

VisuaLies: Towards a Classification of Misinfovis Situations

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Abstract

This paper presents VisuaLies, a workshop designed to engage citizens in identifying misleading information visualisations (Misinfovis). The workshop aims to validate and enhance the Classification of Misinfovis Situations (CMiS), a classification system for lay citizens to spot the formal characteristics of Misinfovis, which we call 'Misinfovis Situations'. Conducted with participants of varying educational backgrounds, VisuaLies included activities to assess pre-existing knowledge, familiarise with Misinfovis concepts, classify Misinfovis examples and lead to an updated version of CMiS featuring fewer Situations with more accessible language. This study underscores the importance of involving lay people in recognising and describing Misinfovis with their own words to support the development of inclusive knowledge societies. Future iterations of VisuaLies aim to involve diverse audiences and refine feedback collection methods to further enhance the classification's effectiveness.

Keywords

Misinfovis

Classification of Misinfovis Situations

Participatory workshop

Introduction

Information visualisations (Infovis) are artifacts that represent one interpretation of reality and that can be misleading. They are powerful rhetorical tools that convey an appearance of objectivity while being intrinsically subjective, and for this reason can guide readers towards non-factual conclusions. The nature and impact of this illusion is situated and can vary based on context and audience and many other factors. In this study, we explore those misleading information visualizations (Misinfovis) with a high potential of misleading readers, both by error and by design.

In times of societal crises, when equilibria are unstable and information production accelerates, Infovis can be used to mislead, to promote specific worldviews and topics (Lee et al., 2021; Lisnic et al., 2023; Doan, 2021; Bhargava & D'Ignazio, 2015; Hemsley & Snyder, 2018; Ferreira et al., 2023). Many studies have focused on the persuasive potential of Infovis. For instance, Segel and Heer (2011) discuss its rhetorical nature; Hullman and Diakopoulos (2011) explore the impact on readers; and Nærland (2020) maps their political significance. With regard to the latter, while Infovis serve as a resource for an informed citizenry, they can also be used for the purpose of disinformation, thereby undermining their primary aim. This study assumes that Infovis have an epistemological character (Drucker, 2020) and communicate in a multimodal (Hiippala, 2020) way that depends on the medium they travel across, and that, as tools operating in real-world contexts, they have societal effects.

For this reason, we claim that it is necessary to make 'Literacy to Misinfovis' accessible to all citizens, regardless of their level of knowledge in the field, and to incorporate it into Media and Information Literacy (MIL) initiatives (Kivinen et al. 2022; Vuorikari et al., 2022). Drawing from Dondis (1974) and Bertin (1967), we aim to unpack the visual elements that can make an Infovis misleading, to build a foundation for studying the circulation of Misinfovis within social environments. Through this approach, we advocate for including more knowledge from the field of Information Design within MIL initiatives. The misleading potential of an Infovis is not just related to its formal characteristics, but also to its circulation, and the contexts in which it is experienced, which all contribute to creating different layers of meaning and misleadingness.

This study focuses on the first layer, that of the formal characteristics, as a starting point for unpacking the remaining ones. Drawing on prior knowledge in Information Design, we propose a systematic approach, the Classification of Misinfovis Situations (CMiS). The aim is to make such knowledge accessible to non-experts, by involving them in the process and serving as an initial step in un-black boxing the communicative layers of Misinfovis within social environments. In our experiment, end users become active shapers of the classification system.

Methodology

To answer the question “How to help citizens recognise the formal characteristics of Misinfovis?”, we developed the CMiS, where ‘Situations’ refers to the formal outcome of something that occurred in the visualisation process which, regardless of intent, is a rupture with shared conventions. By classifying these Situations based on prior knowledge, we want to facilitate the consultation, reading, and analysis, drawing inspiration from Vickery (1970), while opening it to a wider public. In this way, CMiS becomes a compass for orientation and recognition of the possible features of Misinfovis, not as a control checklist but rather as a stimulus to support critical thinking, to foster the awareness that, to varying degrees, all Infovis can mislead. The development of CMiS unfolded in two phases: the systematisation that resulted in the first draft of CMiS, and the assessment of the draft with the final audience. In this paper, we focus on the latter; however, we first outline the methodology employed in the former:

- Selection of contributions. We selected eleven contributions addressing Misinfovis from authors spanning different disciplines to cover as broad a range of perspectives as possible.
- Systematisation of contributions. Through inductive and deductive coding, we collected examples of Misinfovis.
- Assembling the contributions. Through axial coding, we then identified overlaps, synthesised, integrated and standardized terminologies in the first draft of CMiS.

At this point, we organized *VisuaLies*, a workshop to test the accessibility of CMiS, in which participants become active contributors in the design process. We chose this method because it can support the validation process through participatory activities (Ørngreen & Levinsen, 2017), and it allowed us to conduct a qualitative investigation, which was an essential prerequisite for our study, in order to incorporate end-users’ perspectives before finalising the CMiS. We employed techniques already explored for Infovis evaluation, to develop a more holistic understanding of the phenomenon (Carpendale, 2008). Specifically, we aimed to observe participant-classification interactions in laboratory settings, drawing on studies like Huron et al. (2014), which used controlled experiments to examine tasks in the Infovis process. Moreover, we drew inspiration from those activities typically used to test taxonomies, such as Delphi card sorting (Paul, 2008), A-B testing, and usability testing (Hedden, 2022; Soranzo & Cooksey, 2015). Finally, we selected the workshop methodology for its frequent use in the literature to promote literacy, such as visual literacy (Matusiak et al., 2019), Infovis literacy (D’Ignazio & Bhargava, 2018; Huron et al., 2021; Keck et al., 2023), data literacy (Teal et al., 2015), and media literacy (Tactical Tech, 2016). *VisuaLies* lasted one day and was held in a bucolic setting to encourage a sense of security and facilitate collaboration among participants. It involved participants of diverse experience and familiarity with Infovis, essential for ensuring that CMiS was accessible to a broad audience outside the field of information design. We promoted the event via Instagram and X to reach a varied and wide population. Participants engaged with the version of CMiS shown in Fig. 1, featuring thirty-two diverse Misinfovis Situations organised by stage of the Infovis process.

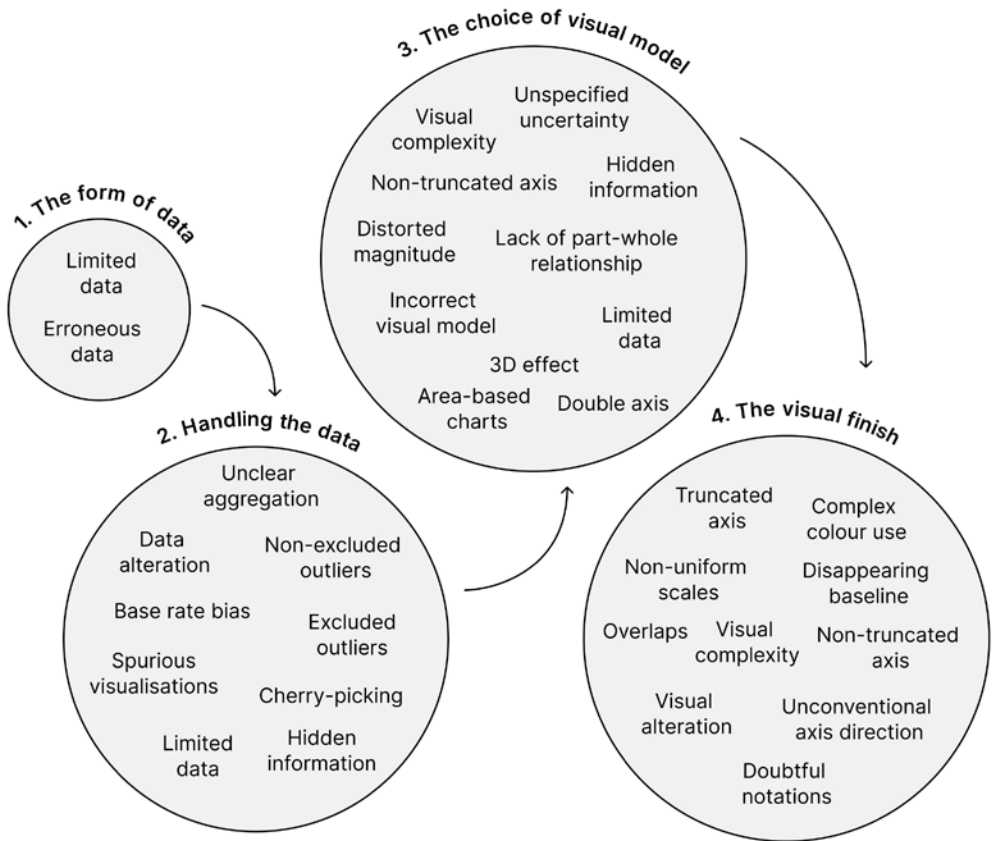


Fig. 1
 Schema of the first draft
 of CMiS, by the authors.

The activities, conducted in Italian and in this paper translated into English, were five in total:

- Pre-existing Knowledge (15 minutes). We provided participants with a small and quick identikit collecting both quantitative (profession, age, educational level), and qualitative data on their knowledge of Infovis, asking them specifically to give their personal definition of the term.
- Familiarisation with VisualLies (20 minutes). This activity consisted of a brief seminar, to present participants with the context of the workshop and the definitions of Misinfovis, societal crises, and Infovis literacy.
- Validate the 'Infovis process' category (45 minutes). CMiS is organised into 4 categories corresponding to the stages of the Infovis process and defines when Misinfovis Situations may occur within this process. This activity aimed to assess the lexicon employed through a playful exercise of meaning-construction: using twine, participants linked Infovis stages to matching descriptions, guided by their understanding of the combinations Fig. 2. Following an unobtrusive observation methodology, we observed without interfering.



Fig. 2
Activity 3: Validate the “Infovis process” category.

- Validate the ‘Misinfovis Situations’ category (60 minutes). This activity aimed to assign each Situation to the corresponding Infovis stage. Using a modified version of Delphi card sorting, we provided participants with a set of cards, each bearing the title and description of a Misinfovis Situation. After discussing the possible options, their task was to attach it to the relevant Infovis stage identified in the previous activity Fig. 3. Once again, we observed without interfering, while remaining available to answer questions and dispel doubts.



Fig. 3
Activity 4: Validate “Misinfovis Situations” category.

- Recognise Misinfovis Situations (120 minutes). During this activity participants explored the workshop site to find 15 Misinfovis and identify whose Situations were present. We sourced the fifteen Misinfovis Fig. 4 from BadVis Browser (Lo et al., 2022) and VisLies (Moreland & Rogowitz, 2023), to propose problematic cases identified in the literature. Each Misinfovis was accompanied by a table listing all the Situations from CMiS, and a column of empty cells for each participant input Fig. 5. Upon discovering a Misinfovis participants would place an X in the cell they believed the Misinfovis would fit into.



Fig. 4
The 15 Misinfos used
for activity 5.

Fig. 5
Activity 5: Recognise
Misinfos Situations.

Results

Pre-existing knowledge of the topic

A total of twelve people participated in *VisuaLies*, with ages ranging from twenty-eight to thirty-two, plus two outliers aged thirty-seven and seventy-seven. The most represented demographic is therefore the post-university age group. The majority (66,7%) held a master's degree or equivalent, a smaller group (16,7%) a bachelor's degree, one participant (8,3%) had no higher education, and another (8,3%) had completed a postgraduate specialisation. Regarding familiarity with *Infovis*, a large majority (83,3%) reported some levels of familiarity, while two participants (16,7%) did not. Among those familiar, 70% held a university degree, suggesting that the educational background may influence knowledge of *Infovis*. Half of the participants described *Infovis* as the visual aid to understand complex data. A thirty-year-old osteopath with a Master's degree explained "More or less, I think so, I don't know how to explain it well, but it allows visualisation of a certain topic so that it is understood more quickly and clearly. Charts are used to translate data and make it accessible to more people." Another participant, with the lowest level of education, linked *Infovis* to truth, saying "Information Visualisation is the difference between true and false data to improve everything on the data." This latter point, in a way, reflects the idea of *Infovis* as a reliable and objective tool.

Familiarisation with *VisuaLies*

Participants actively engaged with the presentation, sparking a discussion on *Infovis*, societal crises, and *Misinfovis*. Specifically, participants expressed interest in learning how to identify *Misinfovis*, how to trust *Infovis* concerning crises such as the COVID-19 pandemic and requested additional examples of both misleading and non-misleading *Infovis*.

Validate the "Infovis process" category

The outcome of this activity revealed that the lexicon employed was, in some instances, inaccessible to non-experts due to the use of specialised terms without detailed explanations, and because participants were not familiar with the *Infovis* process. Specifically, "the form of data" was deemed too general; "handling the data" was difficult to distinguish from the former; "the choice of the visual model" used the specialised term "visual model"; and participants were not aware of the "visual finish" phase. Furthermore, the descriptions of these categories proved to be too brief and not self-explanatory, as for "problems with mapping numerical variables to visual variables" with participants finding difficult to define what numerical variables and visual variables would stand for.

Validate the “Misinfovis Situations” category

The way we structured this activity allowed for broad and in-depth discussions among participants, both in terms of time and conceptual depth, to the extent that we had to intervene to redirect or keep them concise. The general feedback from this session centred on the names used for the Situations, such as “Cherry Picking” or “Non-excluded Outlier,” which some participants found “not very intuitive” because they were too specific, and suggested making the explanations more detailed. Furthermore, we intentionally repeated certain Situations, such as “Limited Data”, at different Infovis stages to observe participants’ reactions: they opted to limit each Situation to a single appearance, categorising “Limited Data” within “The Form of Data”. This activity was instrumental in refining the terminology and combining and/or eliminating some categories for greater clarity.

Recognise Misinfovis Situations

At the end of this activity, at least nine participants identified all fifteen visualisations. The Situations within the ‘Form of Data’ were rarely selected, which might suggest that participants potentially found these Situations difficult to decode or recognise. We observed that in some cases, no participant identified at least one Situation that was present in the Misinfovis. During the activity, some participants admitted feeling confused and either chose not to select a Situation or opted for the one that was most popular among the other participants. Also, some participants formed pairs, as they found it easier to discuss the Misinfovis with a partner rather than alone. Three key points emerged from this activity, and were crucial in shaping the second version of CMiS. The first concerns the feasibility of recognising certain Situations: in cases such as limited data, incorrect data, or data manipulation, the presence of the Situation can be inferred but not verified when the data source is not indicated on the visualisation. Participants suggested including a ‘perhaps’, to indicate a potential for misleading due to the unverifiable aspect, making the Infovis opaque and unreliable. This comment highlights the potential of *VisuaLies* to stimulate critical thinking among participants on the topic. The second point is that many Situations were not recognised because the descriptions were unclear, particularly in the case of complex or field-specific Situations, such as base-rate-bias or area-charts. The final point relates to the repetition of some Situations across different Infovis stages, and the omission of others, such as absence of title, legend, or data source.

Discussion

Although this was the first iteration, *VisuaLies* provided us with interesting results for our research and proved to be a valuable way to observe how citizens engage with the topic of Misinfovis. Diverse feedback from participants across various specialisations provided a broad and balanced contribution, especially when considering that some participants had little to no familiarity with Infovis and Infor-

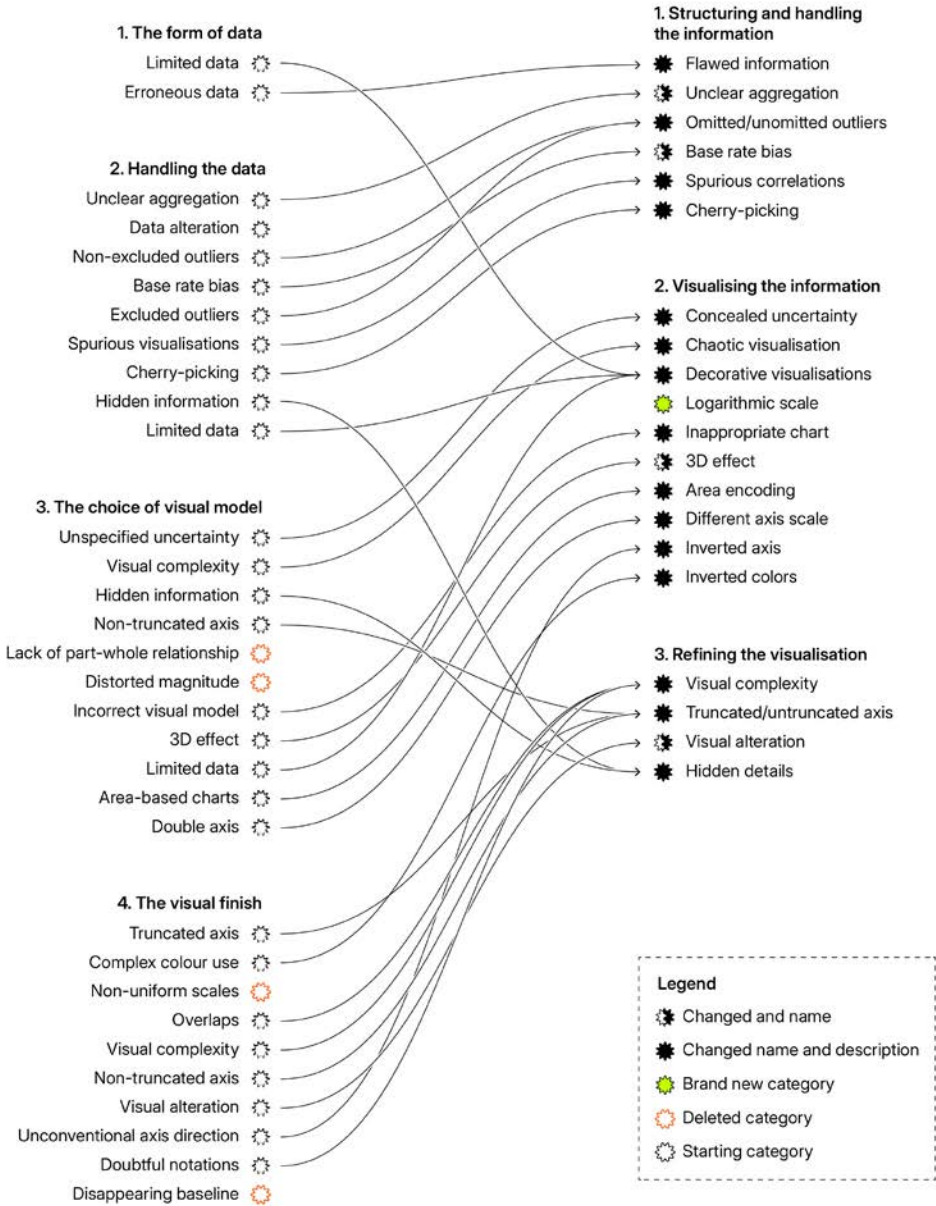


Fig. 6
A comparison between the first and second draft of CMiS, by the authors.

mation Design, and this aligned with our objective of validating and improving CMiS's accessibility. However, the limited pool of participants calls for more iterations of VisualLies, to involve different social categories and collect more quantitative data to explore the patterns of interaction with CMiS.

The outcome of *VisuaLies*¹ is an updated version of CMiS (Aversa & Mauri, 2024), similar in the structure but featuring fewer Situations and a more accessible lexicon Fig. 6. In this version, we merged the first two Infovis stages, 'The form of data' and 'Handling the data', as both addressed the actions involved in working with data and integrated them into the new 'Structuring and handling information'. Moreover, all the three Infovis process categories feature updated titles and more comprehensive descriptions. As for the Misinfovis Situations, the original framework included thirty-two while the updated version counts twenty. We excluded those Situations that were repeated at different stages and merged some, as in the case of un-omitted outliers and omitted outliers, which we combined into omitted/un-omitted outliers. Additionally, we introduced a new Situation, Hidden details, to cover cases in which the Misinfovis omits essential information, such as the title, source, legend, axis labels, and so on.

The workshop confirmed that the issue of Misinfovis requires more social attention, as even those unfamiliar with Infovis and Misinfovis affirmed that they were affected by its circulation. This circulation within social environments can pose a threat to citizens' right to accurate information, which is fundamental in building what UNESCO (Souter, 2010) calls 'inclusive knowledge societies'. We intend CMiS as a first stone in the direction of democratizing literacy on this issue by facilitating the recognition of the misleading potential of an Infovis based on its formal characteristics. *VisuaLies* served as a vehicle to direct CMiS towards citizens, to make it usable and adaptable, conceived as a moment of exchange and inclusion, where potential end-users can influence the design process of CMiS, ensuring it becomes as effective as possible. Through diverse participatory activities aimed at stimulating interest and critical thinking, CMiS was both deconstructed and reconstructed, enabling participants to offer their unique viewpoints and experiences. The promising effects of CMiS can be framed within the ever more relevant space Infovis literacy is gaining within European actions, as introduced in the DigComp 2.0 (Vuorikari et al., 2022).

To conclude, *VisuaLies* presented some constraints which, if well addressed, we believe can make the use of CMiS more effective in the future. First of all, *VisuaLies* calls for more iterations: given the interesting results that have been achieved, we are confident that the experiment can be repeated with different audiences, testing it with various segments of the population. This would improve the reliability of results, in addition to offering a broader perspective. Another development concerns the methods of collecting feedback from participants, to fully grasp the nuances in a more structured way and thus be replicable in future *VisuaLies* sessions.

1

The complete version is available on Zenodo at <https://zenodo.org/records/14260573>.

In conclusion, Misinfovis is a complex problem, especially considering the contexts in which it appears. This experiment wishes to be the first step in a larger study that explores the different sites of meaning a Misinfovis can generate in its social circulation, due to the fact that the misleading effect arises not only from its formal characteristics but also, and perhaps more importantly, from the different narratives attached to it through its dissemination, as highlighted by the seminal work by Lisnic and colleagues (2023). Given this more complex framework, this study aims to provide a grounding starting precisely from the formal characteristics, to allow the unpacking of other elements in the future that can turn an Infovis into a tool of disinformation.

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References

- Aversa, E., & Mauri, M. (2024). *CMiS: the Classification of Misinfovis Situations*. [Data set]. Zenodo. <https://zenodo.org/records/14260573>
- Bertin, J. (1967). *Semiology of graphics: Diagrams, networks, maps* (1st ed). ESRI Press.
- Bhargava, R., & D'Ignazio, C. (2015). Designing Tools and Activities for Data Literacy Learners. In *Web Science, Workshop on data literacy*. Oxford, UK.
- Carpendale, S. (2008). Evaluating Information Visualizations. In A. Kerren, J. T. Stasko, J. D. Fekete, & C. North (Eds.), *Information Visualization* (Vol. 4950, pp. 19-45). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-70956-5_2
- D'Ignazio, C., & Bhargava, R. (2018). Creative data literacy: A constructionist approach to teaching information visualization. *Digital Humanities Quarterly*, 12(4). <https://dspace.mit.edu/handle/1721.1/123473>
- Doan, S. (2021). Misrepresenting COVID-19: Lying With Charts During the Second Golden Age of Data Design. *Journal of Business and Technical Communication*, 35(1), 73-79. <https://doi.org/10.1177/1050651920958392>
- Dondis, D. A. (1974). *A Primer of Visual Literacy*. MIT Press.
- Drucker, J. (2020). *Visualization and Interpretation: Humanistic Approaches to Display*. MIT Press.
- Ferreira, M., Nunes, N., Ceccarini, C., Prandi, C., & Nisi, V. (2023) The Russia-Ukraine war and climate change: Analysis of one year of data-visualisations, In D. De Sainz Molestina, L. Galluzzo, F. Rizzo, D. Spalazzo (Eds.), *IASDR 2023: Life-Changing Design*, 9-13 October, Milan, Italy. <https://doi.org/10.21606/iasdr.2023.431>
- Hedden, H. (2022). *The Accidental Taxonomist* (Third edition). Information Today Inc.
- Hemsley, J., & Snyder, J. (2018). FIVE Dimensions of Visual Misinformation in the Emerging Media Landscape. In B. Southwell, E. Thorson & L. Sheble (Eds.), *Misinformation and Mass Audiences* (pp. 91-106). New York, USA: University of Texas Press. <https://doi.org/10.7560/314555-007>
- Hiiippala, T. (2020). 17. A multimodal perspective on data visualization. In M. Engebretsen & H. Kennedy (Eds.), *Data Visualization in Society* (pp. 277-294). Amsterdam: Amsterdam University Press. <https://doi.org/10.1515/9789048543137-021>
- Hullman, J., & Diakopoulos, N. (2011). Visualization Rhetoric: Framing Effects in Narrative Visualization. *IEEE Transactions on Visualization and Computer Graphics*, 17(12), 2231-2240. <https://doi.org/10.1109/TVCG.2011.255>
- Huron, S., Jansen, Y., & Carpendale, S. (2014). Constructing Visual Representations: Investigating the Use of Tangible Tokens. *IEEE Transactions on Visualization and Computer Graphics*, 20(12), 2102-2111. <https://doi.org/10.1109/TVCG.2014.2346292>
- Huron, S., Bach, B., Hinrichs, U., Keck, M., & Roberts, J. C. (2021). 2nd IEEE vis workshop on data vis activities to facilitate learning, reflecting, discussing, and designing. In *IEEE VIS 2021*.
- Keck, M., Huron, S., Panagiotidou, G., Stoiber, C., Rajabiyazdi, F., Perin, C., Roberts, J. C., & Bach, B. (2023). EduVis: Workshop on Visualization Education, Literacy, and Activities. *arXiv*. <https://doi.org/10.48550/arXiv.2303.10708>
- Kivinen, K. (Ed.), (2022). *Digital Information Literacy Guide: A digital information literacy guide for citizens in the digital age*. Faktabaari EDU. <https://faktabaari.fi/dil/digital-information-literacy-guide.pdf>
- Lee, C., Yang, T., Inchoco, G. D., Jones, G. M., & Satyanarayan, A. (2021). Viral Visualizations: How Coronavirus Skeptics Use Orthodox Data Practices to Promote Unorthodox Science Online. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1-18. <https://doi.org/10.1145/3411764.3445211>
- Lisnic, M., Polychronis, C., Lex, A., & Kogan, M. (2023). Misleading Beyond Visual Tricks: How People Actually Lie with Charts. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, 1-21. <https://doi.org/10.1145/3544548.3580910>
- Lo, L. Y., Gupta, A., Shigyo, K., Wu, A., Bertini, E., & Qu, H. (2022). Misinformed by Visualization: What Do We Learn From Misinformative Visualizations? *Computer Graphics Forum*, 41(3), 515-525. <https://doi.org/10.1111/cgf.14559>
- Matusiak, Krystyna; Heinbach, Chelsea; Harper, Anna; Bovee, Michael. (2019). Visual Literacy in Practice: Use of Images in Students' Academic Work. *College & Research Libraries*, 80(1), 123-139. <https://doi.org/10.5860/crl.80.1.123>
- Moreland K., & Rogowitz B. (2023) VisLies website. <https://www.vislies.org/2023/>
- Nærland, T. (2020). 4. The political significance of data visualization: Four key perspectives. In M. Engebretsen & H. Kennedy (Eds.), *Data Visualization in Society* (pp. 63-74). Amsterdam University Press. <https://doi.org/10.1515/9789048543137-008>
- Ørngreen, R., & Levinsen, K. T. (2017). Workshops as a Research Methodology. *Electronic Journal of E-Learning*, 15(1), 70-81. <http://ejel.org/volume15/issue1>
- Paul, C. L. (2008). A modified Delphi approach to a new card sorting methodology. *Journal of Usability Studies*, 4(1), 7-30.
- Segel, E., & Heer, J. (2010). Narrative Visualization: Telling Stories with Data. *IEEE Transactions on Visualization and Computer Graphics*, 16(6), 1139-1148. <https://doi.org/10.1109/TVCG.2010.179>
- Soranzo, A., & Cooksey, D. (2015). Testing Taxonomies: Beyond Card Sorting. *Bulletin of the Association for Information Science and Technology*, 41(5), 34-39. <https://doi.org/10.1002/bult.2015.1720410509>
- Souter, D. (2010). *Towards inclusive knowledge societies: A review of UNESCO's action in implementing the WSIS outcomes*. United Nations Educational, Scientific and Cultural Organization.
- Tactical Tech. (n.d.). *The Glass Room*. <https://tacticaltech.org/projects/the-glass-room/>
- Teal, T. K., Cranston, K. A., Lapp, H., White, E., Wilson, G., Ram, K., Pawlik, A., & Seok, P. (2015). Data Carpentry: Workshops to increase data literacy for researchers. *International Journal of Digital Curation*, 10(1), 135-143. <https://doi.org/10.2218/ijdc.v10i1.351>
- Vickery, B. C. (1970). *Techniques of Information Retrieval*. Archon Books.
- Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2, The Digital Competence framework for citizens: With new examples of knowledge, skills and attitudes*. Publications Office of the European Union.