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Environmental communication for expert audiences - experimenting three approaches

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ABSTRACT

We studied three novel approaches in environmental science communication for experts: gamification, virtual reality, and art-based scenario workshops and analyze participants' perceptions through qualitative interviews and a survey. Four dimensions emerged from the interviews: *enjoyment*, *usability*, *sociability*, and *learning* that were found to be important for scientific communication. The approaches were perceived as enjoyable and beneficial for creating dialogue. However, the simplification of the information reduced its usability for experts. The approaches were found suitable for understanding other participants' viewpoints rather than disseminating knowledge about the content. Experts as a target group require special focus in the development of science communication.

Introduction

Science communication has received increasing attention, addressing the demand to improve communication between scientists, decision makers, and other users (Eppler, 2007; Corner et al. 2018). Environmental science communication has some specific challenges, as the problems are complex, multidisciplinary, often arouse public interest, and are subjects that can cause strong polarizations (Davis et al., 2018; Corner et al. 2018).

In communication addressed to the general public, the aim is often to achieve or find acceptance and moral trust in environmental knowledge

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and present science more broadly (Kappel & Holmen, 2019). When communicating environmental science to experts, the aim is also to increase the understanding of the complexity of the problems, provide multiple perspectives on the problems, and share the latest research knowledge to spur actions. Expert communication in environmental science has traditionally relied on quantity and quality of knowledge (Kappel & Holmen, 2019) and focused on relevance and clarity. However, when trying to build understanding and convey information about complex and value-bound issues, different types of visualizations and dialogue between providers and users of the information can be particularly helpful in environmental communication.

In this study, we focus on three methods: gamification, virtual reality, and art-based scenario workshops. *Gamification* as a means of environmental communication has been studied especially with regard to cities and urban planning (see eg. Wärneryd, 1975; Bishop, 2011; Juhola et al., 2013). In terms of the impacts, Devisch et al. (2016) suggest that games, gamified environments, and playful experiences can enhance collective reflection skills and further participation and engagement in environmental issues. Gamification design features can contribute to successful user engagement and behavioral changes.

Immersive virtual reality (VR) as an environmental communication method has emerged as the technology has developed. According to Smith (2015), VR works well in eliciting environmental preferences, perceptions, and behaviors. A number of studies also show that VR works especially well in participatory environmental decision-making (Puyana-Romero et al., 2017; Wiberg et al., 2019). In terms of design features, Ahn et al. (2016) found that embodied experiences created through a third-person-view with avatars can facilitate interconnection with other people. They further suggest that VR can be an effective tool to promote involvement with environmental issues.

Furthermore, art-based methods are increasingly getting attention in environmental research and communication. We used an *art-based scenario workshop*, which combined elements of storytelling, drama, and participatory scenario-planning. There is some evidence that storytelling can be a powerful way to nurture engagement with science (Dahlstrom, 2014; Weitkamp, 2019) and that stories help people to understand, process, and recall science-related information (ElShafie, 2018).

To sum up the previous research findings in environmental communication, gamification is especially applied to strengthen user engagement and behavioral change. While games are used in impacting peoples' mind-sets, VR is used to elicit users' environmental preferences, perceptions, and behaviors. In this regard, it is also used in participatory planning and decision-making. Art workshops support the creativity of participants

(Johnson et al., 2014) and arise emotions. Emotions are inseparable from creativity. Emotions and creativity, together with collectivity, enhance coping in uncontrollable and unpredictable situations (Tarr et al., 2018; Vogl et al., 2020).

In this paper, we present and analyze experiences with three environmental science communication approaches targeted at experts and decision-makers that all build on applying different visualizations and types of dialogue. We evaluate the usefulness of the approaches in environmental communication and aim to find answers to the following research questions: How do the participants perceive the science communication experiments? What dimensions emerge as important aspects to consider in environmental science communication?

Methods and materials

Descriptions of the events

We chose three communication approaches that we wanted to test for expert audiences and selected the thematic case for each approach by scanning the Finnish environmental policy arena on hot topics to be communicated. In the first science communication approach, here referred to as the gamification event, playing a board game was used for science communication. The board game is a role-playing game called GreenSurge City, developed in an EU-funded research project GREEN SURGE (Ambrose-Oji et al., 2017) with the aim of informing players about the multiple viewpoints and discussing conflicts related to green infrastructure planning in cities. Before playing, a researcher held a short oral presentation of the research related to green infrastructure planning in the cities. The researchers facilitated the play, explained the rules of the game, and also participated as players. The roles of the game were assigned randomly.

The second event applied immersive VR as the approach to communicate science. The VR simulation was a six-minute virtual field trip in a Finnish forest. The VR simulation was based on the energy and climate strategy of Finland (VNS 2/2013) and forest management scenarios. The VR simulation was viewed on several occasions during a 2-month time period. All the participants separately viewed the same VR simulation. The facilitator remained the same on all occasions.

The third event was focused in the Arctic and used an art-based scenario workshop as a method to communicate science. In the workshop, storylines were used as the translation of a wider scientific text into its core narrative elements, illustrating the research context and the new knowledge (Cortes Arevalo et al., 2019). The storytelling took place at the beginning of the workshop when researchers presented their research

in a form of a story with elements of drama including, for example, a researcher telling about their fieldwork and findings from the Arctic region while standing in an inflatable boat. At the end of the workshop the participants designed and presented their future scenarios for the Arctic and pathways on how to get there. Discussions were facilitated by the researchers, but the scenario building and visualizations were done by a professional facilitator.

All the events with the number of participants, context, aims of the event, and data collected are presented in [Figure 1](#).

Materials

After each event, the participants filled in a questionnaire about their immediate personal responses to the event. To cover the wide spectrum of personal responses to science communication, the framework created by Burns et al. (2003) was used to guide the formation of questionnaire, which comprised 15 closed-ended questions in the form of statements. The questions covered such personal responses as awareness, enjoyment, interest, opinion-forming, and understanding. Participants indicated the extent to which they agreed with the statement on a 5-point Likert scale, ranging from 'strongly disagree' to 'strongly agree', including a neutral midpoint.

In addition, a set of interviews were performed later to have a more in-depth understanding about the participants' perceptions. The individuals to be interviewed were selected randomly from the group who filled out the questionnaire. Everybody asked to be interviewed agreed to do so. Similar to the questionnaire, these semi-structured interviews were designed to cover aspects of the framework by Burns et al. (2003). All questionnaires and interview questions were the same for all the events, although they were modified for the context. See [Figure 1](#) for numbers of survey responses and interviews.

Voluntary participation, informed consent, and anonymity of the participants were ensured and communicated to respondents.

Analysis methods

We categorized the qualitative interview data inductively. We looked for relevant themes from the data, not specific terms or words. We then coded the arising themes in color coding and grouped relevant themes as their sub-themes. As our understanding of the data increased, we narrowed it down to 17 representative categories. These 17 categories were distributed under four main codes of *Enjoyment*, *Usability*, *Sociability*, and *Learning*. We constructed the interview data using ATLAS.ti Research Software.

GAMIFICATION EVENT

CONTEXT	DATE	PARTICIPANTS	SURVEYS FILLED	INTERVIEWS
Urban	November 2018	10	9	4



Participants were city councillors and planning civil servants of the municipalities of the Helsinki metropolitan area. They played a board game GreenSurge City in three parallel groups. In the game, each player randomly picked a role card that determined their role during the game, including a city developer, entrepreneur, NGO representative, and a member of the city government. Players aimed at developing the city and fulfilling the goals set in their role card while negotiating and discussing with the other players.

VIRTUAL REALITY

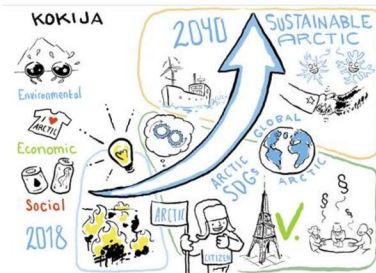
CONTEXT	DATE	PARTICIPANTS	SURVEYS FILLED	INTERVIEWS
Forest and Climate policy	Feb-Mar 2018	81	76	7



Participants were members of the parliament of Finland sitting in the environmental and agricultural committee and governmental officers working in the Ministry of the Environment and the Ministry of Agriculture and Forestry. They were invited to participate in a six-minute long immersive VR story, where they experienced how different levels of harvesting affected the carbon sink of the forest.

ART-BASED SCENARIO WORKSHOP

CONTEXT	DATE	PARTICIPANTS	SURVEYS FILLED	INTERVIEWS
Arctic	September 2018	15	11	4



The event was organized as a side event of the UArctic Congress. The participants were 15 international decision-makers and stakeholders from academy, business and non-governmental organizations. The aim of the workshop was to co-produce sustainability pathways for the Arctic future. Finally the ideas of a plausible future for the Arctic and pathways on how to get there were presented in the Uarctic Congress using the artwork produced by a professional illustrator.

Figure 1. Descriptions of the three science communication events organized and the materials collected.

Enjoyment was related to the overall atmosphere of the event and to the feelings raised by the event. Usability referred both to the usability of the methods as well as the usability of the information communicated in them. Sociability included remarks regarding the role of other participants, the role of the facilitators, and notions of the power dynamics in the groups. Learning code included notions of the raised awareness about the subject as well as increased interest toward the subject. It also contained

themes of opinion-forming about the subject, changed attitudes, and changed understanding. All four main codes covered both positive and negative remarks from the interview data.

The participants' perceptions of the science communication events were assessed using 15 survey questions, covering different personal responses to science communication. The subset of 11 questions related to the main categories formed in the qualitative analysis are reported as percentages.

Results

Enjoyment

All the participants in the gamification event and most of the participants in the VR events and art-based scenario workshop answered that they somewhat or strongly agreed that they enjoyed the events (Figure 2). The participants mostly found all three methods to be fun ways of communicating science (Figure 2).

All three science communication methods were experienced as new, inspiring methods of scientific communication which motivated participation in the events, and inspired the experts to think about science communication in novel ways. This was especially true in the VR events. Also, the relaxed atmosphere that was created and encouraged by these more unconventional methods received positive feedback, especially in the gamification events and the art-based scenario workshop. The surprise element of a scientist rowing a boat in the room and talking about their research received praise as an icebreaker in the art-based scenario workshop that largely defined the ambiance for the event. This was further reported to have had a positive effect on the sharing of knowledge, as people felt safe to speak openly from their own perspectives.

On the adverse effects of the enjoyment, VR events were also reported to stir feelings of anxiety, as the participants were allowed to immerse themselves in the optional futures of the forest and see the impact of increased harvest removals.

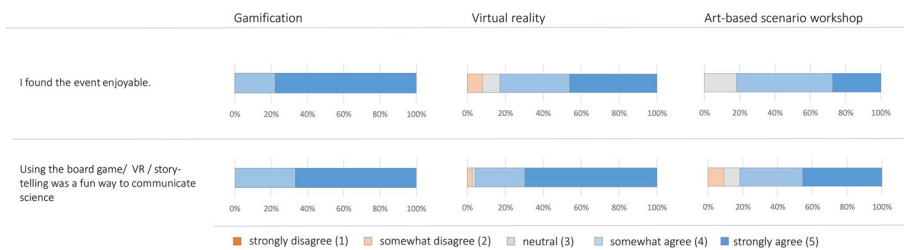


Figure 2. Survey answers related to enjoyment in the three environmental science communication events. $n=9$ (gamification), $n=76$ (virtual reality), $n=11$ (art-based scenario workshop).

The usability of the methods and information

Most of the participants strongly agreed or somewhat agreed that they would like to receive more information on the topic in similar types of events. The reliability of the scientific knowledge was also rated high, although especially in the VR event this raised disagreement with the participants (Figure 3). The VR method was perceived as mainly reliable and as a powerful tool for effective science communication. One participant from the VR events said that this way of receiving information was so new that they had no tools to evaluate the reliability of the information. The use of VR as a communication method as well as being a novel technology caught the participants' interest, even to the point where the actual content information was paid less attention. The clumsiness of a big VR headset affected the usability of the method negatively.

Looking at the usability of the methods, all three methods received both positive and negative remarks on it. The board game in the gamification event was experienced as easy to learn, so the playing itself did not steal attention from the information. Just one participant said the game was too complex to play.

In the art-based workshop, the role of group dynamics was an important factor regarding the usability of the method, and in some cases, hindered it. In all the experiments, the participants felt that the usability was hindered by the lack of depth in the information presented and considered them in many cases more suitable for non-expert audiences. In the gamification event some interviewees stated that they learned a lot about green infrastructure planning solutions and how these affect the urban environment, while some brought up that the detailed information received in the VR event would be hard to remember and thus to use in one's own work due to the lack of references at hand.

Sociability

The role of sociability was evident; most of the participants in all three communication approaches found that the dialogue with scientists and

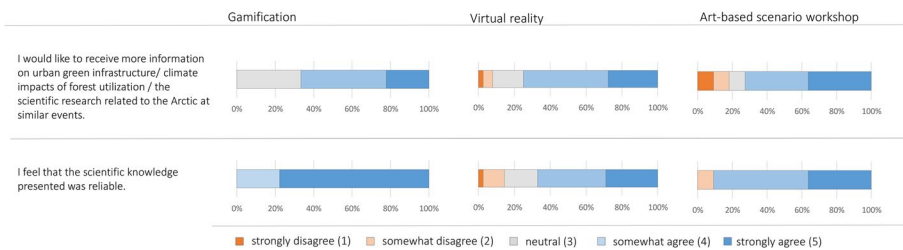


Figure 3. Survey answers related to usability in the three environmental science communication events. $n=9$ (gamification), $n=76$ (virtual reality), $n=11$ (art-based scenario workshop).

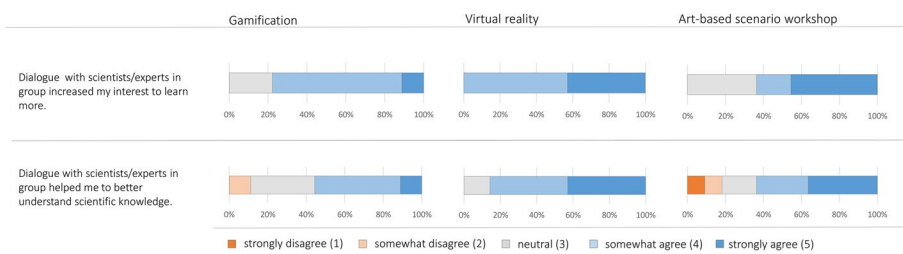


Figure 4. Survey answers related to sociability in the three environmental science communication events. $n=9$ (gamification), $n=14$ (virtual reality, questions concerning sociability were asked only at events where a scientist was present), $n=11$ (art-based scenario workshop).

other participants increased their interest to learn more and increased their understanding of scientific knowledge (Figure 4).

The presence of other participants and the facilitators was an important part of how the participants acquired and digested information. The effect of these social aspects was apparent in the gamification events and art-based scenario workshop. Also in the VR event, which was more individually focused, the discussions after viewing the VR simulation were perceived to increase interest in and understanding of scientific knowledge.

Many interviewees emphasized that the best benefit intellectually were the discussions they had with other participants from different fields, outside the official parts of the experiments, because everyone who participated in the events were experts in their own fields. In many cases, those discussions contributed more than the methods themselves. One participant noted that the power dynamics worked against effectively sharing knowledge, as one or two dominated the discussion (art-based scenario workshop). Also, the language barrier was brought up by one participant from the same event, meaning both the native language of the speakers and the positions from where they spoke. Scientific language versus indigenous language and worldviews made mutual understanding difficult.

Scientists were present at almost all the events - only a few VR events were performed without them. The role of the researchers who facilitated the discussions was reported as being of great importance: they guide the conversations and also participate to a certain degree. In the gamification event the facilitators' knowledgeable comments were mentioned by many as the most important source of new information. Also in the VR events, the presence of the facilitator was experienced as beneficial for sparking up conversations.

In the gamification event, some of the interviewees stated that they would have gotten more out of the event if other participants would have taken their given gaming roles more seriously. In one game group, there

was more discussion and a debate over the choices made related to the urban green infrastructure, thus they felt they also learned more. One participant commented that if the participants would have been able to speak from their professional viewpoint, instead of a given role, that would have increased the shared knowledge.

Learning in the events

Most of the participants reported that the scientific research presented at the event increased their interest to learn more. Participation in the events did not induce changes in the participants' opinions about the handled issue but broadened their understanding of science communication. Only one participant in the gamification event and less than half of the participants in the VR event and art-based scenario workshops answered in the survey that the method helped them to understand scientific knowledge better (Figure 5).

The participants' knowledge base was already quite comprehensive, so the participants did not report much increase in their level of knowledge. Regardless, the events brought new insights to many participants. Especially in the gamification event, participants reported to have gained new perspectives and knowledge regarding the urban green infrastructure planning and the role these different elements have on the environment. The VR events were least mentioned to have had an impact on the views and knowledge the participants had. Instead, almost all the participants said that the event did not affect their views or opinions because the information was already familiar, or they had a different view and would not change it because of one event.

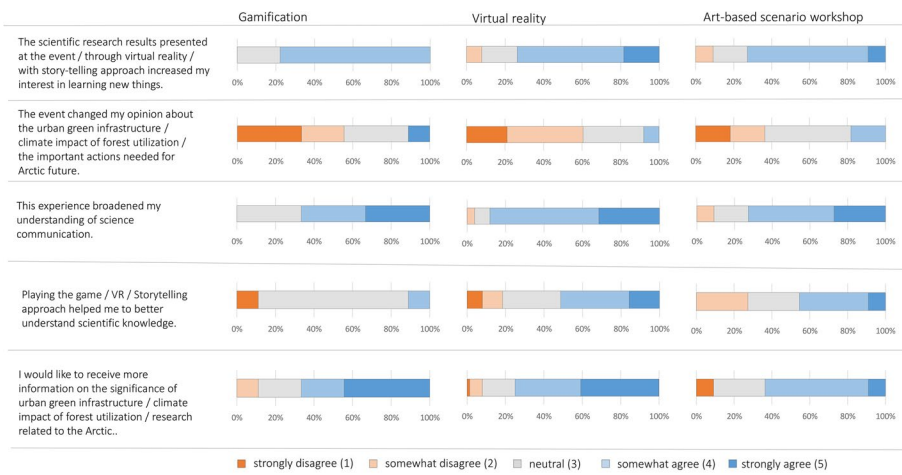


Figure 5. Survey answers related to learning in the three environmental science communication events. $n=9$ (gamification), $n=76$ (virtual reality), $n=11$ (art-based scenario workshop).

Some of the participants in the gamification event and art-based scenario workshops reported increased feeling of expertise and agency after the events. The significance of one's work was usually highlighted by taking part in the events. It was viewed as eye-opening, as expressed by many, to take part in the gamification event as it increased understanding about one's opportunities to make a difference in their line of work. In the art-based scenario workshop, participants felt that their attitude changed even more toward taking action for Arctic areas.

The participants also learned new things about using the novel scientific communication methods and facilitating a successful event (Figure 6).

Discussion

The novel science communication approaches applied in this study attracted the attention of the participants and got them involved in the events. Enjoyment, positive feelings, and attitudes may lead to deeper encounters with science (Burns et al., 2003). Yet, using novel technologies and techniques can create a risk of steering the focus towards the method itself,

	Gamification	Virtual reality	Art-based scenario workshop	Common for all three
Enjoyment	Playfulness made the time pass quickly Evoked both positive and negative emotions	Intriguing new method increased interest to participate Raised anxiety due to the possibility to immerse in the optional futures of the forest	Atmosphere encouraged openness, joy and trust - beneficial for sharing of knowledge	Excitement of the novel approach Inspired the experts to think about science communication in novel ways
Usability of the method	The board game was easy to learn - playing did not steal attention from the content	Powerful tool for science communication Potential for brainwashing or pushing one's agenda as it is immersive and has a strong impact on the feelings The clumsiness of a big VR headset hindered usability Method caught the interest, even to the point where the content was not paid so much attention	Power dynamics hindered group work Language barrier made mutual understanding difficult	-
of the information	half (2/4) learned a lot from the subject half (2/4) stated the content would benefit more non-expert audiences	Information communicated too simplified Reliability of the information was hard to estimate due to the novelty of the method Information from the event hard to remember and use in work due to the lack of references at hand	Information remained shallow, not useful for experts	Information communicated lacked depth
Sociability	Role of facilitator important Some stated, they would have gotten more out of the event if others had taken their given gaming roles seriously The participants would have wanted to know why they are there - would have helped putting information into context	Presence of the experts beneficial for sparking discussions	Role of facilitator important Relaxed atmosphere to discuss and courage to share thoughts Learning especially outside the official parts from other experts Networking with others	Interaction between all participants (facilitator/experts/other participants) play an important role in the sharing of information
Learning	Not much increase in the level of knowledge Taking different game roles offered new perspectives to view the subject Increased understanding about opportunities to make a difference in their own profession Heightened agency and willingness to make change was reported	Not much increase in the level of knowledge Learning about the use of the method/tool itself - how has VR developed?	Not much increase in the level of knowledge Learning about the different perspectives and perceptions of participants Information about the stage of discussion in Finland today Attitude changed even more towards acting for the benefit of the Arctic areas	Only minor change in knowledge level, more impacts on opinions/views The events increased interest to learn more about the subject Learning about the use of novel methods

Figure 6. Summary of the results emerged from the interview and survey answers about the participants' perceptions of the three environmental science communication approaches.

and away from knowledge dissemination and learning, which is important to acknowledge and consider when applying these approaches.

Preparing for the events with more engaging dissemination required simplification of the knowledge. As a result, the participants who were already experts in the field did not gain much new knowledge on the subject matter. Therefore, the events were found to be more usable for encouraging and generating dialogue rather than a primary information channel or communicating novel information.

The VR was felt as a powerful experience even with threats of brain-washing, as mentioned by few participants. It appeared to mainly foster the existing views either for or against the policy that was demonstrated. These results are in line with Haidt (2001) about moral judgements being often intuitive and followed by reasonings that support one's already existing view. Policy officials participating in the VR experiment already had strong opinions about the topic. In these kinds of cases, strong emotional experiences that can be created by using VR (Mattila et al., 2020) could be a powerful tool for creating an intuitive 'like' or 'dislike' outcome for the basis of rational reasoning (see also Nicolaisen, 2022 about emotions in environmental science communication). Interestingly, although some previous literature had found the VR to be a suitable tool for participatory decision-making (Puyana-Romero et al., 2017; Wiberg et al., 2019), here the participants suggested it to fit more for non-expert audiences. This finding can possibly be explained by the content of the VR story applied here, and therefore calls for more thorough research.

The role of the facilitator was considered to have great importance. This was mentioned for all the events but most clearly in the art-based scenario workshop. Again, social interaction (Haidt, 2001) may be needed to change the basis on which the participants judge the experience (See also Holford et al 2023). Because building technological alternatives is not economically viable in all circumstances, using a facilitator that is capable of understanding the various preconceptions that the participants may have and to introduce the experience accordingly may be the most effective solution for creating memorable, positive experiences.

When communicating science through storytelling or gamification, the facilitators should pay extra attention to what elements are crucial to reflect real life for effective communication to happen, as shown in previous literature (Asplund et al., 2019). It is important that crucial aspects of the games reflect real life, even though they are always simplifications to some extent. This also includes the players and whether they are contributing to the game or just playing along because they must. These alternative methods of science communication work best when the participants take an active and unprompted stance in the events. In this regard, the power dynamics should also be considered and balanced in

the group, where the role of the facilitator becomes important in supporting learning and networking.

Also, the role of other participants was highlighted in the interviews. It is meaningful *who* participates in interactive science communication events. The participants paid attention if there were any established researchers present in the event. This was in some interviews mentioned to add to the appeal of the event and made it more convincing. In the context of experts, the participants play an active role in science communication: they interpret the information, discuss it, and pass it on to other participants from their own point of view. It is not just about information dissemination to the participants as is the case of reading scientific journals or listening to lectures. These novel science communication approaches require them to be active participants, as the dialogue between and among the creators and receivers of the information was found to be one of the most beneficial elements in avoiding miscommunication. This can be especially helpful with the complex and value-bound issues related to environmental sciences.

Some of the participants reported an effect on opinions, views, and of understanding other participants' views. The participants reflected that the relaxed social atmosphere and playfulness, especially in the gamification and art-based scenario workshop events, broadened their perspectives on the subject at hand and opened their minds to include other viewpoints. This can trigger the so-called higher level of learning, which can alleviate the problem of decision makers favoring their own opinion and discounting advice (Yaniv & Kleinberger, 2000), and potentially further leverage decision making and actions. As a large amount of prior environmental communications has been focused on building awareness and knowledge, the novel methods analyzed in this study express a potential for knowledge synthesis, sharing and understanding other views, and co-creation, and achieving a common ground.

Conclusions

Communicating science with the three novel approaches analyzed in this study (gamification, VR, and art-based methods such as storytelling) were found to be successful in creating interest, enjoyment, and motivation for dialogue. However, their suitability as a primary communication method for expert audiences was questioned by the participants. This has a lot to do with the fact that the participants experienced the information communicated as too simplified. However, since environmental and sustainability science often deals with complex, multidisciplinary issues and can create strong polarizations between interest groups, these kinds of approaches can also be useful in encouraging dialogue and understanding

other viewpoints with expert audiences. The four dimensions that were found important in this study - enjoyment, usability, sociability and learning - can guide future communication approaches to focus and carefully consider their role in the implementation. However, the role of experts as a target group should be further studied in the theoretical and practical development of science communication.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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