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Work-in-Progress—How Do Different Degrees of Immersion and Points of View in Immersive Videos Affect the Quality of Science Communication?

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Abstract. This work-in-progress paper aims to investigate the effect of immersive 360° and conventional two-dimensional videos presented with a Head-Mounted Display (HMD) as a science communication tool. Immersive videos, recorded in 360° and played back through HMDs, enable capturing authentic experiences, which are often hard or impossible to access in real life. This holds significant promise, potentially reshaping the public's perception of science. However, precisely for this reason, it should be closely examined. Immersive videos can vary in their design. The degree of immersion (in this study: monoscopic, conventional video vs. stereoscopic, 360° video) and the point of view (frontal vs. lateral view of the presenting scientist) from which the video is filmed might influence how the viewers perceive the contents in the videos. The ideal degree of immersion and the impact of different perspectives within these videos remain unclear. Therefore, the project addresses hypotheses related to the impact of varying degrees of immersion and different points of view within immersive videos on dependent variables such as the epistemic trustworthiness of the displayed scientists, the feeling of presence, user engagement, parasocial interactions, and learning retention. The goal of this research is to understand the influence of factors such as the degree of immersion in the context of science communication with immersive videos more precisely and, based on this, to provide informed assistance for the design and presentation of such videos.

Keywords: 360° Video, Immersive Video, Science Communication, Advanced Materials.

1 Introduction

The introduction of Head-Mounted Displays (HMDs) has the potential to significantly transform the landscape of media content through the provision of immersive applications, 360° images, and videos. This shift marks a substantial departure from traditional 2D media formats and conventional transmission methods, opening new perspectives on content reception (e.g., [1]). Given that many students are using videos (for example, those available on YouTube) for learning purposes [2, 3], it becomes even more critical to investigate the potential impacts of more immersive formats on this area of communication. This is particularly relevant, considering the rise in the spread of misinformation within science-related videos [4]. Also, the easy and rapid creation of content on platforms like YouTube has bypassed the traditional gatekeepers of information. With the growing prevalence of immersive media displayed through HMDs, it is anticipated that the production and dissemination of more immersive formats, such as 360° videos, will gain significance in the near future. This development prompts critical inquiries into how the characteristics and circumstances of immersive videos, viewed through HMDs, impact the perception and processing of content, particularly in the context of scientific topics such as advanced materials research and exploration.

This work-in-progress article presents the overarching concept of investigating immersive videos used for science communication. The following sections introduce the factors we intend to examine within our first study.

2 Factors Influencing the Quality of Science Communication

In today's society, skepticism toward scientific evidence is noticeable, with attitudes toward science becoming even more polarized [5]. These attitudes could change with increased exposure to science, but the quality of the exposure appears to be critical in determining whether it changes attitudes positively or negatively [6]. Two characteristics that might influence the impact of science communication through videos viewed on head-mounted displays are the degree of immersion and the perspective from which the content is viewed.

2.1 Degree of Immersion

We want to investigate if the level of immersion, experienced when viewing the same video through an HMD, significantly varies the perception of the content. Therefore, we analyze the effects of different modes of video presentation: either as a conventional video, displayed on a screen within the virtual environment or as a 360° stereoscopic video. In line with earlier research, we argue that the degree of immersion differs between these two formats (e.g., [7]).

The immersive quality of 360° videos promises considerable advantages, such as increased interest and engagement [8]. This benefit arises from their capability to capture authentic experiences and activities [9], making them an effective tool for conveying scientific information. Therefore, this viewing format might help foster more positive attitudes toward the relevance of science [10]. Authentic experiences and activities may also help to reduce negative biases towards science as they have an essential meaning for a comprehensive understanding of scientific knowledge [11].

However, the effects of immersive technologies are generally not yet fully understood, and complete immersion does not always seem to be the best approach to delivering content. Bowman and McMahan [12] suggest that an excessively high level of immersion may not always be necessary since the concept of immersion consists of many components, each of which can bring different benefits. However, the influence of the degree of immersion on the communication of scientific topics has not yet been closely examined.

This research aims to bridge this gap with the following research question: *What degree of immersion, induced by the mode of the video presentation, is most appropriate for videos as a science communication tool?* **(RQ1)**

2.2 Point of View

In addition to the degree of immersion, we aim to investigate the influence of the viewer's point of view (POV) in VR, describable as an egocentric perspective [13], within science communication. Generally, immersive videos can be distinguished by different points of view: Subjective POVs, where you feel part of the scene (involved in the event), and POVs, where you assume an observer role [14]. The selection of these kinds of POVs (in our case, an internal, frontal, or an external, lateral view of the presenting scientist) in immersive videos can potentially affect factors such as the perception of trust and trustworthiness of scientists. This effect may arise from the ability of first-person perspectives to enhance the perception of embodiment compared to external viewpoints [15]. Despite this, the effect of different POVs on the effectiveness of conveying scientific content through immersive videos remains an area that needs exploration but appears crucial to address.

Therefore, the study's second research question is: *From which point of view should an immersive video be filmed when communicating science?* **(RQ 2)**

3 Dependent Variables of the First Study

3.1 Epistemic Trustworthiness and Trust in Science

Immersive technologies hold the potential to construct stronger connections with experts in presentations, thereby making their way of thinking more understandable [16]. For instance, research by Hasler et al. [7] has illustrated that varying degrees of immersion can produce different emotional responses and moral judgments regarding the actions of the individuals presented. Consequently, an essential aspect of our initial study will explore how these findings can influence perceptions of trust and trustworthiness.

Furthermore, the choice of a POV in immersive videos will likely influence perceptions of trust and trustworthiness. For example, first-person perspectives in virtual reality have been demonstrated to increase embodiment and intensify empathy towards the individuals depicted and the groups they represent [17]. When these depicted individuals are scientists, the enhanced embodiment could lead to varying attitudes towards them, contingent upon the selected POV. Additionally, a POV that simulates the experience of eye contact may foster greater trust in the depicted person, aligning with the consensus that individuals who engage in eye contact are perceived as more trustworthy [18].

3.2 Feeling of Presence

The concept of presence is often emphasized when using immersive technologies [19]. The increasing focus on this concept can be explained by the need to understand the psychological implications of new technological advances and the high-quality experiences they can create [20]. Two important facets of presence are the social and spatial components. Spatial presence can be defined as the subjective experience of a user being physically located "inside" a digitally mediated setting even though it is a technology-generated illusion [21]. However, since an important factor of immersive videos for science communication is to not only show realistic scientific environments but also scientists as social factors, social presence is also measured. Regarding social presence, there are different definitions, but they have in common the aspect of being able to perceive others in an online environment [22].

The prevailing assumption is that a higher level of immersive quality leads to a higher level of presence, which can improve the effectiveness of the experience [19]. Therefore, a stronger sense of presence could be perceived when watching immersive 360° videos compared to less immersive videos [23].

3.3 Engagement

Immersive experiences offer the potential to impact engagement positively. One explanation could be the highly authentic experiences, places, and activities they can convey [9]. In particular, immersive 360° videos could lead to higher engagement than less immersive conventional videos, as all conceptual engagement components were associated with immersive 360° videos [8].

The POVs of the videos could also impact the sense of engagement. For example, increased psychological and behavioral engagement could be perceived from a POV with a high sense of embodiment [24]. This might be especially true if there is a sense of interaction with another person, as social factors can impact user engagement [25]. However, more research is needed to assess the engagement benefits of immersive 360° videos compared to more traditional formats [26].

3.4 Learning Retention and Parasocial Interactions

Whether more authentic experiences with immersive videos (e.g., in realistic scientific environments) are also reflected in higher learning retention is unclear. The *Situated Learning Theory* by Lave and Wenger [27] would provide a rationale for higher learning success with immersive technologies compared to non-immersive technologies. It adopts a socio-constructivist perspective, arguing that learning is an unintentional and situational process within authentic experiences and contexts. Especially at higher levels of immersion, a presentation of scientific environments, such as research laboratories, could be seen as an authentic context of science communication, and could therefore, based on this theory, lead to greater learning success. In general, 360° video technology is found to have many positive aspects on learning and can lead to a high mastery of learning content [23]. For example, immersive technologies help to change perspective and frame of reference and thus can be an efficient way to understand demanding content [28]. Therefore, it is considered rather beneficial for learning [8, 29]. However, the ideal level of immersion for learning outcomes is not clarified, as research focusing on learning outcomes related to the use of immersive technologies is sparse [30].

One possible reason for improved learning success with immersive technologies could be explained by increased perceived parasocial interactions. The concept of parasocial interaction was first introduced by Horton and Wohl [31] and refers to media consumers' responses to a media figure they perceive as an intimate interlocutor. A dynamic interchange in conversation often arises during the viewing experience, especially when the media performer bodily addresses the viewer through the camera [32]. This frontal bodily addressing style was shown to improve learning outcomes in conventional videos. For example, Beege et al. [33, 34] found that a frontal view of a lecturer led to stronger perceived parasocial interactions and could lead to significantly better learning outcomes than looking at a lecturer laterally. Whether this also applies to immersive videos and whether these effects are even enhanced by increasing the level of immersion has yet to be proven.

4 The Present Study

The present study aims to systematically investigate the impact of immersive 360° and conventional videos, displayed through Head-Mounted Displays (HMDs), on the effectiveness of science communication. Concretely, this research explores how varying degrees of immersion (stereoscopic, 360° vs. monoscopic, conventional) and different points of view (frontal vs. lateral) influence critical outcomes such as the trustworthiness of scientists, viewer engagement, presence, parasocial interactions, and learning retention. Derived from our initial theoretical considerations, we have formulated the following hypotheses regarding the degree of immersion.

Hypothesis 1*:* Participants watching a stereoscopic 360° video with a head-mounted display report a) a higher feeling of spatial presence, b) higher engagement, c) greater trust in science, d) higher trustworthiness of the scientist being portrayed, e) stronger perceived parasocial interactions, and show f) higher learning outcomes, than participants watching a monoscopic, conventional video with a head-mounted display.

Concerning the point of view, we have determined the following hypotheses.

Hypothesis 2: Participants watching from a point of view with a frontal view of the presenting scientist report a) a higher feeling of social presence, b) higher engagement, c) greater trust in science, d) higher trustworthiness of the scientist being portrayed, e) stronger perceived parasocial interactions, and show f) higher learning outcomes, than participants watching from a point of view with a lateral view of the presenting scientist.

In addition to our hypotheses, we want to exploratively investigate whether there are interactions between the presentation format of the videos (stereoscopic, 360° vs. monoscopic, conventional) and the point of view in the videos on the dependent variables.

By examining these variables within the context of science communication, the research seeks to address gaps in our understanding of how immersive video production and presentation can be optimized to improve public engagement with science.

4.1 Participants and Statistical Approach

Based on a statistical power analysis, we plan to gather data from 80 students aged between 18 and 30 at a German university. To minimize prior knowledge related to the content shown in the presentation, students studying related disciplines (such as Chemistry) will be excluded. We will employ a mixed-model approach within an ANOVA framework to test our hypotheses. This model will explore the two factors' potential main and interaction effects. Additionally, we will collect and analyze data on various potential mediators or moderators, including experience with VR headsets, visuospatial ability, social desirability, motivation and interest in science, belief in one's scientific abilities, prior knowledge, cognitive load, emotional response, and motion sickness.

4.2 Study Design and Material

Our study will use a 2 × 2 mixed design to manipulate the two independent variables. The between-subjects factor within this study is the participants' point of view (POV) toward the presenting scientist in the video (frontal vs. lateral). The within-subjects factor will be immersion, manipulated by the presentation mode of the video (stereoscopic, 360° vs. monoscopic, conventional). Participants are divided into two groups, each watching two videos. In group 1, participants view both videos from a frontal perspective, whereas in group 2, they view them from a lateral perspective (between-subject factor). Each group has four different variations, creating a total of eight possible conditions of the study to counterbalance the influence of content order and the order of the presentation format. Participants are randomly assigned in a counterbalanced distribution to one of these conditions. In all scenarios, participants view the videos through an HMD. In the monoscopic, conventional video condition, participants watch the contents as a conventional, monoscopic video with an HMD, which gives a reduced field of view in a virtual room, where it seems like a screen is positioned in front of the viewer (see also: [7, 16]).

For our study, we captured video footage featuring a real scientist within the authentic environment of a nanomaterials research laboratory. This footage showcases the scientist at her workstation, delivering a presentation on the concepts of advanced materials, including their safety and regulatory aspects. The presentation was designed to suit the comprehension level of visitors without prior knowledge. The scientist gave a ten-minute presentation, segmented into two parts. This presentation was recorded using two high-quality 360° cameras (Insta360 TITAN), with a setup that discreetly positioned the cameras behind the two visitors. One camera captured the presenting scientist's frontal view, while the other provided a lateral perspective, documenting both viewpoints simultaneously (see Fig. 1). Following the recording, the material underwent editing before being integrated into a virtual environment (created in Unity) for this study. It is central to highlight that, contrary to the perception created by Fig. 1, the distance between the presenting scientist and the viewer remained constant across both the conventional and 360° format in the virtual environment, ensuring a consistent viewing experience irrespective of the format.

Fig. 1 Overview of the 2x2 design of the study. All conditions are watched with a head-mounted display (HMD). The scientist located near the windows is giving a talk about advanced materials. Unlike depicted in this overview, in the stereoscopic 360°-video condition, the video surrounds the viewer and creates a depth perception when watched with an HMD.

4.3 Measures and Procedure

To investigate the influence of our factors on dependent variables, we use established instruments wherever possible. The general learning outcomes of participants are evaluated using eight questions specifically designed to align with the content of the displayed videos. These questions were developed in collaboration with domain experts and are formatted as single-choice items, each offering four possible answers, of which only one is correct. Each correct response is awarded one point, allowing for a maximum score of eight points.

To measure the epistemic trustworthiness of the displayed scientist, we employ the Muenster Epistemic Trustworthiness Inventory [35]. General trust in science and scientists will be assessed using the Trust in Science and Scientists Inventory [36]. The concept of spatial presence will be measured using the Spatial Presence Experience Scale [37], while social presence will be assessed through the Temple Presence Inventory [20]. Regarding perceived user engagement, we will utilize an adapted version of the User Engagement Scale [38]. The concept of parasocial interaction will be measured using six questions from the Experience of Parasocial Interaction Scale [39].

The study is divided into two phases. Initially, participants engage in an online questionnaire via Qualtrics, covering demographic information, visuospatial abilities, experience with HMDs, social desirability, motivation and dispositional interest in science, and beliefs about their abilities in science.

Subsequently, a few days later, participants are invited for individual sessions in a controlled research laboratory. Upon arrival, they sign an informed consent form and take a test to assess their prior knowledge. They are then introduced to the HMD equipment (HP Reverb G2 Omnicept Edition) and briefed on its use. As the participants could only interact with the HMD by looking around, they were seated on a fixed chair that could rotate but did not have wheels. To familiarize the participants with the virtual environment, they receive brief instructions to look around in the subsequent phase. Depending on the condition, participants can then spend 30 seconds either exploring a 360° picture of the laboratory or the virtual room where the conventional screen (showing the laboratory) is located. Following the familiarization phase, the video automatically starts in the respective presentation format.

After each of the two video presentations, the participants take off the HMD and are directed to complete questionnaires on a computer to evaluate various dependent variables and additional possible mediators or moderators, such as cognitive load, emotional responses, situational interest, and potential motion sickness experienced during the video presentation. The study concludes after the questionnaire following the second video is completed. The study lasts 75 minutes, and participants are compensated 15€ for their time and contribution.

5 Conclusion and Outlook

Our general research interest lies in exploring whether and how immersive videos, recorded at authentic locations and with various design aspects (as a starting point: degree of immersion, point of view), can be beneficially utilized for science communication. In general, we believe that immersive videos will play an increasingly significant role in science communication. The potential benefits of immersive videos, particularly in terms of presence, are essential. It is, therefore, important to understand the implications and challenges associated with these factors. Understanding the influence of immersive videos on trustworthiness is crucial for improving their design and effectiveness. Assessing how the virtual environment impacts trustworthiness is essential, as it could potentially lead to the risk of misinformation being more willingly accepted by viewers.

Specifically, our first study aims to determine whether already different POVs and the immersive form of presentation influence the presenting scientist's perceived trustworthiness without manipulating trustworthiness through additional information (e.g., stating that the presenter is a professor vs. an influencer paid by a company). Should this be the case, it would give way to further exciting research paths. For example, another comparison could involve examining the effect of the environment in which the presentation was delivered, as the authenticity of the setting could affect our presented dependent variables.

While we have focused on a purely linear presentation and concentrated on psychological constructs such as trustworthiness, engagement, and the feeling of presence, the next step could be to consider more interactive formats of immersive presentations for science communication. Integrating various forms of interaction and navigation into such a presentation would be interesting.

Overall, the future of immersive videos in science communication looks promising, but there remains a need to examine various factors related to reception and design more closely, which sets the stage for this research.

References

1. Lotero, A.D.C., Baía Reis, A.: Work-in-Progress—Immersive Media and War Reporting in Colombia: Uses, Potentialities and Challenges of 360° Video to Narrate Armed Conflicts. Immersive Learning Research - Academic. 1, 130–137 (2023). https://doi.org/10.56198/ZH3JOSAZG
2. Smith, A., Toor, S., van Kessel, P.: Many turn to YouTube for children’s content, news, howto lessons, https://www.pewinternet.org/2018/11/07/many-turn-to-youtube-for-childrens-content-news-how-to-lessons, (2018).
3. Moghavvemi, S., Sulaiman, A., Jaafar, N.I., Kasem, N.: Social media as a complementary learning tool for teaching and learning: The case of youtube. The International Journal of Management Education. 16, 37–42 (2018). https://doi.org/10.1016/j.ijme.2017.12.001
4. Allgaier, J.: Science and Environmental Communication on YouTube: Strategically Distorted Communications in Online Videos on Climate Change and Climate Engineering. Frontiers in Communication. 4, (2019). https://doi.org/10.3389/fcomm.2019.00036
5. Rutjens, B.T., Heine, S.J., Sutton, R.M., van Harreveld, F.: Attitudes towards science. In: Advances in experimental social psychology. pp. 125–165. Elsevier (2018).
6. Gogolin, L., Swartz, F.: A quantitative and qualitative inquiry into the attitudes toward science of nonscience college students. Journal of research in science teaching. 29, 487–504 (1992). https://doi.org/10.1002/tea.3660290505
7. Hasler, B.S., H. Landau, D., Hasson, Y., Schori-Eyal, N., Giron, J., Levy, J., Halperin, E., Friedman, D.: Virtual reality-based conflict resolution: The impact of immersive 360° video on changing view points and moral judgment in the context of violent intergroup conflict. New Media & Society. 23, 2255–2278 (2021).
8. Ranieri, M., Luzzi, D., Cuomo, S., Bruni, I.: If and how do 360 videos fit into education settings? Results from a scoping review of empirical research. Journal of Computer Assisted Learning. 38, 1199–1219 (2022).
9. Hakulinen, J., Keskinen, T., Mäkelä, V., Saarinen, S., Turunen, M.: Omnidirectional Video in Museums – Authentic, Immersive and Entertaining. In: Cheok, A.D., Inami, M., and Romão, T. (eds.) Advances in Computer Entertainment Technology. pp. 567–587. Springer International Publishing, Cham (2018).
10. Boda, P.A., Brown, B.: Priming urban learners’ attitudes toward the relevancy of science: A mixed-methods study testing the importance of context. Journal of Research in Science Teaching. 57, 567–596 (2020). https://doi.org/10.1002/tea.21604
11. Lee, H.-S., Butler, N.: Making authentic science accessible to students. International Journal of Science Education. 25, 923–948 (2003). https://doi.org/10.1080/09500690305023
12. Bowman, D.A., McMahan, R.P.: Virtual reality: how much immersion is enough? Computer. 40, 36–43 (2007). https://doi.org/10.1109/MC.2007.257
13. Grasset, R., Dünser, A., Billinghurst, M.: Moving between contexts-a user evaluation of a transitional interface (2008).
14. Orduna, M., Pérez, P., Gutiérrez, J., García, N.: Methodology to assess quality, presence, empathy, attitude, and attention in 360-degree videos for immersive communications. arXiv preprint arXiv:2103.02550. (2021).

15. Galvan Debarba, H., Bovet, S., Salomon, R., Blanke, O., Herbelin, B., Boulic, R.: Characterizing first and third person viewpoints and their alternation for embodied interaction in virtual reality. PLOS ONE. 12, e0190109 (2017).
16. Schutte, N.S., Stilinović, E.J.: Facilitating empathy through virtual reality. Motivation and emotion. 41, 708–712 (2017). https://doi.org/10.1007/s11031-017-9641-7
17. Mado, M., Herrera, F., Nowak, K., Bailenson, J.: Effect of virtual reality perspective-taking on related and unrelated contexts. Cyberpsychology, Behavior, and Social Networking. 24, 839–845 (2021). https://doi.org/10.1089/cyber.2020.0802
18. Mason, M.F., Tatkow, E.P., Macrae, C.N.: The Look of Love: Gaze Shifts and Person Perception. Psychol Sci. 16, 236–239 (2005). https://doi.org/10.1111/j.0956-7976.2005.00809.x
19. Cummings, J.J., Bailenson, J.N.: How Immersive Is Enough? A Meta-Analysis of the Effect of Immersive Technology on User Presence. Media Psychology. 19, 272–309 (2016). https://doi.org/10.1080/15213269.2015.1015740
20. Lombard, M., Ditton, T.B., Weinstein, L.: Measuring presence: the temple presence inventory. In: Proceedings of the 12th annual international workshop on presence (2009).
21. Hartmann, T., Wirth, W., Vorderer, P., Klimmt, C., Schramm, H., Böcking, S.: Spatial Presence Theory: State of the Art and Challenges Ahead. In: Lombard, M., Biocca, F., Freeman, J., IJsselsteijn, W., and Schaevitz, R.J. (eds.) Immersed in Media: Telepresence Theory, Measurement & Technology. pp. 115–135. Springer International Publishing, Cham (2015).
22. Richardson, J.C., Maeda, Y., Lv, J., Caskurlu, S.: Social presence in relation to students' satisfaction and learning in the online environment: A meta-analysis. Computers in Human Behavior. 71, 402–417 (2017).
23. Evens, M., Empsen, M., Hustinx, W.: A literature review on 360-degree video as an educational tool: towards design guidelines. Journal of Computers in Education. 10, 325–375 (2023). https://doi.org/10.1007/s40692-022-00233-z
24. Flavián, C., Ibáñez-Sánchez, S., Orús, C.: Impacts of technological embodiment through virtual reality on potential guests' emotions and engagement. Journal of Hospitality Marketing & Management. 30, 1–20 (2021).
25. Jin, W., Sun, Y., Wang, N., Zhang, X.: Why users purchase virtual products in MMORPG? An integrative perspective of social presence and user engagement. Internet Research. 27, 408–427 (2017).
26. Harrington, C.M., Kavanagh, D.O., Ballester, G.W., Ballester, A.W., Dicker, P., Traynor, O., Hill, A., Tierney, S.: 360 operative videos: a randomised cross-over study evaluating attentiveness and information retention. Journal of surgical education. 75, 993–1000 (2018). https://doi.org/10.1016/j.jsurg.2017.10.010
27. Lave, J., Wenger, E.: Situated learning: Legitimate peripheral participation. Cambridge university press (1991).
28. Dede, C.: Immersive interfaces for engagement and learning. science. 323, 66–69 (2009).
29. Shadiev, R., Yang, L., Huang, Y.M.: A review of research on 360-degree video and its applications to education. Journal of Research on Technology in Education. 54, 784–799 (2022). https://doi.org/10.1080/15391523.2021.1928572
30. Hamilton, D., McKechnie, J., Edgerton, E., Wilson, C.: Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design. Journal of Computers in Education. 8, 1–32 (2021). https://doi.org/10.1007/s40692-020-00169-2
31. Horton, D., Richard Wohl, R.: Mass Communication and Para-Social Interaction. Psychiatry. 19, 215–229 (1956).
32. Dibble, J.L., Hartmann, T., Rosaen, S.F.: Parasocial interaction and parasocial relationship: Conceptual clarification and a critical assessment of measures. Human Communication Research. 42, 21–44 (2016).
33. Beege, M., Schneider, S., Nebel, S., Rey, G.D.: Look into my eyes! Exploring the effect of addressing in educational videos. Learning and Instruction. 49, 113–120 (2017). https://doi.org/10.1016/j.learninstruc.2017.01.004
34. Beege, M., Nebel, S., Schneider, S., Rey, G.D.: Social entities in educational videos: Combining the effects of addressing and professionalism. Computers in Human Behavior. 93, 40–52 (2019). https://doi.org/10.1016/j.chb.2018.11.051
35. Hendriks, F., Kienhues, D., Bromme, R.: Measuring laypeople's trust in experts in a digital age: The Muenster Epistemic Trustworthiness Inventory (METI). PloS one. 10, e0139309 (2015). https://doi.org/10.1371/journal.pone.0139309
36. Nadelson, L., Jorcyk, C., Yang, D., Jarratt Smith, M., Matson, S., Cornell, K., Husting, V.: I just don't trust them: the development and validation of an assessment instrument to measure trust in science and scientists. School Science and Mathematics. 114, 76–86 (2014). https://doi.org/10.1111/ssm.12051
37. Hartmann, T., Wirth, W., Schramm, H., Klimmt, C., Vorderer, P., Gysbers, A., Böcking, S., Ravaja, N., Laarni, J., Saari, T.: The spatial presence experience scale (SPES). Journal of Media Psychology (2015).
38. O'Brien, H.L., Toms, E.G.: The development and evaluation of a survey to measure user engagement. Journal of the American Society for Information Science and Technology. 61, 50–69 (2010). https://doi.org/10.1002/asi.21229
39. Hartmann, T., Goldhoorn, C.: Horton and Wohl revisited: Exploring viewers' experience of parasocial interaction. Journal of communication. 61, 1104–1121 (2011). https://doi.org/10.1111/j.1460-2466.2011.01595.x