<td>Analysis of 12 audio-recorded group table conversations (4-7 participants each) and 158 Learner Reports (of all participants)</td>
<td>Chapter 7</td>
</tr>
<tr>
<td>Video-Narrative Based Reflection</td>
<td>4. What synergies and trade-offs between literature-based playfulness design elements arise in real-life RRI-reflection contexts?</td>
<td>Two workshops with 59 iGem students in total</td>
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<td><strong>Case study 3</strong></td>
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<td>Frame Reflection Lab</td>
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<td><strong>Case study 4</strong></td>
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<tr>
<td>Opinion Lab</td>
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<td><strong>Case study 5</strong></td>
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<tr>
<td>Theatrical Debate</td>
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</table>

3.2.1 Internal validity

DBR faces the challenge that researchers strongly influence the outcomes that are generated, as they take a hybrid role as designers and practitioners (Wang and Hannafin, 2005). We applied two strategies to address this challenge.
Firstly, we performed all studies in teams to ensure critical evaluation of the gathered data and study findings. The case studies were always performed by one lead researcher-designer, supported by one other researcher, who facilitated workshops and had (co-)designed the reflection methods as well. One or more critical friends (Erwee & Conway, 2006) supported them. These researchers were not part of the core research team, but reflected critically on the findings and the structure of the manuscripts of each study. By varying the researchers involved, and their roles, we hoped to increase the likeliness that the case studies would yield valid and meaningful conclusions (cf. Eisenhardt, 1989).

Secondly, we applied the mixing of research techniques as a strategy to overcome tunnel vision or bias in data analysis (cf. Mertens, 2013). Case studies 2, 3, and 5 (Chapters 6, 7 & 9, see Table 3.1), employed multiple data gathering techniques. For example, notes of participants about own experiences with regard to engaging in the reflection were compared to our analyses of conversation transcripts, which made identification of juxtapositions and alignment possible. In addition, the first author applied iteration in all studies, by which data were analyzed and re-coded various times. Last, the case studies altogether, formed a broad mix of sources to answer the study questions. Although this diversity raised certain difficulties for cross-case comparison, this approach allowed us to identify strong patterns in the contribution of playfulness design elements to RRI-reflection.

### 3.2.2 External validity

RRI-reflection is a broad concept. To make the thesis’ findings generalizable for a variety of reflection processes in RRI contexts, we tried to use the strength of DBR (Barab & Squire, 2004), by designing the case studies in such a way that the combination of them altogether would explore RRI-reflection in the broadest possible sense. In that respect, we explicitly considered that RRI requires adherence to a variety of process dimensions (Stilgoe et al., 2013). Therefore, we took care that our case studies covered a broad selection of these process dimensions. All reflection methods investigated in our case studies concerned the practical realization of ‘reflexivity’ and ‘inclusion’. Depending on the participants for who the reflection methods were designed, the other RRI process dimensions were covered as follows (see Figure 3.3):

- **TransLearning**, case study 1, focused on the facilitation of reflection within R&I. Participants of the workshops were part of multi-stakeholder R&I (cf. Gordijn & Helder, 2013) in which transdisciplinary research (Thompson Klein, 2001) and collaboration took place (comparable to Regeer, 2009), for the realization of sustainable development in rural areas. They were knowledge institution, entrepreneurial and policymaker-representatives, and intermediaries of the collaboration, who had asked us to facilitate the reflection. Reflection outcomes were to be used in the further practices of the innovation initiatives, for which TransLearning could address the facilitation of ‘responsiveness’ within R&I.
• Case studies 2, 4 and 5 had characteristics of Public Engagement (cf. Davies et al., 2009), with ‘non-R&I’ participants, being citizens. As a result, the reflection methods could not facilitate ‘responsiveness’ within R&I.
• Case study 3 tested the FRL reflection method with iGem, high school and Master students. iGem students could be considered as actors ‘within R&I’ of SB, while high school and Master students were actors ‘outside R&I’ in SB. As a result, the sessions performed with iGem students, touch the facilitation of ‘responsiveness’ within R&I.
• Case study 5 about the TD, addressed the ‘anticipation’ of futures with R&I in SB. Since RRI-reflection methods of case studies 2-5 concerned one-time events with citizens, we focused less on addressing responsiveness on the side of non-R&I actors.

Figure 3.3: a visualization of participants engaged in the various case studies of this thesis, and how (thereby) each study relates to the various RRI process dimensions cf. Stilgoe et al. (2014).

7. iGem teams collaborate for one year, after which many students continue studying or start their career in other fields; structural change in R&I into synthetic biology would therefore be hard to realize by means of a single reflection moment. Nevertheless, the students were working on their iGem project by the time they joined the FRL session, for which insights from this session had the potential to impact their current genetic engineering work.
CHAPTER 4

Conceptualizing playfulness for reflection processes in responsible research and innovation contexts:

A narrative literature review
4. CONCEPTUALIZING PLAYFULNESS FOR REFLECTION PROCESSES IN RESPONSIBLE RESEARCH AND INNOVATION CONTEXTS:

A narrative literature review

Abstract

Playfulness supports people in learning. This study synthesizes a framework for playfulness for one particular type of learning: responsible research and innovation (RRI) reflection processes. Playfulness design elements were extracted from literature about playfulness in various learning and reflection contexts, by inductive coding of playfulness conceptualizations, playful tool(s) descriptions and their effects. We extracted four activity principles – ‘narration’, ‘imagination’, ‘action-reflection’ and ‘co-creation’ – and three playfulness process requirements – ‘experimentation space’, ‘focus’ and ‘stimulating guidance’. Due to the utilized database search queries, important articles about RRI-reflection processes are possibly overlooked. Also, overlaps between the design elements and gamification may exist. Last, their suitability for adults, offline and hybrid reflection processes require further investigation. We translate each playfulness design element into the context of RRI-reflection processes and advise on how to use them in designing playful reflection processes, which can prove their anticipated fruitfulness. Nevertheless, due to the utilized database search queries, important articles about RRI-reflection processes are possibly overlooked. Also, overlaps between the design elements and gamification may exist. Therefore, their suitability for adults, offline and hybrid reflection processes require further investigation.

4.1 Introduction

Responsible research and innovation (RRI) promotes the idea that researchers (R) and innovators (I) regularly engage in inclusive reflection processes, by means of stakeholder and citizen engagement, consultation and dialogue (Wilsdon & Willis, 2004; Owen et al., 2013). In these science–society interactions, participants reflect on possible futures, values, perspectives, needs, interests and choices, and (re-) define problems, purposes, roles and responsibilities with regard to the R&I field at stake (Stilgoe et al., 2013). Differences between views and commonalities are articulated (Sykes & Macnaghten, 2013), in which learning plays a central role (Wilsdon & Willis, 2004; Owen et al., 2013).

The reflection processes in the context of RRI contribute to the shaping of science in society in multiple ways. At the level of individual participants, R&I practitioners
become familiar with various stakeholder and citizen views of R&I, which they can take into account in R&I practices. Non-R&I participants train their scientific citizenship skills (Horst & Michael, 2011), which can be a useful basis for technology and science-related decision-making in their personal or professional lives, and for future science–society reflection efforts (Griffin, 2011). Briefly said, all participants become aware of their own and other people’s views of the R&I practice, which can change their attitudes towards other views and may impact their current and future behaviors (Davies et al., 2009; van der Meij, 2015). At the level of the R&I system, RRI-reflection processes can be directed towards anticipation and assessment of future impacts, and the design of a commonly desired future (Guston & Sarewitz, 2002). This may lead to the discovery of new market opportunities, responsible research agendas and ethical guiding principles for science governance, as well as changes to R&I processes and systems (Broerse & De Cock Buning, 2011; Owen et al., 2013; Stilgoe et al., 2014).

As RRI-reflection processes comprise reflection on “what is known (....) and what is not known, associated uncertainties, risks, areas of ignorance, assumptions, questions and (ethical) dilemmas” (Owen et al., 2012, p. 755), they challenge process participants in numerous ways. Participants with little expertise of the R&I practice at stake may feel too ignorant of the techno-scientific details to engage in a conversation about it with others, especially with R&I practitioners (cf. Castell et al., 2014; Nisbet & Markowitz, 2014). R&I practitioners, in their turn, may feel unskilled to engage in ‘value-laden’ interactions with non-researchers (Broerse & De Cock Buning, 2011), or they see the reflection as a speculative activity, outside the scope of their core R&I work (Keulartz et al., 2004). On top of that, engaging in deep learning and reflection, such as deliberating underlying values and purposes and the articulation of underlying framings and assumptions, is relatively new and complex to many participants (Broerse & De Cock Buning, 2011). Also, participants can experience a creative burden if they have to come up with ideas or solutions for the unknown future (Rowe & Watermeyer, 2013).

In this study, we propose the concept of playfulness, often associated with effective learning and reflection, as a promising line of exploration for the support of participants in learning during RRI-reflection processes. Already in 1910, Dewey argued that “To be playful and serious at the same time is possible, and it defines the ideal mental condition. Absence of dogmatism and prejudice, presence of intellectual curiosity and flexibility, are manifest in the free play of the mind upon a topic”. (1910, p. 218). He considered playfulness as ‘an attitude of mind’ resulting in particular playful behaviors (Dewey, 1910, p. 162). Somewhat later, Huizinga (1949) studied playful behaviors ‘in’ cultures and human interactions more extensively, characterizing them by freedom, order and their profitless nature. Lieberman (1967, 1976) thereafter started to quantitatively study playfulness in relation to learning. She considered high levels of playfulness, especially alertness and intellectual curiosity, as benevolent to learning, and to performance in creative and imaginative tasks (1967, 1976). In later years, playfulness literature seemed dominated by studies in computer sciences, often building upon Webster and Martocchio’s (1992) research
Conceptualizing playfulness into microcomputer playfulness. After the millennial change, playfulness in the context of human learning and interaction re-appeared as an area of focus. Gaver (2002) re-emphasized the importance of playfulness in daily life, noting that playful designs should help people to recognize their inner playfulness. Proyer (2011) suggested that, based on a study among young university students, playfulness helps people to deal with demanding or unexpected tasks, like those in academia. In a later study on playfulness among adults, Proyer also suggested that playfulness helps people to excel in unstructured work environments (2012).

Building upon Dewey (1910), Gaver (2002), and Proyer (2011, 2012), we postulate that playfulness is an attitude that helps people to learn and to perform complex tasks, and that playful tools and environments can evoke it. As a consequence, we consider that playfulness might support participants during RRI-reflection processes, because it could help them to cope with the uncertainties and newness of the R&I content and the process itself. In addition, we consider that these processes might benefit from intellectually curious, alert, flexible, inventive and prejudice-free participants. Therefore, we tentatively define playfulness in the context of RRI-reflection processes as an intellectually curious, alert, flexible, inventive and prejudice-free attitude in (1) the analysis of new complex information or issues as well as in (2) the synthesis of new, creative ideas or solutions.

Several scholars have studied seemingly playful RRI-reflection environments, tools and processes (e.g., Cox et al., 2009; Horst & Michael, 2011; Wieringa et al., 2011; Davies et al., 2012; Kerbe & Schmidt, 2013; Felt et al., 2014). These studies show promising benefits to the usefulness of outcomes and participant experiences, but explicit reporting on the conceptualization of playfulness in their designs of tools or processes seems absent. Therefore, this study presents a literature review aimed at conceptualizing playfulness for RRI-reflection processes. As playfulness in RRI-reflection processes has not been widely studied, we investigated the relationship between playfulness and learning and reflection, which are central to RRI-reflection processes (Sykes & Macnaghten, 2013). We identified playfulness design elements based on a systematic search of scholarly literature on playfulness and playful approaches in a broad variety of learning and reflection contexts.

As various studies into engagement and participation processes distinguish between necessary supportive conditions and activities (e.g., Abelson et al. 2003; Carpini et al., 2004; Rowe & Frewer, 2005; Pittens et al., 2013), we aimed to search in literature for ‘process conditions’ that have been found to evoke playful attitudes and behaviors during learning and reflection, and ‘activity principles’ that put playfulness into further practice. We considered both process conditions and activity principles as ‘playful design elements’, which can facilitate the contribution of playfulness to RRI-reflection processes.
4.2 Methodology

Reviews of a synthesizing nature can address “new or emerging topics that would benefit from a holistic conceptualization and synthesis of the literature to date” (Toracco, 2005, p. 357). As playfulness has not been explicitly conceptualized for RRI-reflection contexts yet, we have taken a synthesizing literature review approach in this study (comparable to Pathare & Shields, 2012), based on principles of narrative literature reviewing (Sylvester et al., 2013), to identify playfulness design elements that could be potentially useful for RRI-reflection processes. Building upon the integrative synthesizing review approach (Toracco, 2005), we searched for concepts of playfulness that contributed to particular learning contexts, based on the assumption that they are relevant to RRI-reflection processes.

4.2.1 Study selection

Since playfulness in learning and reflection contexts is an emerging topic, we considered that strictly delimiting study designs would substantially reduce the identification of relevant approaches. We therefore searched for theoretical, qualitative, explorative, quasi-experimental and empirical studies on playfulness in learning and reflection contexts, including studies of both young people and adults. Conference papers were also included because we considered that these would help to identify explorative tool descriptions from which criteria and principles could be derived. For inclusion in the full-text review process, studies needed to meet the following criteria: (1) they were written in English; (2) they had a proper article structure (summary, introduction, aim, method, results and conclusion/discussion); (3) they included a conceptualization of playfulness or playful learning, rather than just referring to playfulness in the title or abstract and (4) they described or evaluated the application of the playful tool or environment applied in informal and formal learning and reflection. Non-empirical studies did not have to meet criteria 2 and 4, and quantitative studies were spared from criteria 3 and 4 if they correlated playfulness to other concepts. Articles about games, gaming or gamification were also allowed if play and learning were explicitly described as elements related to the game or gamefulness at stake. Research contexts considered as relevant for this study were online, offline or hybrid learning at primary schools, secondary schools and universities, and online, offline or hybrid learning in formal and informal professional settings.

4.2.2 Search strategy

To maximize the number of relevant studies, we used a search query that combined playfulness with concepts central to RRI-reflection processes: reflection and learning. The main search terms were therefore ‘playfulness’ or ‘playful’ with the accompanying string ‘AND learning OR reflection OR reflexivity OR “reflective learning” OR “reflexive learning”’. To include studies with clear descriptions of playful tools, we also used a separate keyword search for ‘playful design’ and ‘designing for playfulness’. The database searches were done on the Web of Knowledge and...
Initially, we restricted the publication dates of the literature search to 2010–2014 because we considered that contemporary articles would put more emphasis on new learning tools such as virtual worlds, augmented reality or hybrid learning. This choice was made because online–offline integration is an important development in citizen engagement in science (Delborne et al., 2011). However, searches on the keywords ‘playfulness AND reflection’, ‘playfulness AND reflexive learning’, and ‘playfulness AND reflective learning’ did not yield articles in the publication date range 2010–2014 in both databases. Also, the authors did not reach a saturation point after reading the selected articles published between 2010 and 2014. Instead, new concepts kept coming up. Therefore, a second literature search was done for articles on ‘playfulness AND learning’ and ‘playful learning’ for all years. Applying the same criteria as given above, this extra search yielded several additional articles. In addition, several relevant articles already known to the authors were included. References from included studies were also hand-searched, resulting in the identification of a few more articles.

4.2.3 Mapping the data

We applied a staged review process, comprising “initial review of abstracts and then an in-depth review” (Torraco, 2005, p. 361). First, the articles meeting the inclusion criteria were summarized, including quotes, in a matrix with several generic categories (author, date, journal, keywords, times cited) and several other descriptors:

- Methods: quantitative or qualitative research, theoretical, desk or empirical investigation;
- Context: adults or children (plus age range), country in which study was performed;
- Descriptions of investigated or evaluated learning tool(s) (if applicable);
- Conceptualization(s) of playfulness or adjacent dominant terminology, such as play, playful and games, gaming or gamefulness, in relation to learning;
- Major findings on playfulness in general and/or playful tools in relation to learning.

4.2.4 Classifying and synthesis of playfulness design elements

During the analysis, the synthesis of playfulness design elements took place by alternating and iterating between inductive and deductive analysis. Patterns and commonalities were inductively sought in concepts that were used to define playfulness or in descriptions of their playful learning environment or tools central to their investigations. Parallel to this, we generated themes from these patterns and reformulated them in further rounds of more deductive reviewing, aiming to identify definitions, sub-elements, effects on learning and reflection, related to tools and learning exercises. The key themes were classified either as activity principle or process requirement for playful learning and reflection, in order to identify promising contributions to learning and reflection processes.
4.2.5 Initial outcomes

The initial search yielded 1393 articles in total. We assessed these articles based on titles and abstracts, yielding 88 potentially relevant studies for full-text screening. Applying our inclusion criteria resulted in the final selection of 19 studies. The second additional literature search on all dates and the several additional keyword searches yielded five extra articles. In addition, one relevant study was selected from the hand searching of references and one article previously known to the authors was also included. Figure 4.1 depicts a flow-chart of the search and selection strategy steps and their results in terms of numbers of articles. Common reasons for exclusion of studies based on full-text screening were:

- The study was too distant from the scope of this review (e.g., playfulness in the context of usability of electronic devices, neurosciences or psychological treatments, or articles primarily focused on fine tuning quantitative research methodologies for playfulness scales);
- Playfulness or playful were only mentioned once in the paper and not further conceptualized, nor put in a context of other adjacent concepts or learning;
- The research population was very different from the scope of this review, such as a focus on play or playfulness with babies or animals.

Eventually, we reviewed 26 scholarly publications in-depth; the studies were conducted in all continents of the world except South America. Table 4.1 provides an overview of the included studies with several contextual details. Eight studies covered playful learning in primary schools, five in secondary schools, six in universities, four in adult learning or professional contexts, one about families (parents with children) and two had society or people ‘in general’ as learning context. Per article, the degree to which playfulness or playful learning was conceptualized differed greatly (see Table 4.1) varying from a few sentences in the background section (−), several concepts explicitly mentioned with references (±) and extensive description based on a multitude of references to scholarly articles or empirical data (++) (Table 4.1).

4.3 Findings

The included articles referred to four activity principles: ‘narration’, ‘imagination’, ‘action-reflection’ and ‘co-creation’. Depending on the aims of the learning and reflection, these activity principles were applied individually or in a combination with one another. Additionally, we identified ‘focus’ and ‘experimentation space’ as essential process conditions. These were crucial conditions throughout all playful activities. A further process condition was ‘stimulating guidance’, which was essential to keep learners engaged throughout the learning and reflection process. In the following sections, we elaborate on each playfulness design element, its sub-aspects and the promised effects on learning and reflection (also see Table 4.2). The meaning and potential of these design elements for RRI-reflection processes are covered in the discussion.
Figure 4.1: flowchart of the literature search and review steps, and the number of articles that these yielded.
Table 4.1: overview of the reviewed articles about playful learning and reflection.

<table>
<thead>
<tr>
<th>Authors + date</th>
<th>Empirical / theoretical (x cited)*</th>
<th>Context of learning: age (country)</th>
<th>Applied and investigated playful learning / reflection (of= offline, o=online, h=hybrid)</th>
<th>Degree of conceptualization (-/±/+   )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcock (2010)</td>
<td>Emp (2)</td>
<td>4-year olds (New Zealand)</td>
<td>Various adult-child or children play activities (of)</td>
<td>+</td>
</tr>
<tr>
<td>Berkovski, Freyne, and Coombe (2012)</td>
<td>Emp (0)</td>
<td>Players aged between 9 and 12 (Australia)</td>
<td>An activity-motivating game (h)</td>
<td>±</td>
</tr>
<tr>
<td>Caci, Chiazzese, and D’Amico (2013)</td>
<td>Emp (0)*</td>
<td>5th year Secondary Schools students (Italy)</td>
<td>LEGO robot building + computer programming sessions (h)</td>
<td>±</td>
</tr>
<tr>
<td>Cheng and Winston (2011)</td>
<td>Emp (0)</td>
<td>17-year-old female students (UK)</td>
<td>Shakespeare drama in English teaching (of)</td>
<td>-</td>
</tr>
<tr>
<td>Cheng (2011)</td>
<td>Emp (6)</td>
<td>Secondary school science teachers (China)</td>
<td>Various creative work formats in class (+ intervision for teachers) (of)</td>
<td>-</td>
</tr>
<tr>
<td>Ching and Ching (2012)</td>
<td>Emp (2)</td>
<td>Graduate level English teaching students (USA)</td>
<td>Techno-literacy autobiographical narratives assignment (TLANs) embedded in ‘writing in a digital age’ course (h)</td>
<td>-</td>
</tr>
<tr>
<td>Ferguson (2011)</td>
<td>Emp (3)</td>
<td>Kids aged 13 - 17 + teacher staff members (UK)</td>
<td>Collaborative virtual world building game (c)</td>
<td>-</td>
</tr>
<tr>
<td>Fisher et al. (2013)</td>
<td>Emp (3)</td>
<td>4- to 5-year-old children (USA)</td>
<td>Guided play with various shapes to learn geometrics (of)</td>
<td>±</td>
</tr>
<tr>
<td>Frank (2007)</td>
<td>Theory / Desk (14)*</td>
<td>Adults (military training) (Sweden)</td>
<td>Foreign ground - cultural team trainer for international missions (o)</td>
<td>±</td>
</tr>
<tr>
<td>Hong et al. (2009)</td>
<td>Empirical</td>
<td>Teachers with K5 and K6 students - game suitable for K4 and above (Taiwan)</td>
<td>Strike-up, educational game about evolutionary contest (o)</td>
<td>++</td>
</tr>
<tr>
<td>Kangas (2010)</td>
<td>Emp (25)</td>
<td>Students aged 7–12 + teachers (Finland)</td>
<td>Playground design (of)</td>
<td>++</td>
</tr>
<tr>
<td>Kera (2014)</td>
<td>Theory / Desk (2)</td>
<td>N.R. &gt; Society &amp; science in general (International)</td>
<td>Several SynBio art-science events and initiatives (h)</td>
<td>-</td>
</tr>
<tr>
<td>Laren, Ronicka, and Pithouse-Morgan (2013)</td>
<td>Emp (0)</td>
<td>Health care teachers (South Africa)</td>
<td>Participatory storyboarding (of)</td>
<td>±±</td>
</tr>
<tr>
<td>Lin (2010)</td>
<td>Emp (6)</td>
<td>Children aged 11–12 (Taiwan)</td>
<td>10-week drama course (of)</td>
<td>-</td>
</tr>
<tr>
<td>Lindley et al. (2009)</td>
<td>Emp (3)</td>
<td>Families (parents and kids) (UK)</td>
<td>Innovative voicemail product design (h)</td>
<td>±</td>
</tr>
<tr>
<td>Lucero and Arrasvuori (2013)</td>
<td>Theo + Emp (2)</td>
<td>N.R. &gt; All ages (Finland)</td>
<td>PLEX cards for designing playful interactions (h)</td>
<td>±</td>
</tr>
</tbody>
</table>
4.3.1 Narration

Various scholars describe the value of narrative elements for playful learning contexts (e.g., Price et al., 2003; Jacobs & Heracleous, 2007; Kangas, 2010; Triantafyllakos et al., 2010, 2011; Ching & Ching, 2012; Poplin, 2012; Caci et al., 2013; Laren et al., 2013). Kangas (2010) argues that the act of sharing and hearing a story, with a particular sequence of events that comprises a satisfying whole, contributes to learning largely because this type of exchanging is part of our human thinking patterns. In her study, she made children create a fictitious story about ‘playing’ in order to design a commonly desired new playground (Kangas, 2010).

Triantafyllakos, et al. (2010, 2011) found that realistic personal stories are supportive to learning and reflection because this personalization enables learners to identify themselves with the content. For example, they asked students to develop and speak in the name of an alter ego called ‘mini-me’ to reflect on a university course.
Narratives and their protagonists hence seemed to make the learning content structured and personal.

Several scholars found that ‘narration’ contributes to learning, especially when reality and fiction are combined, in past, present as well as in future times, since fictitious worlds or elements can be humorous and hence evoke extra engagement of the learners (Lin 2010; Cheng & Winston, 2011; Poplin, 2012). The effect of ‘narration’ on learning as described in the reviewed literature is engagement by empathy, since the narratives invite learners to step in the shoes of others and take on a temporary perspective that is different from their own. In this way, the content of the learning and reflection process becomes more personal to them (e.g., in Lin, 2010; Laren et al., 2013). We, therefore, argue that narratives ‘loosen-up’ own perspectives and increase learners’ degrees of engagement with, and sometimes even respect for, other perspectives.

Table 4.2: playfulness design elements (activity principles and process requirements), their sub-aspects and anticipated effects.
4.3.2 Imagination

Various scholars describe the usefulness of ‘imagination’ for playful learning contexts (e.g., Terrenghi et al., 2006; Jacobs & Heracleous, 2007; Lindley et al., 2009; Kangas, 2010; Lin, 2010; Cheng, 2011; Laren et al., 2013; Kera, 2014). Although not always using the word ‘imagination’, our reviewed articles mentioned new or unusual processes of thinking about the unknown. For example, Cheng (2011) introduced brainstorming activities to get children in a creative mode for thinking about the unknown, while other authors made learners brainstorm about ‘what if ...?’-questions (e.g., in Jacobs & Heracleous, 2007; Kangas, 2010; Lin, 2010) or create scenarios, for example, by means of storyboarding, to encourage reflection (Laren et al., 2013). Several authors reported the use of ambiguous objects and content to activate imaginative thinking. For example, Jacobs and Heracleous introduced LEGO to make managers and employees develop ‘ideal bank-client settings’ (2007), while Lindley et al. (2009) designed unfamiliar visualizations for a voicemail machine to evoke new, non-preconceived forms of interaction among users, and between users and the voicemail machine.

Although ‘imagination’ exercises were described in various articles, the problematization of ‘imagination’ itself was absent. Therefore, the anticipated effects of ‘imagination’ can only be constructed from its characteristics as described above, namely making the unknown more tangible (e.g., Cheng, 2011) and the elicitation of a multitude of viewpoints and thoughts (e.g., in Jacobs & Heracleous 2007; Lindley et al. 2009; Laren et al., 2013).

4.3.3 Action-reflection

Various scholars write about the use of action combined with reflection in playful learning contexts (e.g., Price et al., 2003; Price & Rogers, 2004; Jacobs & Heracleous, 2007; Alcock, 2010; Kangas, 2010; Lin, 2010; Caci et al., 2013). Scholars argue that learning and reflection benefit from play characteristics such as the undertaking of a multitude of ‘physical’ actions within a certain, bounded context or system (Alcock 2010; Caci et al., 2013). For example, Caci et al. (2013) asked pupils to create LEGO robots and program the robot-controls on a computer, but the pupils also tested the robots by making them perform actions. By seeing the consequences of their robot programming, the pupils learned how to improve on the robots (Caci et al., 2013). Some authors considered more active role-playing in a particular situation (e.g., van Oers, 2013), or the role-playing of a particular person, to experience that person’s behaviors and thoughts (Lin, 2010). In addition, some authors considered the need for immediate feedback on the performed actions to encourage learners to reflect on their actions (e.g., in Price & Rogers, 2004; Cheng, 2011).

Furthermore, Kera (2014) argued that ‘do-it-yourself-science’ movements are needed around the world in which citizens could playfully explore and experiment, either together or with scientists, in order to continuously discuss ‘why?’ with one another and other societal actors. Several other authors considered the value of
active exploration and answering of ‘why?’-questions with learners while undertaking activities as well. For example, Price and Rogers (2004) asked children to explicitly and physically explore several features of a fictitious animal named SNARK, focusing on the purposes of particular animal features, such as the sounds they make and the reasons for particular body shapes.

Outcomes of ‘action-reflection’ activities that were mentioned in the reviewed publications suggest that they facilitate consequential thinking during the learning and reflection: learners juxtapose the familiar and unfamiliar, discover the different effects of actions (Price & Rogers, 2004), or discover actual actions and reactions as a consequence of preconceived thinking (Caci et al., 2013).

4.3.4 Co-creation

Various scholars describe the usefulness of co-creative activities in playful learning contexts in which a large diversity of ideas and thoughts are collaboratively converged into tangible or less tangible outcomes (e.g., Price et al., 2003; Price & Rogers, 2004; Jacobs & Heracleous, 2007; Kangas, 2010; Ferguson, 2011; Poplin, 2012; Caci et al., 2013). Although not always mentioned with the word ‘co-creation’, our reviewed literature considered various collaborative creation tasks as contributive to playful learning environments, particularly if responsibilities were assigned to the group of collaborators and a tangible result is requested. For example, Ferguson (2011) found that a community-building task in Second Life led to collaborative creativity among learners. Through conversing and collaborating, learners started to tackle environmental, ethical, governance and aesthetic issues in their community-building process (Ferguson, 2011).

The key usefulness of collaboration for co-creation in playful learning may lie in Kangas’ (2010) socio-cultural vision of learning: in social processes, people tend to first learn inter-mentally and thereafter intra-mentally. In other words, the collaborative tackling of something completely new to reach a particular, commonly agreed-upon tangible goal requires negotiation of different minds within which individual learning also implicitly takes place. Several anticipated effects of co-creation were described in the reviewed literature:

- Social effects: shared or common thinking acknowledging diversity and individual differences (Jacobs & Heracleous, 2007; Poplin, 2012), and the creation of respect within the group by the negotiation during the performance of the group task (e.g., Kangas, 2010; Poplin, 2012).
- Visions or tangible products, as base for further reflection (e.g., in Price et al., 2003; Price & Rogers, 2004; Kangas, 2010) or as concepts for real applications that learners collaboratively consider suitable for a particular purpose (e.g., Jacobs & Heracleous, 2007; Kangas, 2010).

Since ‘co-creation’ may relate to the creation of tangible and/or social outcomes based on alignment, this activity principle seems to have a more converging nature than the three activity principles described above.
4.3.5 Experimentation space

Various scholars describe the need for an ‘experimentation space’ in learning environments as an essential process design element (e.g., Price et al., 2003; Lindley et al., 2009; Alcock, 2010; Cheng, 2011; Cheng & Winston, 2011; Ching & Ching, 2012; Pavlas et al., 2012; Fisher et al., 2013; Lucero & Arrasvuori, 2013; van Oers, 2013). Examples of such process conditions in the literature are:

- **Openness** for all ideas that are shared (e.g., in Kangas, 2010; Lin, 2010), or openness for all outcomes or (inter-)actions that are developed as solutions to tasks given to the participants (e.g., Price et al., 2003; Triantafyllakos et al., 2010; Cheng, 2011; Cheng & Winston, 2011; Kera, 2014).
- Elimination of initial judgment (Alcock, 2010) and freedom to make errors (van Oers, 2013).
- **Voluntariness** (Alcock, 2010; van Oers, 2013; Fisher et al., 2013).
- **Time abundance** (e.g., in Su et al., 2013; Alcock, 2010; Triantafyllakos et al., 2010, 2011; Cheng, 2011).
- Flexibility in process structure and order (e.g., in Hong et al., 2009; Alcock, 2010; Kangas, 2010).

The anticipated effect of providing a large ‘experimentation space’ seems to be the discovery of new opportunities, solutions or interactions (e.g., Price et al., 2003; Ferguson, 2011; Caci et al., 2013; Kera, 2014). In other words, a large ‘experimentation space’ supports the creation of a multitude of diverging thoughts and actions. Several scholars mention that the actual used ‘experimentation space’ (and hence innovativeness of the conversations or creations) is partially determined by the number and ambiguity of objects that are provided to learners (e.g., Price et al., 2003; Lindley et al., 2009; Kangas, 2010).

4.3.6 Focus

Various scholars describe ‘focus’ as being essential to playful learning contexts (e.g., Jacobs & Heracleous, 2007; Lindley et al., 2009; Kangas, 2010; Lin, 2010; Cheng, 2011; Ching & Ching, 2012; Pavlas et al., 2012; Su et al., 2013; van Oers, 2013). They emphasize that learners need to know what to do or what is expected of them throughout the learning process, since learners tend to feel safer when they know what to expect (e.g., in Cheng, 2011; Ching & Ching, 2012; Su et al., 2013). Various process-focusing characteristics could be identified in the reviewed literature:

- Explicit alternation between and separation of ‘action-reflection’ steps (e.g., in Jacobs & Heracleous, 2007; Kangas, 2010; Lin, 2010; Caci et al., 2013).
- Sub-tasks, each with their own sub-goals, either done as a group or spread among individual learners (e.g., in Terrenghi et al., 2006; Kangas, 2010); preferably in line with individual capabilities (Frank, 2007; Hong et al., 2009; Berkovski et al., 2012).
- Simplifying the learning content (e.g., Frank, 2007; Poplin, 2012) without losing sight of the complexity or connections between particular sub-topics (Kera, 2014).
When small and comprehensible tasks or topics are given to learners, deeper reflection is facilitated (Jacobs & Heracleous, 2007; Kangas, 2010). In other words, relatively small tasks and content give learners greater opportunity and time to focus on these issues, yielding deeper learning and but also facilitating reflection on broader issues.

4.3.7 Stimulating guidance

In addition to the playfulness design elements mentioned in the previous subsections, various scholars describe a need for stimulating process guidance in playful learning contexts (e.g., Price et al., 2003; Price & Rogers, 2004; Terrenghi et al., 2006; Frank, 2007; Kangas, 2010; Lin, 2010; Cheng & Winston, 2011; Berkovski et al., 2012; Ching & Ching, 2012; Pavlas et al., 2012; Su et al., 2013; Triantafyllakos et al., 2010, 2011). Some scholars mention the need for personal attention to each participant by other learners and by the learning process facilitator (e.g., Hong et al., 2009; Kangas, 2010; Ferguson, 2011; Ching & Ching, 2012; van Oers, 2013). Certain challenges, rewards and feedback with regard to the learner’s efforts, provided by tools or facilitators embedded in the learning environment, also appear to enhance individual motivations (e.g., Price et al., 2003; Price & Rogers, 2004; Terrenghi et al., 2006; Triantafyllakos et al., 2010). We categorize these findings as a process condition named ‘stimulating guidance’.

The effect of ‘stimulating guidance’ lies in increased motivation and engagement of learners throughout the whole learning process (e.g., as found in Lin, 2010; Fisher et al., 2013). If motivated and engaged, learners experience the feeling of ‘being in the moment’, also referred to as an autotelic experience (Pavlas et al., 2012; Su et al., 2013).

4.4 Discussion

We identified and conceptualized four playfulness activity principles – ‘narration’, ‘imagination’, ‘action-reflection’ and ‘co-creation’ – and three playfulness process requirements – ‘experimentation space’, ‘focus’, ‘stimulating guidance’ – each with its own characteristics and learning effects. The playfulness process requirements are, ideally, jointly applied throughout all learning and reflection processes. Activity principles may be applied in a particular sequence, separated or combined with one another. The choice on ‘which activity principle to apply when’ may depend on congruence between the activity principle effects (see Table 4.2) and the aims of each step of a learning and reflection process, such as a desire to make the content personal, or have tangible outcomes. The application of the process conditions and (a selection of the) activity principles is very likely to enrich RRI-reflection processes.
4.4.1 Study limitations and suggestions for further research

Our study focused on learning from and translating literature about playfulness in various learning and reflection contexts towards the context of RRI-reflection processes. Before we translate our findings, we should discuss several issues concerning our applied search strategy. First, we have not included numerous promising RRI-reflection approaches that use playful elements without mentioning it as such (e.g., Guston & Sarewitz, 2002; Cox et al., 2009; Bandelli & Konijn 2011; Horst & Michael 2011; Wieringa et al., 2011; Davies et al., 2012; Kerbe & Schmidt, 2013; Felt et al., 2014). Instead, the articles from which we did extract our playfulness design elements studied relatively small-scaled (±30 person), homogeneous interactive learning and reflection about ‘established’ science, technology or other content, with youngsters and adults. RRI-reflection processes are truly different: they rely on the (mostly) voluntary presence of participants, can be (unpredictably) heterogeneous in terms of participant composition and address content related to a non-established R&I field. The processes can run continuously and parallel to R&I trajectories, for which they can go beyond a one-time event, or use online tools too (Owen et al., 2012; Sykes & Macnaghten, 2013). These differences might give the impression that our design principles are merely applicable to evoke playfulness in small scale, policy-free (Davies et al., 2008) or ‘Habermasian’ reflection practices (Keulartz et al., 2002), in which procedural aspects are more important than the outcomes.

Also, playfulness can be defined as “the predisposition to frame (or reframe) a situation in such a way as to provide oneself (and possibly others) with amusement, humor, and/or entertainment” (Barnett, 2007, p. 955), for which we risk a chance that our extracted design principles merely evoke this type of playfulness; as opposed to playfulness as an intellectually curious, alert, flexible, inventive and prejudice-free attitude, which we considered as fruitful for RRI-reflection processes. Therefore, further research is needed into RRI-reflection formats that apply the playfulness design elements presented here, in order to evaluate their actual effects in RRI-reflection processes with, e.g., an upstream, continuous and/or policy-motivated character. In particular, such studies could help to unravel more about which activity principle best serves what kind of RRI-reflection process aims, as well as about the effective combination of the activity principles.

Given that 13 out of the 26 articles were concerned with child learning, the differences in effectiveness of playfulness design elements between adult and child learning need to be assessed. Guitard et al. (2005) consider that there are not many differences between adult and child playfulness, except that adults with a playful attitude tend to use less imagination than children. Proyer and Jehle (2013) argue that adult playfulness relates to humorousness, cheerfulness, expressiveness, other-directedness, uninhibitedness and intellectuality. While the first 5 of the 6 aspects seem more inherently connected to child-hood behaviors, effortlessness in intellectual tasks might represent an additional effect of playfulness among adults.
Considering these potential differences between childhood and adult playfulness, further investigation is needed to see whether the playfulness design elements identified here do make adults playful. Laren et al. (2013) and Jacobs and Heracleous (2007) emphasize that strong facilitation is needed in playful adult learning and reflection contexts. We therefore especially call for further investigation into the playfulness process principle ‘stimulating guidance’ to gain insights on what exact stimuli and activity principles are needed to evoke playfulness among adults in learning and reflection environments.

Furthermore, 9 of the 26 reviewed articles used playfulness and gameful learning almost interchangeably. For this reason, the distinction between our playfulness design elements and focal aspects of gamification might need further investigation. Some authors mentioned that competitions and challenges activate engagement in playful learning (e.g., Lucero & Arrasvuori, 2013; Berkovski et al., 2012). However, Pavlas et al. (2012) stress the need to guard a balance between evoking immersion in the playful task and explicitness about the meta-task, namely the learning that is meant to happen. Kangas (2010) considered that forms of pressure could inhibit playful learning. We therefore argue that guiding stimuli, such as competition, may not be very suitable for playful reflection processes in RRI contexts because it might reduce the experimentation space. However, if game-like challenges are embedded in the process, facilitators could guard against ‘scoring’ becoming too much of the learner’s focus so that learners experience freedom in exploring and creating out-of-the-box solutions.

Last, we note that 11 of the 26 reviewed articles are concerned with offline learning, while six focused on online environments and nine of them concerned hybrid learning. This may indicate that online or hybrid RRI-reflection process designs could also build upon our extracted design elements. Indeed many articles emphasized the potential of combining online and offline tools (e.g., Price et al., 2003; Price & Rogers 2004; Berkovski et al., 2012; Caci et al., 2013). However, Price et al. (2003) noted that a major challenge lies in making the tangible and virtual world correspond, for example, when learners need to experience virtual effects of their offline actions, and vice versa. In particular, ‘action-reflection’ activities and our process condition ‘experimentation space’, might suffer from ‘going hybrid’. Therefore, we argue that our design elements are merely suitable for RRI-reflection processes in which online tools are used supportively; a total shift towards playful online-only reflection processes in RRI contexts may require additional research into design elements and adequate tools.
4.4.2 Translating the design elements for RRI-reflection processes

In RRI contexts, reflection process participants are expected to discuss their opinions, values, hopes and concerns related to R&I (e.g., Stilgoe et al., 2013). As mentioned in the introduction, some people may feel too ignorant of the techno-scientific details to discuss it with others (Nisbet & Markowitz, 2014). In addition, the type of reflective conversations that take place during these reflection processes can be unfamiliar to participants (Broerse & De Cock Buning, 2011). Since narratives have familiar structures, a carefully designed and presented narrative which exhibits authenticity to keep the content identifiable could help participants to feel more capable of understanding the R&I field, and may help them to feel eligible to share their views. The added value of the activity principle ‘narration’ primarily lies in the contextualization of content. The stories of real or fictitious people about their own experiences and framings can make the process more personal and accessible. Stories could be used as conversation starters or as ‘food for reflection’ presented at various moments throughout the RRI-reflection process. Participants could share their own thoughts story-wise too.

An important dimension of RRI processes is the anticipation of possible and desirable future impacts (Guston & Sarewitz, 2002; Owen et al., 2012). Various interesting formats already exist such as application and techno-moral scenario development (Stemerding, 2015), theatrical performances (Cox et al., 2009), art (Kerbe & Schmidt, 2013) and the card-based Public Engagement tools on nanotechnology (Felt et al., 2014). Often, it is difficult for people, on the one hand, to envision unknown futures and, on the other hand, to leave the comfort of the usual (Rowe & Watermeyer, 2013). If we consider the activity principle ‘imagination’ (e.g., Jacobs & Heracleous, 2007; Lindley et al., 2009), providing an abundance of reflection materials that are very open to interpretation is of utmost importance because they encourage participants to think beyond routines and prejudgments, and to reflect on alternative viewpoints. This ‘what if’ thinking benefits from the use of a multitude of objects and tools with a high ambiguity, such as visualizations, audio/sounds or 3D shapes.

Looking at reflection processes in RRI contexts that aim for real-time technology assessment (Guston & Sarewitz, 2002; Stemerding, 2015), the playful activity principle ‘action-reflection’ teaches us the potential value of making people develop particular impact scenarios related to science or innovation. ‘Action-reflection’ activities help people to discover the potential consequences of their own and other people’s viewpoints and actions, based on the reactions of other players, the environment or individual/group reflections (e.g., Caci et al., 2013). Incorporating moments of reflection and feedback on action throughout the RRI-reflection process offers possibilities to reflect on performed actions and create new actions, to directly discover the practical consequences of ideas. Participants can discover the implications of their own views but, potentially, also the implications of the views of others.
In RRI contexts, reflection processes can aim to develop research agendas, innovative products or more general, commonly desired futures (Stilgoe et al., 2014). The activity principle ‘co-creation’ could be a contribution to such processes. It has a more converging nature than the other three activity principles that we identified and it could support focused, commonly agreed-upon results. Focus on the task of creating a real product ensures that people need to agree on different aspects, particularly the result to be achieved. Collaborative processes require negotiation, supporting the development of mutual understanding and respect for various participants’ visions (e.g., in Kangas, 2010; Poplin, 2012). ‘Co-creation’ thus produces alignment and joint responsibility. At the same time, there is the risk that the ‘co-creation’ task might become too much of a goal in itself (as mentioned in Pavlas et al. 2012), potentially forcing people to agree with one another beyond their boundaries of acceptance. As RRI-reflection processes ideally pay much attention to diversity (Owen et al., 2012), we argue that it is more important to place emphasis on the negotiation of meaning in ‘co-creation’ activities during RRI-reflection processes, than on reaching consensus.

The process condition ‘experimentation space’ highlights an important aspect for RRI-reflection that has not been specifically emphasized in the evaluation frameworks available in the literature, namely the openness to errors and flexibility towards the input of participants, or new and unforeseen circumstances. ‘Experimentation space’ is enlarged by the abundance of time and space, and flexible and modular process structures (e.g., Alcock, 2010). Translating this to RRI-reflection contexts, we can argue that these processes need facilitators with an open and flexible attitude, and exercises where high degree of freedom is allowed, e.g., to ‘fail’ and (re-)do things differently than asked. Allowing participants to ‘hack the process’ may stimulate their openness and flexibility, and thereby increase chances that they fully use the experimentation space.

The playfulness process condition ‘focus’ raises the idea that reflection process participants in RRI contexts should be provided with tangible content and sets of small tasks that carefully build upon each other. The issues on the table in RRI-reflection processes are generally rather complex, multi-dimensional and intertwined with other issues, such as thoughts, values, concerns, hopes and desires, roles and responsibilities (e.g., Stilgoe et al., 2013). Moreover, reflection in RRI contexts may serve various aims that might, at some times, even be conflicting in the case of embracing difference and reaching decisions, for example. The design element ‘focus’ teaches us that small sub-tasks are needed to keep the learning process playful (e.g., Terrenghi et al., 2006; Kangas, 2010). Building upon this, we argue that RRI-reflection processes should employ small process steps that clearly distinguish between these different types of content or make the various types of content and related tasks very explicit. At the same time, to prevent oversimplification (Kera, 2014) and jumping to conclusions, ‘focus’ should not be used at the expense of the complexity of the topic.
The literature about RRI-reflection processes mentions several notions about adequate guidance of the processes, such as stimulating participation and ensuring equal opportunities to participate (e.g., Rowe & Frewer, 2005; Davies et al., 2012; Rowe & Watermeyer, 2013). Nevertheless, the process condition ‘stimulating guidance’ indicates that attention to a stimulating environment and the providence of positive stimuli to and among participants are also important. In RRI-reflection, where participants have to understand others, anticipate unknown futures and reflect on deeper values and purposes, ‘stimulating guidance’ might need to be intensified towards providing tools that make participants encourage one another, and physical environments that trigger people, yet sustain their comfort. Do we call for spacious, oxygen-abundant, bright, colorful spaces, with soft pillows, snacks, drinks and jazz music? More research will have to figure out the exact guiding stimuli. As a facilitator, one can at least safeguard the realization of the other process conditions, e.g., ensuring or enlarging the ‘experimentation space’ by positive acknowledgement, postponing judgment and rewarding thought sharing, but also by giving tasks and asking detailed questions for further focus.

4.4.3. Concluding remark

In addition to already existing general guidelines for reflection processes in engagement and participation contexts (Abelson et al., 2003; Rowe & Frewer 2005; Pittens et al., 2013), this overview provides guidance to the further translation of these requirements towards the design of RRI-reflection processes that facilitate participants to reflect on various aspects surrounding R&I, create innovative ideas and mutually learn from one another. The potential effects of playfulness seem to have an impact on many aspects of RRI-reflection processes, which may enrich the outcomes of science–society interactions for RRI. We therefore encourage science–society intermediaries to apply and further develop the playfulness design principles conceptualized in this study to RRI-reflection processes.

Acknowledgements
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CHAPTER 5
Case study 1
5. HYBRID E-LEARNING TOOL TRANSLEARNING:

Video storytelling to foster vicarious learning within multi-stakeholder collaboration networks

Abstract

E-learning and storytelling approaches can support informal vicarious learning within geographically widely distributed multi-stakeholder collaboration networks. This case study evaluates hybrid e-learning and video-storytelling approach ‘TransLearning’ by investigation into how its storytelling e-tool supported informal vicarious learning, while it was applied in multi-stakeholder collaborations called ‘Regional Ateliers’. TransLearning was meant to supplement learning within RAs about running rural sustainable innovation projects. The e-tools’ video-stories were thematically coded for content analysis. Stakeholder workshops in which the e-tool was used, as well as gathered user experiences, were transcribed, analyzed inductively and juxtaposed. Findings indicate that stakeholders vicariously learned by (1) creative association and (2) collaborative creation of new stories, based on watching individual or multiple videos, respectively. However, the e-tool’s learning content seemed rife with conceptual knowledge, indicating an absence of concrete experiences that are essential for rich(er) vicarious learning. Storytelling e-tools developed for vicarious learning in novice collaborations may inherently encounter this. To conclude, hybrid storytelling approaches like TransLearning seem to support informal vicarious learning best if they employ (1) processes in which learners actively co-create content (selection of topics and storytellers), (2) extensive storyboarding (3) and learning facilitators that encourage learners to collaboratively compare videos and think associatively.

5.1 Introduction

Collaboration between multiple stakeholders is needed for sustainable innovation (Cooke et al., 2000; Gibbons, 1999), but since our societal systems are changing more rapidly than ever (Dyke, 2009), few people have experiences to base their actions upon. This can hamper the collaboration for sustainable innovation. Vicarious learning, learning from observing the experiences of others, can help (Bandura, 1977; Dyke, 2009). As a result, collaborations for sustainable innovation benefit from moments of interaction in which informal sharing, learning and reflection on own and others’ experiences takes place (Loorbach, 2010; Regeer, 2009; Sol et al., 2013). Such learning takes time and requires an atmosphere of trust to make people actually share their experiences (Sol et al., 2013). Time limitations and geographic distance can also inhibit the occurrence or effectiveness of the informal face-to-face knowledge exchange.
Hybrid e-learning tools – combined offline and online learning support (Ahmed, 2010) – can assist informal vicarious learning within multi-stakeholder collaboration without necessitating numerous face-to-face meetings. For example, experiential stories can be captured audiovisually and made available online (Cunsolo Willox et al., 2013; Davenport & Murtaugh, 1997). In this way, people can learn anywhere and anytime from experiences captured in e-tools without actually having to meet the storytellers.

Scholars have identified challenges facing the development of hybrid e-learning tools for vicarious learning; yet little studies seem aimed at tackling them. For example, learning experiences are often not directly applicable in different contexts (Hodgson, 1984; Procter et al., 1999; Schwab & Miner, 2008). Experiential knowledge is usually deeply embedded in the original learning context in which it was obtained (Procter et al., 1999; Regeer, 2009). To de- and re-contextualize stories to others contexts (Ackerman, 2000), learners need additional support. Few studies seem to exist that investigate (the exact role of) such support. Other under-investigated issues in hybrid e-learning include the development of systematic approaches (Sherry & Gibson, 2002) and the assigning of adequate and achievable roles to each online and offline components (Jones & Lau, 2010).

With a view to addressing the challenges facing hybrid e-learning tools, this paper evaluates hybrid e-learning tool ‘TransLearning’ while it was implemented in a Dutch informal learning network for sustainable innovation. TransLearning takes an informal vicarious learning facilitation approach, combining (1) an online repository with videos in which stakeholders tell stories about the collaboration networks they are involved in and (2) workshops in which (other) collaborating stakeholders of the network use the e-tool (De Wildt-Liesveld et al., 2014). As developers, learning facilitators and researchers of this TransLearning case, we reflect on its application within a new case context, namely Dutch ‘transition experiments’ (cf. Loorbach, 2010) called ‘Regional Ateliers’ (RAs). RAs develop and facilitate multi-stakeholder innovation projects that aim to make rural areas of the Netherlands more sustainable. Projects include sustainable energy production systems, school–business collaborations in agriculture and initiatives to tackle population decline in rural areas. RAs also aim to support informal knowledge sharing between stakeholders for lifelong learning and reflection on how to effectively manage sustainable innovation (Beers, 2011).

Previous research has shown that the TransLearning approach supported informal vicarious learning at the level of individuals and groups (De Wildt-Liesveld et al., 2014). In the current case study, we investigate how this storytelling e-tool fosters the vicarious learning, by examining the learning processes of stakeholders who used the repository during workshops. We aim to identify hybrid e-learning approaches that effectively support informal vicarious learning in distributed collaborative networks, so that we can make recommendations for other e-learning tool developers. To do this, we link characteristics of TransLearning to vicarious learning processes in face-to-face workshops.

1. See: www.kenniswerkplaats.eu
5.2 Theoretical background

Learning from experiences is a crucial aspect of learning throughout life (Dyke, 2009). When direct opportunities for learning are not readily available, learners can benefit from vicarious experience, namely the experience of others (Bandura, 1977; Myers et al., 2012). In large-scale, novel, heterogeneous innovation processes, people are often novices with regard to particular aspects of the process for which actions cannot be based on first hand acquired experiences (Loorbach, 2010; Rotmans et al., 2001). In sustainable innovation collaboration networks, vicarious experiences therefore need to be obtained in formal or informal ways. This study focuses on the latter. We acknowledge that learning can result from listening to others talking about their real experiences (Dyke, 2009). With ‘informal vicarious learning’ we refer to learning from vicarious experiences (Bandura, 1977). We acknowledge that individuals can learn about ‘doing sustainable innovation’ by listening to others talking about their successful and unsuccessful experiences, and that this can stimulate self-efficacy in which the learner feels more capable and stimulated to undertake comparable efforts (Bandura, 1977).

Since sustainable innovation itself involves ‘learning by experiencing’ (Sol et al., 2013), informal vicarious learning comprises here the listening to ‘experiential learning’ from another person also engaged in sustainable innovation. This other person has attained experiential learning by direct involvement, combined with reflection on the outcomes of actions or behaviors (based on Dyke, 2009).

According to Kolb (1976), learning by first-hand experience is a cyclic process of (1) observing and reflecting, (2) forming concepts and generalizations, (3) testing concepts in new situations and (4) experiencing concretely. Going through all four learning phases, in any possible order, increases the chance that a person can successfully apply newly obtained knowledge in other or new contexts (Kolb, 1976; Tsai & Lee, 2006). Therefore, vicarious learning about engaging in sustainable innovation would, ideally, comprise listening to another person talking about his or her experiential learning cycle.

The TransLearning approach takes two pathways to support informal vicarious learning in the context of multi-stakeholder collaboration. First, it uses storytelling to support de- and re-contextualization. Storytelling is a well-tried method to purposefully learn from another’s experiential knowledge (Anderson & Muirhead, 2011; Cunsolo Willox et al., 2013). Storytellers that embed their knowledge in a rich context, known as thick stories, support the de- and re-contextualization, helping to translate the embedded knowledge into potentially useful knowledge for another person (Guba & Lincoln, 1989; Procter et al., 1999). Stories or narratives can be described as a sequence of events in which protagonists react to and shape actions (McKee, 1997). Learning from storytelling is generally perceived as pleasurable (Myers et al., 2012). Stories activate the listeners’ mind because the listener needs to interpret the story actively, producing greater long-term learning impact than a list of ‘dry facts’ (Negrete & Lartigue, 2004).
Whereas, traditional forms of storytelling may focus on partially fictitious narratives (McKee, 1997), TransLearning focuses on stories about real experiences, stored on video. Second, TransLearning uses hybrid e-learning to overcome the necessity of synchronous face-to-face meetings (cf. Jones & Lau, 2010). Since hybrid e-learning does not necessarily require that all learners and learning facilitators meet at the same place and time (Ahmed, 2010), it seems very suitable for informal learning within multi-stakeholder innovation networks. TransLearning, therefore, follows the characteristics of hybrid e-learning (cf. Ahmed, 2010; Jones & Lau, 2010) by mixing online (video stories) and offline tools (workshops) to support informal learning in multi-stakeholder collaboration networks.

5.2.1 TransLearning

TransLearning (see Figure 5.1) represents a relatively new approach. It was originally developed to facilitate learning between stakeholders that collaborate in sustainable innovation projects (De Wildt-Liesveld et al., 2014). Previous TransLearning projects (De Wildt-Liesveld et al., 2014; Regeer, 2009) comprised four steps:

1. Storyteller selection: a cross-section of various stakeholders involved in the collaboration is interviewed.
2. Video story capturing: collaborators are interviewed on film on the subject of their key learning experiences in innovative projects, such as sustainable agriculture.
3. Categorization of videos and e-tool front-end creation: using the Active Archives system (Davenport & Murtaugh, 1997), film bodies are cut into 2- to 3-min videos, transcribed and tagged, to give users an indication of the content. Each video is tagged individually by at least two people. These taggers then decide together which keywords best capture the video’s content, with a maximum of five tags per video. The TransLearning user interface is designed to afford intuitive and playful browsing through videos, giving the user a fair amount of autonomy in choosing which videos to view. If users select a tag, videos with that tag are highlighted. On selection, the video enlarges in a pop-up screen. While playing, the transcripts are displayed, in which users can browse forward or rewind.
4. Reflection workshops: stakeholders are invited in a face-to-face group session, during which they browse the video repository in pairs (making them ‘users’ of the tool) and discuss in plenary conversations their key learning points.

To study how TransLearning fostered vicarious learning within the RAs, we employed three research questions:

(1A) To what extent are various phases of Kolb’s experiential learning represented in the TransLearning e-tool and (1B) in particular in videos that stakeholders use as a starting point for informal vicarious learning?
(2) What vicarious learning processes does the e-tool evoke during face-to-face workshops?
(3) What are the user-perceived effects of the TransLearning approach?
5.3 Methodology

5.3.1 Case description

This case study applied and further specified the four TransLearning steps as depicted in Figure 5.1 within the context of Dutch multi-stakeholder collaboration initiatives ‘Regional Ateliers’ (hereafter RAs). Stakeholders collaborating in RA projects include schools, researchers, government, NGOs and commercial companies. Each RA has a manager that supervises and mediates all collaborating stakeholders. Four of the 16 RAs requested learning interventions to professionalize the organization, realization and management of their projects (Beers, 2011). TransLearning was applied in these RAs as one of the learning interventions. Next, we describe the four TransLearning steps as they were applied in this case context.

2. See: www.kenniswerkplaats.eu
Chapter 5

**Storyteller selection**
In step one (see Figure 5.1), researchers FK and MM operated as tool developers. RA managers supported FK and MM to recruit storytellers, representative for the variety of stakeholders involved in the four RAs: education (eight teachers, three school managers), research (two scientists), government (five municipality employees), NGOs (two) and entrepreneurs (four). The RA managers were interviewed, as well as the founder of the initial RA and one experienced manager of a comparable initiative.

**Video story capturing**
In step two, interviews were undertaken with the selected stakeholders, followed by filming. A previous TransLearning study concluded that audiovisual stories need direction to make them effective for informal vicarious learning (De Wildt-Liesveld et al., 2014). Therefore, MM undertook individual pre-filming interviews with the stakeholders, inspired by Critical Incident Technique (Butterfield et al., 2005). On a timeline that represented the duration of their involvement in the RA, interviewees were asked to point out their most critical learning moments and tell their learning experiences. Subsequently, MM made storyboards, suggesting five scenes for video recording. Interviewees could adjust or add scenes to the storyboard. We asked interviewees to concisely re-tell their learning experiences in front of a video camera in line with the storyboard. To capture informal film shots, storytellers were asked to look at MM standing next to the camera.

**E-tool creation**
In step three, we uploaded the films in Active Archives and created 2–3-min videos. In the back-end, videos were transcribed for subtitles and each video received a title tag: ‘How to ..... (topic)....?’ or ‘What is.....(topic).....?’ (See Table 5.1, and Dutch texts on the left in Figures 5.2, 5.3 & Figure 5.4). Videos were also given 1–5 keyword tags indicating their content, plus one tag for the storyteller’s name and one for the RA name. In the e-tool’s front-end users see thumbnails of all videos on a white background. Videos can be selected on the basis of title-tags. Depending on the selection, video thumbnails grow larger, smaller or disappear. With a mouse-over function, the keywords and storyteller name become visible, inviting users to select a video reflecting their interests (see Figure 5.4). Once a video is selected, it starts playing in a pop-up screen.

<table>
<thead>
<tr>
<th>Table 5.1: the video title tags.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How to....:</strong></td>
</tr>
<tr>
<td>.... Engage all educational levels within the RA?</td>
</tr>
<tr>
<td>.... Engage colleagues within the RA?</td>
</tr>
<tr>
<td>.... Engage entrepreneurs within the RA?</td>
</tr>
<tr>
<td>.... Deal with different interests?</td>
</tr>
<tr>
<td>.... Engage your own environment?</td>
</tr>
<tr>
<td>.... Further the RA?</td>
</tr>
<tr>
<td>.... Promote the RA?</td>
</tr>
<tr>
<td>.... Show the added value of the RA?</td>
</tr>
<tr>
<td>.... Start an RA project?</td>
</tr>
<tr>
<td>.... Start an RA?</td>
</tr>
<tr>
<td>.... Structure the collaboration?</td>
</tr>
<tr>
<td>.... Guarantee continuity?</td>
</tr>
</tbody>
</table>

What are required competencies of RA participants?
What is an RA?
What do people learn from engaging in an RA?
What are deliverables of an RA?
What are deliverables of an RA project?
Reflection workshops
The fourth and final TransLearning step concerned three three-hour face-to-face workshops, organized by MM and FK, in two different RAs. RA managers selected and invited stakeholders, based on their personal selection, and attended their own workshop(s) too. Participation was voluntary. The manager of RA1 invited three participants from the municipal government, one of which was also an entrepreneur, four participants from lower and intermediate vocational education, one of which was also an entrepreneur, and one researcher. RA2-manager invited two participants from higher vocational education, seven participants from government (five municipal and two provincial), one entrepreneur, and two researchers.

The RA2 manager also organized a third workshop with four participants from higher vocational education (all team managers and executive teachers), one entrepreneur, two managers of other RAs and one researcher with an interest in RAs from the perspective of lifelong learning. The workshops aimed to promote learning between stakeholders about issues and ideas related to their collaboration or projects at that particular moment in time.

After a short introduction, FK and MM grouped participants in pairs. In several rounds, the pairs were asked to browse the TransLearning e-tool on a laptop for 20 min. The facilitator (FK) then guided a plenary conversation (1 h max) to share key learning points among participants. To anchor the learning in their current reality and to wrap-up the session, the facilitator asked participants to describe their immediate action after the workshop. With agreement of all workshop participants, plenary conversations were audio-recorded for analysis. Recordings were stored at the researching institution to which MM and FK are affiliated but deleted after anonymous verbatim transcription.

Figure 5.2: screen-shot TransLearning home screen.
Figure 5.3: screen-shot of TransLearning front-end with one tag selected (bold in the ‘vragen’-column at the left) and a mouse-over pop-up of one clip (at the end of the arrow).

Figure 5.4: the TransLearning case study approach schematically visualized.
5.3.2 Data collection and analysis

To answer research question 1a (see above), the transcribed text of the videos was analyzed by means of thematic coding (Braun & Clarke, 2006). For the coding, we integrated Kolb's learning cycle (1976) with the concept of vicarious learning (see Figure 5.4). Tsai and Lee (2006) specified four knowledge types that can be obtained within a cyclic experiential learning process. MM and FK performed the repository content analysis by searching for the presence of these different knowledge types in videos, using the following thematic coding guidelines:

- **Know-why knowledge, gained from observing:** The storyteller elaborates on underlying mechanisms of concepts, using words and phrases like ‘Because’ and ‘I (have) see(n) that’ and ‘maybe it is due to’.
- **Know-what knowledge, based on concepts formation:** The storyteller explains or defines concepts related to the topic at stake (e.g., ‘Engaging colleagues within the collaboration is/means/implies...’). These concepts related to explicit knowledge, such as facts, theories, guidelines and rules about RAs.
- **Know-how knowledge, gained from testing concepts:** The storyteller elaborates on how certain concepts are/were put into practice (e.g., ‘What we/I do/did’ or ‘an example is’).
- **Care-why knowledge, gained from reflection on testing concepts:** The storyteller voices concerns about the concepts, expresses a personal vision on them or self-formed ideas for improvement. Video transcripts were trawled for phrases like: ‘It’s really important to’, ‘I would love to’ or ‘We still really need to work on...’.

Individual videos contained from one to four of these experiential knowledge types. After labeling the videos based on types of experiential knowledge, we searched for noteworthy patterns in the video repository, such as the number of videos with full learning cycles, learning phases distributed over multiple videos about one particular topic and the dominance of distinct learning cycle phases in the repository as a whole. We hypothesized that RA collaborators could vicariously learn more successfully from the e-tool if multiple learning phases were shared in individual videos and if each knowledge type was equally represented in the repository content.

To answer research questions 1b and 2, the three workshop transcripts were analyzed using inductive coding (Thomas, 2006). Plenary workshop conversations were traced for moments in which participants referred explicitly to the e-tool. From the 21 explicit references to the e-tool in the workshop transcripts, we traced the video in the repository based on participants’ descriptions of the video or the storyteller. Workshop participants referred to the repository in general three times and twice gave a vague video description. As a result, we could only trace some 16 of the 21 explicit references to videos. MM and FK analyzed the group conversations before and after these video reference moments to discover underlying patterns, identifying two major vicarious group-learning processes.

Research question 3 (user-perceived effects of TransLearning) was answered by means of the following data sources:
Informal conversations with participants held by FK and MM throughout the workshops about the contribution of the e-tool to the learning; FK and MM discussed their findings and reported them as researcher notes afterwards.

Moments in plenary workshop transcripts at which participants discussed the e-tool’s functionality.

Follow-up e-mail interviews with the RA managers, in which they answered the questions: ‘what insights did the workshop give you?’ and ‘what was the contribution of the e-tool?’.

Data from these sources were analyzed inductively and juxtaposed with findings from the repository and workshop analyses. Therefore, results in the section below are accompanied with illustrative workshop, video or interview transcript extracts. These were translated from Dutch to English and adapted for the purpose of readability.

5.4 Results

5.4.1 The e-tool content

Our analysis of the repository reveals that 37 of the 235 videos (16%) contained learning experiences of full learning cycles. Storytellers of these videos addressed all four types of knowledge from an experiential learning process as defined by Tsai and Lee (2006): know-what, know-how, know-why and care-why. Other videos presented stories about one, two or three phases of a learning cycle. Stories about each phase of the learning cycle existed, albeit distributed over multiple videos. To learn vicariously over the full learning cycle hence requires watching of multiple videos. Furthermore, care-why knowledge dominated in the repository: 159 videos (68%) embedded care-why knowledge alone or combined with more learning phases, of which 43 videos (18%) embedded only care-why stories without any other learning phase. Know-how knowledge was present in 43% of the videos, know-what in 48% of the videos and 40% of the videos addressed the know-why about collaborating in RAs on sustainable innovation. These latter three types of knowledge had a high co-occurrence with at least one other knowledge type.

The e-tool’s potential to offer rich vicarious experiences to workshop participants (RA stakeholders) seems hampered by the dominance of care-why knowledge in the repository’s content, as well by dominance of care-why knowledge in single videos without the presence of other learning phases (18% of the repository) and relatively few videos with full learning cycles (16%). In follow-up interviews with RA managers, one manager noted that it took substantial ‘visual work’ to identify relevant learning points in the repository indeed. In contrast, two other managers considered the non-verbal communication and other visuals, like the storytellers’ working environment (farms, schools, municipality buildings, personal offices) to be pleasurable, helping them to form a good picture of the storytellers’ experiences.
5.4.2 Workshop learning processes

Of the 16 times that RA stakeholders referred to individual videos during workshop conversations, eight videos comprised stories with three or four phases of a learning cycle. In other words, 50% of the vicarious group learning evoked by the e-tool was based on videos that presented relatively little experiential learning. Further learning predominantly took place through plenary conversations. Analysis of workshop transcripts revealed two major pathways to vicarious learning.

**Inter-video comparison**

A first vicarious learning process involved the ‘collaborative construction of new stories by inter-video comparison’. Workshop participants used ingredients from multiple videos as ‘building blocks’ to collaboratively construct new storylines about the RA. Although the tags of those videos were always different, participants identified elements combining these videos. Storylines that arose by the associative creation of inter-video linkages helped them in forming ideas to improve RAs. For example, in one workshop (RA2, workshop 1/2) the plenary conversation addressed the continuity of the RA and stakeholders’ co-ownership of the RA and its projects. One participant suggested that stakeholders should pay fees to make them more directly involved in the RA. Another participant responded:

“I saw a video about financing. It was the manager of a school in (...). He said that the Regional Atelier is not only from the school - which I found quite good because actually now only his school and the municipality are really investing money in the RA.”

The participant referred here to a video with a school manager addressing the topic ‘How to guarantee continuity?’, with the following core content:

“(…) An organization cannot be kept alive merely with grants (...). My school should not be the only one financing it, nor should the government. No, also stakeholders of the Regional Atelier must help to keep the Atelier working sustainably.”

Keyword tags assigned to this video were freedom, regional co-ownership and setting boundaries.

After the reference to this video and this notion, another participant continued the plenary workshop conversation by referring to a different video:

“The funny thing is, I’ve actually picked up from these films (…) someone said “governments can facilitate; it is okay to lay foundations by means of subsidies”. But I’m thinking - me being part of a research institute collaborating in the RA (…) - the moment has come that we should start to invest as well.”

This participant referred to a video of an employee of a semi-governmental organization talking about ‘How to engage entrepreneurs?’:

“Especially when you look at companies, they always weigh ‘costs’ versus ‘short-term return on investment’. We cannot blame them for that, because that’s how it works. So you notice that companies often drop out of those innovation processes that have only long-term return on investments (…) That’s one of the reasons why governments do well to give subsidies.
Sometimes people complain that ‘businesses rely too much on subsidies and don’t invest anymore themselves’. The question is whether this is the case because where the market initially ignores things, we have a government [to back the project] (...).”

The only keyword tag assigned to this video was subsidies. As these extracts aim to illustrate, workshop participants identified elements unifying the videos to learn lessons about investments in relation to continuity. Although the videos had completely different tags, workshop participants integrated their content to create a new storyline about ‘continuity’: initiating a fee paying for more stakeholder commitment and independence from governmental funding, possibly attracting new stakeholders and increasing the continuity of the RA.

Bypass learning
Ten of 16 references to videos concerned another vicarious group learning process, which we have called ‘bypass learning’. In bypass learning, the workshop conversation covers topic A, a participant refers to a video about a seemingly different topic B, after which that same participant presents newly gained insights with regard to the initial conversation topic A. For example, in one plenary conversation about the added value of the RA, the absence of entrepreneurs in the collaboration was the dominant worry of participants (topic A) (RA2, workshop 1/1). At a certain moment, one workshop participant referred to a video in which a high school teacher says: “These days I’m getting colleagues in my team more and more involved in RA projects because the added value is becoming more apparent to them: Students are more motivated (...), and approach teachers ‘Sir how do we deal with the Flora and Fauna legislation of the Netherlands?’ In previous projects students mostly thought ‘That does not apply to me’ regarding the Flora and Fauna law. But now an entrepreneur might say ‘You are not allowed to prune here right now because there are a number of nests in the trees! So how are we going to solve this now?’ (...) This is also becoming clearer to teachers. They think ‘Hey wait, more happens in there than just performing a little project outside the school. Actually, real learning takes place!’.”

The workshop participant referred to this video as follows: “I heard a teacher saying that the projects cover really recognizable questions for students. (...) I don’t remember what he named that legislation about cutting down bushes and stuff.... I believe that if you cover this legislation in class, students say ‘That’s got nothing to do with me’. But when they are working in a project outside the school for a real gardener who says ‘well boys, we cannot cut the bushes now’, this legislation comes alive! (...) And I often already have a lot of contact with entrepreneurs... indeed, I too can engage this stakeholder way more!”

The participant started to realize something about the workshop topic added value of the RA and engaging entrepreneurs (topic A) by elaborating on this video about engaging teachers (topic B). During the rest of the workshop, all participants came to the realization that they had many existing contacts with entrepreneurs for educational purposes, and that these contacts should be used to engage more
entrepreneurs in the RA too. They argued that this approach would make the RA more valuable when compared to other multi-stakeholder collaboration initiatives in their province.

Our informal conversations held with workshop participants, demonstrated that they also experienced this bypass learning, albeit expressed in other words. For example, one participant said:

“You take the time to purposefully listen to the things people have to say. (...) And then it appears you can use a lot of it. And it does not have to be exactly the same as the person [in the video] intended but you start to make further associations. (...) In my mind ideas come up that this person probably did not intend to give, yet they trigger me.”

5.4.3 Other TransLearning effects

In addition to the above-mentioned vicarious learning processes, plenary workshop conversations seemed also enriched by other characteristics of the repository. First, the repository provided a mirror against which to consider the collaboration and its shortcomings. For example, during one workshop (RA2), participants were concerned with the question ‘Why are there so few entrepreneurs in the database?’ They reached a conclusion that this absence reflected the low commitment of entrepreneurs in the collaboration network. As a result, workshop participants came up with many ideas to increase involvement of entrepreneurs.

Second, an individual storyteller personality could inspire participants in their learning too. For example, one participant – a managing teacher – mentioned:

“I saw something beautiful. It was a teacher. It made me think “damn, that guy... When he speaks with an entrepreneur, he radiates passion!”. I think that engaging entrepreneurs in the RA would be far easier with such teachers (..)”

Looking at the storytellers referred to by participants, these storytellers were either unfamiliar to workshop participants, triggering their curiosity or well-respected pioneers with substantial experiences of RAs.

Furthermore, participant reactions showed that the e-tool functioned as a good starter for plenary workshop conversations. RA managers were convinced that participants gained new insights into others’ opinions about RAs during the workshops. For example, one manager said:

“I liked to hear how participants thought of the RA; how they participate and work in it. Many beautiful examples were shared.”

According to the managers, the collaborative sharing and development of ideas during the workshops gave them insights into the weaknesses of their RA and opportunities for improvement. However, one RA manager noted:

“Since everyone looks at different videos, the discussion would sometimes start on many different topics at the same time”.

Also, another manager opined:

“I think it would be better to define several topics that are important for RAs beforehand and identify the videos about these pre-defined topics more clearly in the repository. The composition and diversity of topics could have been better”.

In addition to the idea to pre-define topics to capture videos about before interviewing storytellers, some workshop participants wanted a greater variety of stakeholders to be interviewed for a more complete picture of the RA. Last, workshop participants and RA managers wanted longer workshops for more profound discussions.

5.5 Discussion

The TransLearning approach evoked two major informal vicarious learning processes. We derive from this study that a number of the hybrid storytelling e-tool’s characteristics fostered this learning within the RAs. To stimulate others to apply comparable approaches in multi-stakeholder networks, we discuss several of these characteristics below.

5.5.1 Aligning storytelling e-tools and workshops

TransLearning users told us that the e-tool did not always serve the learning needs of workshop participants. If we look at our repository content analysis, the storytellers predominantly shared knowledge on one particular part of the experiential learning cycle, which could explain the dissatisfaction of users. Care-why knowledge was present in 68% of the videos, and almost one fifth of all the videos (18%) presented this care-why knowledge without any other type of experiential knowledge (cf. Tsai & Lee, 2006). Care-why knowledge comprises caring why things are done and can be both a start and an end-point of a learning cycle (Tsai & Lee, 2006). Just as much as the workshop participants, storytellers seemed to be in search of solutions to questions concerning ‘How to manage and organize an RA?’.

To overcome potential mismatches between video storytelling e-tools and learning needs of learners, especially in relatively novice networks, it may be necessary to let tool producers and users iteratively and participatively co-develop the storytelling e-tools and monitor their usefulness during face-to-face learning moments. Wikis already apply such co-creative efforts (Wheeler et al., 2008), but in storytelling e-learning this seems still a rather upcoming approach (e.g., van der Ham et al., 2013) that deserves more attention.

One vicarious group learning processes that we identified concerned the collaborative creation of new stories by comparing multiple videos to one another. Since the appointing of roles to the offline and online components is a challenge in hybrid e-learning (Jones & Lau, 2010), this finding suggests one particular role for digital storytelling in face-to-face group learning processes. Namely, given the way that story construction took place in our workshops, we reckon that workshop participants should be stimulated very actively to seek similarities and differences
between stories, to maximize their understanding of the learning topic at stake. A workshop facilitator can stimulate this.

Furthermore, our results suggest that storytelling e-tools are very suitable for creative problem-solving workshops. In the case of bypass learning, a second learning process that we have identified, workshop participants shared individually generated new views on a topic by discussing a video, generally on a seemingly unrelated topic. Bypass learning may be due to the fact that distractions can facilitate creative problem solving (Zhong et al., 2009). Distraction evokes unconscious thoughts, giving people inspirational sparks that can lead to a ‘eureka moment’ and major discoveries (Zhong et al., 2010). In this way, the TransLearning e-tool seems to function as a repository full of distractions that provoke new solutions to problems in users’ minds. The face-to-face format of a creative problem-solving workshop seems therefore the complementary offline learning format for storytelling e-tools: experiential stories may not always provide ready answers but provoke new lines of thought that may appear illogical at first sight but offer a potentially great starting point for development of interesting solutions to complex problems.

5.5.2 Relevance of stories

This TransLearning case study taught us three other lessons for increasing the potential of storytelling e-tools for vicarious learning. First, TransLearning users advised us to define a set of video tags before filming, in interaction with future users. This is consistent with Tsoi (2008) who argues that “it is essential to first identify the critical features of the concept to be learnt so that varied activities can be designed to assist the learner to identify these critical attributes and eventually leading to acquisition of concept mastery” (p. 51). Capturing stories with a pre-defined topic list hence might increase the e-tool efficacy, helping users to identify and compare multiple videos on the same topic and thereby further facilitating offline vicarious learning.

Second, the relevance of the e-tool for vicarious learning appeared to increase when learners respected the storytellers. Our workshop participants quite often referred to videos of storytellers who were well-respected pioneers within their network. They also referred to unknown storytellers who stimulated their curiosity. The general disposition theory states that characters of a story influence the engagement of a viewer with a storyline (Raney, 2004). To trigger users’ curiosity and interest, it seems therefore advisable to film people with certain inspirational narrative capabilities. An option could be that network collaborators themselves pre-select storytellers, in addition to the pre-selection of story topics that we suggested above. However, the authenticity of stories should be guarded too, to guarantee the ‘thickness’ (Guba & Lincoln, 1989; Procter et al., 1999) that is essential for vicarious learning (Ackerman, 2000; Regeer, 2009).
Finally, a process of story capturing that adheres to storytelling principles could improve the learning experiences presented in an e-tool aimed at facilitating informal vicarious learning. Previous studies of TransLearning suggest that more directive capturing of stories is needed to ensure certain video content density (De Wildt-Liesveld et al., 2014). For the new TransLearning approach evaluated in this case study, we tried to capture stories directly by storyboarding sessions with the storytellers. Yet our TransLearning users noted that it was sometimes hard to stay engaged while watching videos. Traditional storytelling principles teach us that storylines mostly need to reveal a particular problem in the beginning, a struggle or confrontation in the middle and a climax in the end (McKee, 1997). Although vicarious learning requires hearing authentic experiential stories of others (Ackerman et al., 1996), traditional storytelling principles may be a useful guide for storyboarding to create videos that keep viewers engaged. This might improve the effectiveness of vicarious learning. For example, storytellers could start each video with a particular problem, such as an issue they experienced, or still experience, and explain their preliminary road towards resolution of the problem, including the obstacles or struggles along the way.

5.6 Conclusions

Systematic approaches are crucial to hybrid e-learning (Sherry & Gibson, 2002). This case study has shown that the systematic development and implementation of the hybrid video storytelling e-tool, TransLearning, supported informal vicarious learning in multi-stakeholder networks in various ways. However, we foresee that the supportive potential of approaches like TransLearning increase if users (the ‘learners’) can co-create and optimize the tools, for example, during workshops, or, more informally, at home. Building upon that notion and our findings, we recommend the following to learning facilitators that intend to develop comparable storytelling e-tools for vicarious learning in multi-stakeholder networks:

- Map together with the learners which topics they want to learn about.
- Let learners co-select which representative set of stakeholders should be interviewed to capture experiential stories (on film, audio-visual or written), aiming for people with good storytelling capabilities.
- Conduct preparatory interviews with the selected storytellers, with the pre-selected learning topics as guide.
- Make, with the storytellers, a storyboard to capture coherent authentic 2–3- min stories – auditive, audio-visual or written – with a story path, for example, like McKee’s (1997): exposition of a problem, struggles in the process of solving the problem and the climax of a(n intermediate) resolution.
- When using the e-tool during face-to-face workshops, encourage learners to think associatively while hearing the stories, and let them collaboratively compare stories to derive key learning points.
- Make it possible for users to give stories tags to improve the story database for future use.
- Stimulate learners to upload self-captured or written stories.
We hope that these suggestions may give new ideas for future storytelling and hybrid e-learning tool development for informal vicarious learning in multi-stakeholder collaborations, and thereby, for example, further sustainable innovation.

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CHAPTER 6
Case study 2
6. SUPPORTING CITIZENS IN REFLECTION ON SYNTHETIC BIOLOGY BY MEANS OF VIDEO-NARRATIVES

Abstract

To unravel how video-narratives can support reflection in Responsible Research and Innovation (RRI) contexts, this study evaluates four video-narratives designed for citizen-reflection on synthetic biology (SB). Each video-narrative comprised of separate clips about three subtopics in which actors represented different views of SB. The video-clips were presented to Dutch citizens in two different set-ups: per narrator and per sub-topic. Both set-ups appeared to trigger three reflection processes and three reflection outcomes. Our findings suggest that video-narratives shown per subtopic support reflection more extensively provided that workshop set-ups pay considerable attention to reflection on values and assumptions.

6.1 Introduction

Responsible Research and Innovation (RRI) stands for “the integration and institutionalization of established mechanisms of reflection, anticipation, and inclusive deliberation in and around the processes of research and innovation” (Owen et al., 2012, p. 755). As this definition emphasizes, RRI calls for processes in which a representative variety of societal actors reflect (Owen et al., 2012; Von Schomberg, 2013) on “purposes and motivations” of research and innovation (R&I) (Owen et al., 2012, p. 254), societal-ethical and technical aspects, as well as “tacit understandings, assumptions, uncertainties, framings and commitments” (Stilgoe et al., 2013, p. 1575).

During such RRI-reflection processes, participants practice and employ their scientific citizenship (Bandelli & Konijn, 2015; Boerwinkel et al., 2014; Horst & Michael, 2011). Whereas the learning among participants is often mentioned as a reflection outcome (Broerse & De Cock Buning, 2011), reflection processes on the level of individual participants can be the development and re-definition of the own perspectives (Loeber, Griessler, & Versteeg, 2011), and (re-)consideration of other perspectives, critically or accepting (Van der Meij, 2016; Davies et al., 2009). On the level of the R&I system, the reflection in RRI contexts can eventually make decision-making on R&I more societally responsible and, as a consequence, more inclusive (Korthals, 2011; Stilgoe et al., 2013).

Participants of RRI-reflection processes need certain guidance. Emerging R&I fields, which call for upstream, continuous, inclusive reflection processes the most (Sykes & Macnaghten, 2013), are often shrouded in uncertainties (Owen et al., 2012).
The methods, approaches, potential applications and feasibilities are unknown or undecided, making purposes and societal-ethical aspects very difficult to determine (Boerwinkel et al., 2014). Scholars previously identified several process conditions to support the exploration of diversity in RRI-reflection, such as the provision of sufficient background information, independent facilitation (Rowe & Frewer, 2000) and the paying of attention to diverse participants (Carpini et al., 2004). The current study aims to look more closely at how tools and formats could facilitate reflection on R&I.

Various studies into informal learning emphasize the power of science-narratives and video-narratives about science or technology to stimulate reflection on R&I. Avraamidou & Osborne identify key components of scientific narratives such as purpose, timing, narrators, and a beginning-middle-end structure (2009, p. 1693). Their usefulness as a tool for reflection lies in the fact that narratives resemble the ways by which the human brain makes sense of the world (Murmann & Avraamidou, 2014). Furthermore, narratives, and especially video-narratives, stimulate a viewer to grow an emotional connection with regard to narrators (Walker et al., 2005; Pineda & Bernhardsson, 2011). This identification, or reduction of ‘otherness’ (Walker et al., 2005, p. 283), in combination with the rich context that narratives provide such as time, place and narrator emotions, make it likely that the viewer respectfully weighs the narrated content (South et al., 2008). Moreover, if people view multiple video-narratives about the same topic, they start to assess and compare the narratives, developing understanding of a topic from different perspectives (van der Meij et al., 2016; see Chapter 5).

The various scientific narrative formats that Avraamidou & Osborne describe, could raise the idea that only scientists are ‘allowed’ to narrate about science and technology to support citizens in reflection on R&I. This aligns with the conventional thinking that a citizen’s science knowledge deficit has to be overcome by communicating scientific knowledge (Bucchi, 2008; Sykes and Macnaghten, 2013). However in a context of RRI this thinking does no longer stand. Namely, in RRI citizens’ framings, assumptions, and reflections on impacts are explicitly considered (Owen et al., 2012; Stilgoe et al., 2013; Sykes & Macnaghten, 2013). Therefore, an interesting line of thinking about narratives for RRI contexts, is Skydsgaard et al.’s suggestion that reflection is better stimulated if ‘expert narratives’ are combined with ‘personal narratives’, in which perspectives on R&I derived from lived experiences of non-scientists are shared (2016, p. 48). Such narratives facilitate personal, ‘deep conceptual learning’, reflection and discussion on R&I (Skydsgaard et al., 2016, p. 50). In this study, we therefore propose an RRI-specific approach to video-narratives for reflection on R&I, namely narratives in which semi-fictional characters realistically and attractively represent citizen-viewpoints of R&I in a short and semi-structured way.
Various scholars designed, implemented and evaluated reflection on R&I by means of narratives (Boerwinkel et al., 2014), video (Horst & Michael, 2011) and video-narratives (e.g., Lucivero, 2016; Schmidt et al., 2015) for policy and policy-free purposes (Stilgoe et al., 2014). However, these studies mostly investigate fiction, and pay little attention to how video-narrative composition contributes to reflection processes and outcomes exactly on the level of the individual participants. Given that R&I reflection processes can have transformative impacts on participants (Davies et al., 2009; Loeber, et al., 2011; Sykes & Macnaghten, 2013), further research should consider the relationship between the presentation of video-narratives and their impacts on reflection. This approach would yield insights into the design requirements of video-narratives as supportive tools for reflection in RRI contexts.

This study investigates the presentation of video-narratives, designed to support reflection on synthetic biology (hereafter SB), in relation to reflection processes and outcomes. SB is an emerging field in which R&I practitioners use biotechnology to design and build new biological products and systems, with specific preconceived functionalities (cf. Schmidt et al., 2009). “[SB] aspires to move away from genetic engineering guided by trial and error towards a rational design process in which whole genomes can be constructed at the computer.” (Boldt, 2016, p. 2). In the past few years, SB has been labeled as controversial (Balmer & Martin, 2008; Torgersen & Schmidt, 2013) since the “discourse on fundamental issues such as biosafety and biosecurity, intellectual property rights, environmental consequences, and ethical and societal implications is still open” (Ancillotti et al., 2016, p. 309). SB therefore functions as an interesting R&I field for the purpose of this study.

We designed and recorded video-narratives in which four actors, specialized in improvisation, performed a monologue representing citizen narratives of science. The narratives, each portraying a distinct perspective on SB, were constructed based on central assumptions in Science & Technology Studies (Verbeek, 2005) and a series of citizen panels that produced discourses of SB (Betten et al., 2017). Each narrator tells its story in three separate video-clips, each covering a particular sub-topic, resulting in twelve separate video-clips in total. We presented these clips in two different presentation set-ups to volunteer-citizens of diverse age, background and gender, in both individual and group settings. One part of participants saw all clips of two of the narrators first, followed by all clips of the other two narrators. We hypothesized that this approach would stimulate identification with each narrator, and therefore thorough consideration of the diverse views (cf. Walker et al., 2005; South et al., 2008). The other participants saw video-clips per subtopic so that they could, we assumed, compare clips of the four narrators more comprehensively and per sub-topic (cf. van der Meij et al., 2016; see Chapter 5). By analyzing the conversations as a result of the video watching, we aimed to answer the following two research questions: (1) What reflection processes and outcomes are triggered by the video-narratives? (2) How do these triggered reflection processes and outcomes differ across presentation set-ups?
6.2 Reflection on R&I

When people encounter a new situation, like R&I in SB, they tend to engage in a process of inquiry to analyze the situation and make sense of it, comprising first and second order reflection (Grin & van der Graaf, 1996). First order reflection encompasses the “consideration of problem definitions and evaluation of solutions” (Grin & van der Graaf, 1996, p. 299). At this level of first order notions, effectiveness, risks, problems, costs and preferred (alternative) solutions are considered (Grin & van der Graaf, 1996; McKee, 2003). For example, at this level people see SB as interesting, promising, potentially dangerous or unnecessary (e.g., as described in Ancillotti et al., 2016). Second order reflection involves the formulation of reasons behind first order notions, such as values and beliefs (Grin & van der Graaf, 1996). At the level of second order notions, for example, several societal actors in the Netherlands dislike SB, arguing that R&I should not be allowed to freely create all kinds of organisms (Ancillotti et al., 2016). In the elicitation of viewpoints in presence of others, people tend to focus on aspects that are relevant to their own viewpoint, and are often unaware of their second order notions, leaving them un-addressed. Making values and beliefs explicit is, however, a crucial key to dialogue (McKee, 2003). Namely it facilitates in-depth understanding of one’s own and other peoples’ perspectives (Drake & Donohue, 1996; Kupper et al., 2007).

In this study, we consider that first and second order reflection are also crucial for reflection on R&I. Figure 6.1 shows our conceptualization of the ideal RRI-reflection process at the level of a person.

![Figure 6.1: components of reflection.](image-url)
Quadrant 1 refers to an individual’s awareness of his/her own first order notions with regard to R&I; Quadrant 2 represents awareness of second order notions. Quadrant 3 refers to awareness of other people’s first order notions, while 4 represents a person’s awareness of other people’s second order notions. When reflection covers all four quadrants, a full or complete reflection process is demonstrated. As mentioned above, narratives have the potential to support reflection. We therefore argue that citizen video-narratives of science that demonstrate first and second order reflection might encourage a viewer to reflect on the first and second order notions of himself/herself and of others too.

6.3 Method

6.3.1 Designing the prototype

Several scholars developed typologies to categorize the ways in which human beings make sense of technology and biotechnology (e.g., Rogers, 1962; Verbeek, 2005; Nisbet & Markowitz, 2014). The technology diffusion model (Rogers, 1962) distinguishes between early adopters, the early and late majority and laggards. Alternatively, Nisbet and Markowitz categorize people into groups of science ‘optimists’, ‘pessimists’ and the ‘conflicted’, who see science in a pessimist as well as optimist way (2014, p. 3). Although the latter approach is focused on biotechnology, these typologies give little indication of values and beliefs beyond speed of adoption or attitude. To develop video-narratives for reflection on SB, our challenge was to find a framework that would support understanding of both first and second order reflection. Given that the distinction between organisms and technology often determines a person’s view of SB (Müller, 2016), we used a framework that builds on the work of technology philosopher Verbeek (2005) and a study of Betten et al. into Dutch citizens’ views of SB (2017). The framework positions various assumptions and belief that people can have regarding the relationship between human beings and technology as a basis for sense making related to SB (see Figure 6.2, derived from Betten et al., 2017).1

The left side of the horizontal axis refers to the externalization of technology (Verbeek, 2005): technology is something separate from human beings. The right side of the horizontal axis resembles Verbeek’s transhumanist approach, which views technology as fused with human beings (2005). The vertical axis spans the existentialists (top) who approach technology purely instrumentally, versus determinists (bottom). Existentialists see human beings as dominators of technology, and technology as value-free, whereas determinists see technology as value-laden (Verbeek, 2005). In Figure 6.2, the top-left quadrant demonstrates the mechanic’s view of SB, whereas the top-right represents the inventor. The bottom-left quadrant represents the critic, and we named the bottom-right a bionaut.

1 Figures 6.1 and 6.2 both comprise quadrants. However, they map different understandings hence cannot be transposed on top of each other.
We created narratives for each quadrant of Figure 6.2 in two steps. First, we aligned their storylines with our conceptualization of reflection on R&I as described earlier, covering first and second order notions in three clips about sub-topics that address one or multiple questions:

1. Each narrative has an introductory clip about two first order questions, in which narrators problematize SB's dilemmas and possibilities: (1a) ‘What is SB to you?’ and (1b) ‘What is the role of SB in our future society?’

2. The second set of clips addresses second order notions: values and assumptions underlying the various views of SB (see Figures 6.2 and 6.3). These clips cover the question (2) ‘What is the relationship between humans and technology?’

3. The third set of clips address first order notions again, referring to solution finding, by means of the questions (3a) ‘What is an adequate ethical approach to SB?’ and (3b) ‘What is the role of citizens in the future development of SB?’

After having designed this structure, we recorded the video-narratives by means of scripted reality: we asked improvisation actors to represent one quadrant of Figure 6.2. Our choice for actors rooted in the notion that fully authentic narratives, e.g. citizens narrating spontaneously in front of a camera, can result in rather lengthy stories that are neither structured nor deep enough for reflection (cf. van der Meij et al., 2016; see Chapter 5). During appointments with individual actors, the video-director presented Figure 6.2, the roles of mechanic, critic, innovator or bionaut, and the sub-topics.
We asked the actors to invent a name for their character (see at the bottom of each quadrant in Figure 6.2). After a collaborative identification of several keywords for their narrative, we recorded video-clips for each sub-topic (see Appendix 1). Given that narratives are most powerful when they have a clear structure (Murmann & Avraamidou, 2014), the film-director and the actors made sure that each clip had a clear beginning and end. From now on, we refer to the actors as narrators.

6.3.2 Testing the prototype

To investigate how the video-narratives evoked reflection on SB, and under which conditions this differed, we organized two group and seven individual test sessions in which a total of 9 men and 9 women voluntarily took part as participants. Their ages ranged from 17 to 67 years old. With the group sessions, we aimed to identify basic reflection processes and outcomes evoked by the presenting of and reflecting on the video-narratives. The individual test sessions were organized to complement the group session data (cf. Lambert & Loiselle, 2008) with the aim to reveal the individual reflection processes and outcomes as triggered by the video-narratives more precisely.

The group test sessions took place at Wetlab-evenings in Amsterdam with two groups of seven and four adult participants respectively. These participants were visiting an ‘Introduction to do-it-yourself synthetic biology’-event so they were novices but probably more interested in SB than average citizens. The individual test sessions took place in Amsterdam, Utrecht and Nijmegen, with citizens that were unacquainted with the field. In these sessions we aimed for a spread in gender and in knowledge of R&I. The individual participants were indirect acquaintances of the researchers and research assistant. Participants of the group test sessions did not participate in individual test sessions, and vice versa.

We presented video-narratives in a narrator presentation set-up in one group session and four individual test sessions, and a sub-topic presentation set-up in the other sessions (see Table 6.1 & 6.2, and Figure 6.3). In the latter, we presented narratives of all four narrators sub-topic by sub-topic, each immediately followed by reflective conversations, aiming to trigger inter-video comparison on individual sub-topics. This resulted in sessions with three viewing and conversation rounds, namely one round for each sub-topic. In the narrator set-up, we presented full video-narratives of two narrators, aiming to trigger closer identification with each narrator. As a result, these sessions had two rounds, namely the viewing of and conversing about videos of two narrators at a time. We varied the sequence in which the narrators were shown.

Both set-ups took 1.5 hours and comprised the following steps:

- We gave an explanation about the study, emphasizing the neutrality of the facilitator to prevent bias; all different viewpoints were welcomed.
- We asked informed consent for audio recording for anonymous data analysis.

2. See: http://waag.org/en/lab/open-wetlab
The presenting of a short video introducing SB, plus conversing with individual participants on their initial view of the field. We derived this video from a presentation used in Betten et al. (2017). The video presented technical principles of SB and its promised possibilities in various application domains, mentioning that there are currently unknown uncertainties and risks too.

Several rounds of watching video narratives (two rounds in the narrator setup, three rounds in the subtopic setup, see Figure 6.3).
Case study 2: Video-narrative based reflection

- After each round of video watching, participants were asked to fill in a Learner Report (LR; Van Kesteren, 1993), which comprised six sentences without an end, requiring participants to complete these sentences. As LRs are meant for individual reflection on learning (van Kesteren, 1993), we designed the reports to make participants reflect on their responses to the videos, and relate the views of the narrators to their own view (“After seeing this video, I became aware of/was surprised/(un)pleased that/know that I/others . . .”).

- We held active conversations with the participant(s) about the videos: “What do you think about Christine/Karin/Walter/Marlous?” (in the narrator setup) or “What do you think about these viewpoints?” (in the subtopic setup). The interviewer limited its role to one “deepening” question per round (e.g., “How come you see it this way?”), to gain insights into the extent to which first and second order reflection would spontaneously happen after participants had seen the videos.

- An end-reflection, in which we conversed with the participant(s) about what had happened during the test session.

**Data gathering, reduction and processing**

The test sessions were anonymously transcribed verbatim, including the interviewer’s texts. For the labeling, we chose to reduce the data to the level of sentences (DeCuir-Gunby et al., 2011). To make analysis of reflection possible at the level of individual participants, we separated group session transcripts in sentences per participant. However, for meaningful analysis we needed to maintain certain contextual information surrounding the sentences of each individual participant. In the individualized transcripts, we therefore included facilitator questions and some other immediately preceding contributions of other participants too. Lastly, we also inserted the sentences that participants wrote in their LRs in the conversation transcripts at moments in the session that participants had done the LRs.

**Data analysis and coding strategy**

We coded the transcripts, including the LR answers, by using a combination of deductive and inductive coding (Braun & Clarke, 2006), comprising iteration between the revision of theory and repeated examination of raw data (DeCuir-Gunby et al., 2011). Firstly, the first author coded transcripts on the occurrence of first and second order reflection as conceptualized above (Grin & van der Graaf, 1996). Secondly, based on the initial coding, the first author identified several data-driven themes, with particular attention to identifying reflection processes and outcomes. Examples and non-examples of themes were discussed and refined with the third author to determine the reliability of the codes and the coder (cf. DeCuir-Gunby et al., 2011). Differences in opinions between researchers were resolved by discussion among the authors. This led to the identification of several themes in the transcripts. Thirdly, we compared these identified themes to the perceptions of participants on what had happened during the session, as expressed in their LRs or during conversations with the interviewer. These perceptions were used to verify the themes as identified by the authors, and inductively yielded three reflection processes and three reflection outcomes.
Table 6.1: group test session participant characteristics and session set-up details.

<table>
<thead>
<tr>
<th>Group session</th>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Education</th>
<th>Test session set-up details*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>GP1</td>
<td>Male</td>
<td>23</td>
<td>Higher vocational education</td>
<td>N: CKWM</td>
</tr>
<tr>
<td></td>
<td>GP2</td>
<td>Male</td>
<td>25</td>
<td>University MSc</td>
<td>N: CKWM</td>
</tr>
<tr>
<td></td>
<td>GP3</td>
<td>Female</td>
<td>25</td>
<td>Higher vocational education</td>
<td>N: CKWM</td>
</tr>
<tr>
<td></td>
<td>GP4</td>
<td>Female</td>
<td>25</td>
<td>University MSc</td>
<td>N: CKWM</td>
</tr>
<tr>
<td></td>
<td>GP5</td>
<td>Female</td>
<td>25</td>
<td>Higher vocational education</td>
<td>N: CKWM</td>
</tr>
<tr>
<td></td>
<td>GP6</td>
<td>Female</td>
<td>27</td>
<td>University MSc</td>
<td>N: CKWM</td>
</tr>
<tr>
<td></td>
<td>GP7</td>
<td>Female</td>
<td>31</td>
<td>Higher vocational education</td>
<td>N: CKWM</td>
</tr>
<tr>
<td>Session 2</td>
<td>GP8</td>
<td>Male</td>
<td>25</td>
<td>University MSc</td>
<td>ST: KMCW</td>
</tr>
<tr>
<td></td>
<td>GP9</td>
<td>Male</td>
<td>25</td>
<td>Higher vocational education</td>
<td>ST: KMCW</td>
</tr>
<tr>
<td></td>
<td>GP10</td>
<td>Male</td>
<td>26</td>
<td>University MSc</td>
<td>ST: KMCW</td>
</tr>
<tr>
<td></td>
<td>GP11</td>
<td>Female</td>
<td>28</td>
<td>University MSc</td>
<td>ST: KMCW</td>
</tr>
</tbody>
</table>

Table 6.2: individual test session participant characteristics and session set-up details.

<table>
<thead>
<tr>
<th>Session participant</th>
<th>Gender</th>
<th>Age</th>
<th>Education</th>
<th>Test session set-up details*</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP1</td>
<td>Male</td>
<td>27</td>
<td>University MSc</td>
<td>N: WMCK</td>
</tr>
<tr>
<td>IP2</td>
<td>Female</td>
<td>27</td>
<td>PhD</td>
<td>ST: CKWM</td>
</tr>
<tr>
<td>IP3</td>
<td>Female</td>
<td>24</td>
<td>Higher vocational education</td>
<td>ST: WCMK</td>
</tr>
<tr>
<td>IP4</td>
<td>Male</td>
<td>36</td>
<td>Higher vocational education</td>
<td>N: WMKC</td>
</tr>
<tr>
<td>IP5</td>
<td>Female</td>
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<td>University MA</td>
<td>N: KMCW</td>
</tr>
<tr>
<td>IP6</td>
<td>Male</td>
<td>67</td>
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<td>ST: KWCM</td>
</tr>
<tr>
<td>IP7</td>
<td>Male</td>
<td>17</td>
<td>High school HAVO</td>
<td>N: WKCM</td>
</tr>
</tbody>
</table>

*Legend: ST= subtopic set-up, N= narrator set-up, C= Christine, K= Karin, W= Walter, M= Marlous.

6.4 Findings

We identified three reflection outcomes and three reflection processes that were dominantly triggered by reflection on the video-narratives. The various processes and outcomes were demonstrated simultaneously during conversations: the reflection outcomes and processes did not exclude one another and even reinforced one another. Table 6.3 shows how often each reflection process and outcome occurred in the different set-ups. As 11 citizens participated in the narrator set-up and 7 in the sub-topic set-up, we also calculated the ‘relative instances’: we divided instances of reflection processes and outcomes in narrator sessions by 11, and instances that occurred in sub-topic sessions by 7 (see Table 6.3).
Case study 2: Video-narrative based reflection

6.4.1 Reflection outcomes

Comparing participants’ final and initial discourses at the beginning and end of test sessions respectively, we identified three common reflection outcomes: (1) participants slightly modified their initial views by hearing and reflecting on the viewpoints represented in the video-narratives; (2) participants developed more analytical understanding of narrators’ perspectives, even when they were totally different from their own; and (3) participants started to value the existence of a multiplicity of perspectives as represented in the video-narratives. The following quote of group session participant GP11 summarizes these findings:

“(...) I’ve not really changed my opinion but it might lead me to be more wary of dismissing other people’s viewpoints.”

We provide details of each outcome in further detail below. Quotes were translated from Dutch and adjusted for readability purposes.

Minor modifications

During test sessions, video-narratives increased participants’ vocabulary and knowledge of SB but their general tone of language about the field remained. When participants’ initial view of SB was enthusiastic or hesitant, they continued to hold this view until the end of the session. We traced minor changes in views during conversation (15 instances among 10 participants). Four participants reported in LRs and reflective conversations that they had slightly changed their views, illustrated by the following quote of individual test session participant IP4:

“In the beginning, I only thought of risks. (...) But later on I saw more possibilities too. (...) As you are always influenced. (...) The more things are being told, the more it starts to work in your mind; it starts to live.”

### Table 6.3: overview of reflection process and outcome instances, distinguishing between conversations (conv.) and Learner Reports (LRs), narrator and subtopic set-up, the total number of instances, and instances corrected by the number of participants per set-up (in brackets).

<table>
<thead>
<tr>
<th>Category</th>
<th>Labels</th>
<th>N set-up (n = 11)</th>
<th>ST set-up (n = 7)</th>
<th>Total (n = 18)</th>
<th>LRs N set-up (n = 11)</th>
<th>LRs ST set-up (n = 7)</th>
<th>Total in all LRs (n =18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflection outcomes</td>
<td>Minor modification</td>
<td>11 (1,00)</td>
<td>4 (0,57)</td>
<td>15 (0,83)</td>
<td>4 (0,36)</td>
<td>0 (0,00)</td>
<td>4 (0,22)</td>
</tr>
<tr>
<td></td>
<td>Analytical understanding</td>
<td>10 (0,91)</td>
<td>6 (0,86)</td>
<td>16 (0,89)</td>
<td>4 (0,36)</td>
<td>5 (0,71)</td>
<td>9 (0,50)</td>
</tr>
<tr>
<td></td>
<td>Diversity appreciation</td>
<td>7 (0,64)</td>
<td>4 (0,57)</td>
<td>11 (0,61)</td>
<td>10 (0,90)</td>
<td>8 (1,14)</td>
<td>18 (1,00)</td>
</tr>
<tr>
<td>Reflection processes</td>
<td>Shopping (1st order)</td>
<td>23 (2,09)</td>
<td>18 (2,57)</td>
<td>41 (2,28)</td>
<td>18 (1,64)</td>
<td>17 (2,43)</td>
<td>35 (1,94)</td>
</tr>
<tr>
<td></td>
<td>Demarcation (1st order)</td>
<td>21 (1,91)</td>
<td>17 (2,43)</td>
<td>38 (2,11)</td>
<td>24 (2,18)</td>
<td>23 (3,29)</td>
<td>42 (2,33)</td>
</tr>
<tr>
<td></td>
<td>Understanding fundamental differences (2nd order)</td>
<td>2 (0,18)</td>
<td>8 (1,14)</td>
<td>10 (0,56)</td>
<td>3 (0,27)</td>
<td>4 (0,57)</td>
<td>7 (0,39)</td>
</tr>
</tbody>
</table>
Analytical understanding
Throughout the process of watching video-narratives and conversing about the content, participants developed an enlarged analytical understanding of other views (16 instances among 9 participants). At the beginning of test sessions, participants could be critical and sometimes even become slightly annoyed by narrators with views different to their own. As the sessions progressed, participants started expressing certain understanding of these different views. Test session participants who initially identified themselves with the opinions expressed by Karin (critic), later in the session seemed to gain understanding for the viewpoints of Christine (mechanic) or Walter (inventor). Alternatively, participants that observably resembled and identified the most with Christine, Walter or Marlous, seemed to develop certain understanding for Karin’s arguments too.

The following quote of individual test session participant IP1 illustrates the growth of analytical understanding. Throughout the session, the participant had repetitively expressed disagreement with Karin’s critical stance towards SB. However, almost at the end of the session, the participant said the following:

“Karin does hit a nerve there by [noting that] (...) if everybody could decide the gender of their child in the future (...), the consequences could be enormous. Although I don’t agree with her way of looking at it, she makes you realize that this is how far it could go.”

After this, the participant began to consider the need for thinking about regulations on SB, like Karin, although not agreeing with Karin’s views in many respects. To summarize this identified reflection outcome, the viewing and considering of video-narratives seemed to increase participants’ understanding of other views of SB.

Appreciation of diversity
Often coupled, but representing a more generic outcome than increased analytical understanding, participants started to value the existence of a multitude of views of SB as represented in the video-narratives (11 instances among 10 participants). For example, group session participant GP10 wrote, after seeing video-narratives about ‘What is SB?’ and ‘What is its potential impact on our future society?’, in the LR:

“Perhaps it could be said that the first and last viewpoints represent ‘society’ [Karin], ‘humanism’ [Walter], while the other viewpoints are focused on practicalities, process, technology [Christine & Marlous]. All viewpoints are needed.”

Several times in conversations during this session, this participant again shared her appreciation of diverse perspectives. It seemed that the video-narratives with various perspectives on the topic helped participants to discover a value in multiple perspectives. Given that the LRs showed 18 additional instances of this reflection outcome (see Table 6.3), it could be the case that this increased appreciation of diversity occurred more often than expressed in conversations.

6.4.2 Reflection processes
Looking at the ways in which participants reflected on the views represented in
the video-narratives and their own view respectively, we identified three dominant processes. We identified two processes of reflection at the level of first order notions: shopping and demarcation. One less common process had a deepening character in which second order reflection also took place.

**Shopping**
The video-narratives had the effect of encouraging participants to combine and jump back and forth between the four narratives to articulate their own view (41 instances among 17 participants). The conversation fragments below, from individual test session participant IP7, illustrate this shopping process. After seeing the introductory video, the participant cautiously shared an initial view of SB:

“... I saw that people are already creating new limbs ... Things like that would be really useful. ... [I] think that they’re going to do it especially in the medical field or something. (...) But I don’t know, maybe they can do bad things with it. Not that I know what. (...) If [this technology] gets into the wrong hands (...) Yes, that might just happen. Of course I don’t know exactly what people can do but if it did that would not be good.”

Subsequently, after seeing the full video-narratives of Walter and Karin, the participant commented:

“Yes, I would say we should not mess about with nature too much. It would make the ecosystem fall apart. But do I think we can give nature a little push, steering it in the right direction.”

In this quote, IP7 emphasized the cautious arguments of narrator Karin combined with the optimistic arguments of narrator Walter. Incorporating the views of these narrators helped this participant to enrich the initial pro and contra arguments as cautiously opted before viewing the videos. IP7 reflected on the following during the process:

“Well it [seeing Karin and Walter] helped me a bit to form an opinion because they show a little bit about two sides.”

Another participant of an individual test session confirmed this process as well, while reflecting on the session at the end:

“(…) These people show you angles that you would not have thought about otherwise. So that’s the nice thing about it. It helps you to form your opinion.”

The 41 instances of shopping show that this process made participants develop a more precise view.

**Demarcation**
Participants of our test sessions also defined their own view by highlighting aspects of video-narratives with which they disagreed (38 instances among 15 participants). This reflection process generally occurred when participants were less hesitant to develop their own view, and when they were confronted with narratives that they perceived as different from their own. An illustration of this demarcation comes from a group session. After the facilitator asked participants to respond to the content of the introductory video, participant GP6 noted:

“(…) I’m worried about the governance of the innovations in SynBio. (...) I was
wondering how funding is applied and how that steers in some way. What type of research is going to be done and how is it going to be applied?“

These immediate concerns slightly resemble the narrator Karin in terms of having concerns, but also narrator Christine in terms of minimizing the risks of innovation. However, after having seen two full video-narratives of Christine and Karin, the GP6 mentioned in the LR:

“After seeing the film clips, I know that I feel I am caught between both clips. I can understand the rhetoric of both [Karin & Christine], and yet I do not agree fully with them.”

In the LR, GP6 also explained her disagreement with Karin:

“I was surprised by that conversation on the relationship between humans and technology in clip 2. [Karin] places technology as an ‘other’, something outside ourselves, when in fact it is part of us.”

During the plenary conversation, the participant commented about her further disagreement with the video characters:

“Christine mentioned that the debate should not be led by fear. But is fear not just always present in making decisions for choosing how to implement SynBio? For instance, if people say ‘for health reasons it’s okay, but for other reasons it’s not okay’, isn’t that also driven by fear? The fear of death. Is that a rational decision? You can’t really say it’s a rational debate. It is never a rational debate.”

This inquiry into the video-narratives that were initially comparable with the participant’s own initial view created further boundaries on the participant’s views.

Discovering fundamental differences and similarities

Although the above quotes show certain second order discourse, deeper reflection on, for example, why one should have concerns regarding SB or why is it important to be optimistic about SB, was generally absent in most of the shopping or demarcation instances. We could identify only 21 instances of second order reflection in conversations (and 7 additional instances in LRs) that revealed analysis of values and assumptions underlying their own or other views of SB. Ten of these 21 instances could be clustered as a pattern (see Table 6.3), namely that participants discovered why they agreed or disagreed with particular narrators. The quote of individual test session IP2 illustrates this:

“Well, I agree the most with what Christine said. I think this is also why I felt so hesitant in my reaction to Karin in the previous video; she really pretended as if the development stands by itself and that [humans] have no control over it. [Christine] articulated that it is ultimately humans who decide. Developments may come unexpectedly but ultimately it is humanity who makes the reasonable choice about what happens with it. And I agree the most with that. And that whole story of Walter about that film he refers to in which humans and technology coalesce, really sounds like a nasty nightmare. [Laughing] (...) He may think this but technology is a sort of utensil and thus we ultimately decide what happens. Something that makes life easier and makes it better, and not something that sort of merges with us ... like in that film.”
IP2 discovered that his own position was closer to Christine’s because he disagreed with the underlying assumptions of Karin and Walter.

6.4.3 Influences of the setups, prototype and facilitation techniques

Although the test scale was small, several differences could be observed between the narrator and sub-topic set-ups. Overall, if corrected by the number of participants per session (see Table 6.3), the sub-topic set-up especially triggered reflection processes more powerfully than the narrator set-up. Firstly, in the sub-topic set-up, shopping occurred 18 times versus 23 times in the narrator set-up. Correcting these instances by the number of participants (7 versus 11 respectively), the sub-topic set-up triggered shopping more extensively. Also, 35 instances of shopping could be identified in the LRs, indicating that the LRs might have been a major trigger of this reflection process.

Secondly, some 17 of the demarcation instances occurred in the sub-topic set-up, versus 21 instances in the narrator set-up. Correcting these instances by number of participants (see Table 6.3) indicates that the sub-topic set-up triggered demarcation more extensively. We noted that LRs showed 42 additional instances of demarcation. Therefore, we postulate that participants may have been more hesitant to express disagreement with opposing viewpoints in the face-to-face conversations, especially in group sessions, in which individual participants had less time to talk. Thirdly, the sub-topic set-up seemed to trigger second order reflection more extensively than the narrator set-up (8/10 instances), particularly the video-clips about “What is the relation between humans and technology?” These set-up differences suggest that the sub-topic set-up carries more potential for thorough, first and second order reflection on R&I compared to the narrator set-up.

We also noted several set-up overarching effects. First, the introductory video triggered the initial reflection process. It was designed to be neutral, namely explanatory about the technologies used in SB and indicative with regard to possibilities and risks, without promoting or over-criticizing the field in content or tone of voice (see Appendix 2). The content was derived from an SB introduction presentation as tested in Betten et al. (2017). Still, participant GP10 mentioned in response to the introductory video:

“...I thought there was some surprising imagery used. In particular, the DNA feeding into this kind of like iconic factory with DNA coming out of the other side (...) I think a lot of people are concerned about the industrialization of human life. So ehm, yeah to me that [video] kind of triggered this thought.”

Indeed the introductory made use of several schematic illustrations, which could have framed SB in particular ways. However, participants did not articulate extreme resistance or extreme enthusiasm towards SB after the introductory video with references to its visualizations. Most participants moderately emphasized potentially positive and negative aspects of SB in response to the introductory video, although at that time they could not always articulate their precise views.
Second, we noted eight instances in which participants were annoyed by particular characters as the following quote of a group session participant illustrates:

“(…) The DJ reminds me of like people of my generation that just know little bit about the technology and are, like, ‘yaaay technology!’ ”

However, just as frequently, participants were inspired by particular narrators. This annoyance and inspiration was particularly generated by Walter, the innovator, who had many ideas about what people should be able to do with SB. Third, we ensured that each video clip lasted less than three minutes. However, our participants could not always remember the narratives; three participants mentioned this explicitly during conversations. This memory issue might have had an impact on the depth of participants’ reflections with regard to the content of the video-narratives. Fourth, explicit deepening questions from the facilitator (e.g., “How come you see it in this way?”) seemed to trigger more extensive, deeper reflections. Most discoveries of fundamental differences arose after explicit questioning of the facilitator. Last, the participants’ answers to the unfinished sentences in the LRs, such as ‘After seeing this video-narrative I know that….’ and ‘I was surprised / pleased / displeased that…’, seemed to encourage participants to analyze each of the narratives during conversations in more depth (“I agree with (name), but I don’t agree with (name)”). In particular, the unfinished sentences ‘I liked ….‘ and ‘I didn’t like ….‘ appeared to trigger participants to engage in shopping and demarcation.

6.5 Conclusion and discussion

In this exploratory study, we found that reflection on video-narratives of four different views of SB induced several valuable reflection processes and outcomes. The video-narratives facilitated development of understanding of other views among our test session participants. As a result of the video-narratives, participants appeared to appreciate the diversity of perspectives on SB without completely abandoning or disrupting their own initial views. These reflection outcomes emerged from a second order and two first order reflection processes. The latter concerned shopping, in which participants carefully collected aspects of various videos to construct and express their own view, as well as demarcation in which participants defined what they thought of SB by disagreeing with particular aspects of the videos. On the rare instances of second order reflection, participants became more aware of their reasons for agreeing or disagreeing with particular aspects of the video-narratives. Our findings demonstrate differences between the impacts of the two set-ups in which we tested the video-narratives. A set-up in which videos were shown on the basis of sub-topics resulted in relatively more instances of reflection processes and outcomes, when corrected for the greater number of participants. Moreover, almost all instances of second order reflection occurred in the sub-topic set-up, particularly after viewing video-narratives on the sub-topic ‘What is the relationship between human beings and technology?’ In addition, the facilitator and LRs played an important role in triggering reflection outcomes and processes.
These findings suggest that the presentation of video-narratives can be useful for inclusive reflection in RRI contexts. We have identified several ideas on how to present video-narratives for the stimulation of different reflection processes and outcomes, but also several challenges in making the video-narratives recognizable, immersive, and contextually qualitative to actually achieve the occurrence of these reflection processes and outcomes. In the next section, we therefore share insights into the design of video-narratives for reflection on R&I. After this, we reflect on the value of video-narrative based reflection in RRI contexts.

6.5.1 Design implications

First, our findings indicate that video-narrative based reflection does require complementary tools and exercises to deepen the reflection. Our findings showed that video-narratives did not trigger much second order reflection on their own. Learner Report questions (cf. van Kesteren, 1993) and facilitation were useful additional means to deepen reflection. From this, we consider that strong facilitation and additional tools, such as PlayDecide cards (Bandelli & Konijn, 2011), could be incorporated in video-narrative based reflection to guide participants into deeper reflection.

Second, van der Meij et al. (2016; see Chapter 5) showed that videos benefit from a strong topical focus to guide the learning and reflection. Our findings confirm this notion. The sub-topic set-up seemed to facilitate second order reflection (Grin & van der Graaf, 1996) slightly better than the narrator set-up. In the sub-topic set-up, second order discourse could be seen directly after showing videos on the question ‘What is the relationship between human beings and technology?’ As a result, we argue that video-narrative based reflection processes need to be divided into small steps of reflection. They should include a separate moment for the viewing of video-narratives about second order notions concerning the T&I at stake, followed by reflection.

Last, video-narrative based reflection requires videos with narrators with seemingly equal knowledgeability, importance, seriousness and humor. One of our narrators, Walter, appeared to annoy our test session participants more than the other characters. Although this can be a matter of taste, this narrator had a more indifferent, informal attitude when compared to the other narrators, possibly triggering participants’ tendency to abandon his viewpoints. Murmann and Avraamidou (2014) noted that the quality of actors strongly determines the impact of narrative-based science learning. Although videos provide rich context that promotes immersion and facilitates learning (Pineda & Bernhardsson, 2011; Walker et al., 2005), we argue that Walter’s acting style and role might have negatively overwhelmed our participants. If this was the case, annoyance inhibited the degree to which his views could be seriously assessed. Therefore, it might be useful to make actors collaborate with one another in making video-narratives, to equalize their vocabulary, vividness, talking speed, and even the duration of their stories.
6.5.2 The added value of video-narratives for reflection on SB

Reflection on first and second order notions is important if dialogues are to result in mutual understanding (McKee, 2003). In reflection without additional tools, the facilitator has to assure that attention is paid to diversity to encourage participants’ understanding for diverse views (Rowe & Frewer, 2005). It is a limitation of this study that no experimental design was applied with a control group that reflected on SB without videos or with unrelated videos. We made this choice, because we were looking for a qualitative in-depth understanding of the ways by which our participants made sense of the different citizen-narratives, rather than examining effect relationships between the stimulus and group discussions. Nevertheless, a possible comparator is the study of Betten et al. (2017), which found that citizens can voice issues and concerns regarding SB when put together in a citizen panel, but reflect less explicitly on the underlying structure of those issues and concerns by default. This, we argue, is the added value of video-based narratives. Namely, our video-narratives, showing four different perspectives on SB, supported participants to dive into the rationales of various viewpoints, and thereby develop analytical understanding and appreciation for diverse perspectives.

Additionally, we used a new format for science narratives. We did not present an action story that shows a major problem to which SB delivers a solution; neither did we present a movie in which a ‘visually attractive researcher’ excitingly explains the promises and risks of SB. In contrast, we made improvisation actors narrate monologues to represent citizen-views of SB as identified in Betten et al. (2017). We had structured the narrative-rationales by means of Verbeek (2005), and composed the monologues by making them cover a problematization of SB, values and assumptions underlying these, and then the ethical approach to SB (cf. Grin & van der Graaf, 1996). These narrated monologues do not fit in the narrative categorization of Avraamidou and Osborne (2009). Based on this experience, we argue that our new format for narratives is interesting for the facilitation of reflection on SB, in addition to more common forms of narratives such as science fiction (Knippels, et al., 2009) or artist impressions of SB futures (Schmidt et al., 2015).

Dewulf and Bouwen (2012) identified various strategies of interaction between people’s views in face-to-face conversations: incorporation, disconnection, polarization, accommodation, and reconnection. With regard to reconnection they argued, “reconnecting faces the double challenge of taking one’s own and the challenging issue framing simultaneously as serious and finding a workable relation between them” (Dewulf & Bouwen, 2012, p. 188). We perceive a link between Dewulf and Bouwen’s favorable application of reconnection and the shopping process that we identified in our study. After seeing the video-narratives, our participants seemed to identify overarching patterns in two or more narratives in order to further develop their own view, and occasionally also embedded these overarching elements into their view.
A larger study may be needed to identify whether this process resembles Dewulf and Bouwen’s frame reconnection. We consciously designed the video-narratives to show context and rationales underlying different views, which may have made them all plausible enough for serious consideration of their content seriously. Consciously composed video-narratives, covering both first and second order notions, may support the growth of respect for diverse perspectives. Assuming that this leads to mutually respectful conversations, video-narratives could be of great value for dialogues that aim to stimulate mutual learning.

6.5.3 The role of video-narrative based reflection for RRI

Deliberative reflection processes constitute a crucial element of the responsible embedding of science and technology in society (Stilgoe et al., 2013). Such deliberative processes are challenging to organize because the diversity of views and backgrounds can lead to polarization, inhibiting fruitful reflection on values, purposes, goals and futures of science and technology (Abelson et al., 2003; Carpini et al., 2004; Rowe & Frewer, 2005). We argue that reflection exercises supported by semi-scripted video-narratives may contribute to fruitful deliberation.

Video narrative-based reflection seems to lower the threshold for people to interact and say what they think, creating the opportunity for diverse views to be expressed and heard. Such respect for diversity will become increasingly crucial if commonly agreed pathways and future visions of science and technology are to be developed.

Acknowledgements

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