




Using Data Comics to Enhance Visualization Literacy

M. Boucher¹ , C. Stoiber¹  and W. Aigner¹ 

¹University of Applied Sciences St. Pölten, Austria

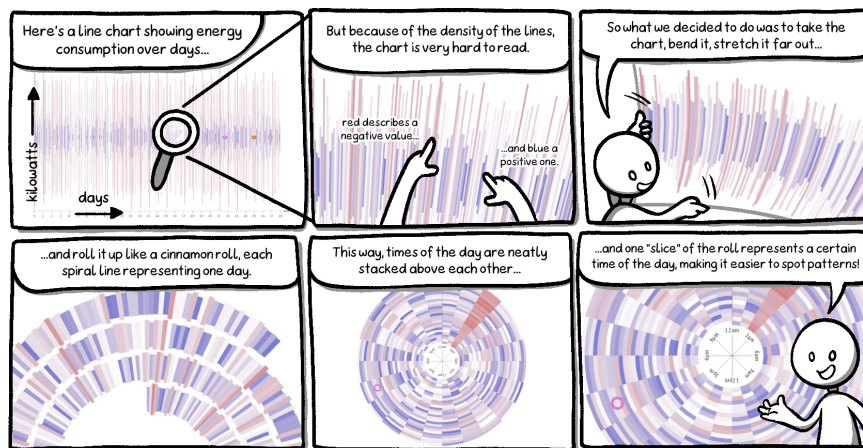


Figure 1: An example of a data comic explaining the visual mapping of a spiral chart based on a line graph.

Abstract

Visualization Literacy as a skill is becoming important, as growing amounts of data require complex ways of visualizing and interpreting them. Yet, it is hardly taught during general education, and not many resources conveying visualization knowledge in an easily accessible way exist. We draw on the notion of data comics, which are already well-suited for communicating visualization insights, but so far have not been explored in the context of teaching visualization skills. We aim to map the research landscape around this idea through a systematic literature research and present a first overview of related areas and how they might influence data comics used to enhance visualization literacy.

CCS Concepts

• **Human-centered computing** → Visualization theory, concepts and paradigms;

1. Introduction and Related Work

The correct interpretation of data visualizations is becoming increasingly important not only to experts, but also to the general public, as especially recent events around Covid-19 have shown [Shn20]. The general public was introduced to various data visualizations presenting medical data such as reproduction numbers, Covid-19 cases, hospitalization, etc. However, visualization beyond simple bar- and line charts is seldomly taught in the course of general education, resulting in a low visualization literacy among the public [BMBH16]. This can be a problem considering that a lot of data can only be thoroughly explored through less widely known, possibly even interactive visualization techniques.

There are few resources conveying visualization knowledge in an accessible format. Text books mostly provide a general overview only, while chart and tool libraries like *Rawgraphs* [raw] or *Voyager* [voy] provide high-level insights and require some previous knowledge to be handled. Websites explaining different visualization types do exist, e.g., *The Graphic Continuum* [SR14], *Data Viz Catalogue* [Rib20], and *From Data to Viz* [HH21], however, they exclusively use textual descriptions of images, and the data sets used in the visualization examples are very abstract. This can be problematic for novice users, which is why we believe that tailored, hands-on guides on how to understand and solve specific problems with data visualizations are needed.

Recently, a genre called data comics has been explored as a means to data-driven storytelling [BRCP17]. Through their simple and accessible format, they are very well suited for communicating insights even in complex visualizations (e.g., [BKH*16]), achieving what neither illustrated text nor videos can do alone: They keep an all-time overview, allowing the audience to read and understand at their own pace, but at the same time offer a linear narrative like a video would, only without relying on the audience's memory of the content [BKH*16]. So far, data comics have not been explored in the context of teaching visualization. Wang et al. use some principles of data comics in a set of visualization cheat sheets [WSMRB20], but the full format, albeit having the potential, has not been used to teach visualization yet.

Using data comics to teach visualization requires knowledge and poses challenges from multiple domains: data visualization, comics, and teaching. We align these three parent disciplines in a Venn Diagram, as seen in Figure 2, in an attempt to map the research areas that need to be explored, and provide an insight into the research landscape.

2. Method

In a first step of scouting the research areas of our map, we performed a systematic literature review. We first conducted a general search in Google Scholar using keywords such as *data comics*, *teaching with comics*, *visualization teaching*, and *comic visualization*. Then, we surveyed the first 10 result pages of digital libraries such as ACM, SpringerLink, IEEE Xplore, and Sage Journals. Additionally, we identified related papers through reference snowballing. We describe our first insights in the following.

3. Mapping the Research Landscape

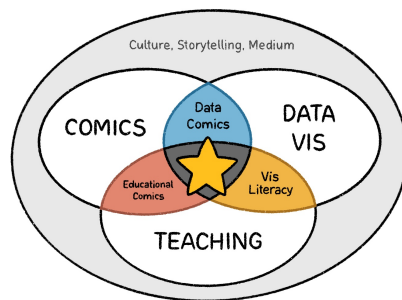


Figure 2: Our map of the involved research areas shows dimensions influencing each other when using data comics to enhance visualization literacy. Outside of the Venn diagram are factors relevant to all areas, such as culture, storytelling, or medium.

Comics + Teaching = Educational Comics: Comics have a history of being used in educational contexts, and various studies across different topics consistently showed that through their multimodal nature, accessibility, as well as through using characters which enable emotional attachment and a basis for self-reference, they are very effective for improving the audience's motivation and engagement [Far18]. A lot of educational comics are designed for classroom use with children (examples ranging from English [Iss18]

or Science [MHSD21] to Programming classes [SLL*21]). Meanwhile, however, non-fiction comics of explanatory nature, dubbed "Graphic Guides", have even become their own book genre for all age groups [int].

Comics + Data Vis = Data Comics: Although the first data comics heavily focused on leading characters explaining visualizations [ZME15], they, as well as aesthetics and/or specific rendering like in graphic guides are only secondary to data comics. Studies suggest that hand-drawn, sketchy styles do enhance engagement even in data visualizations [WII*12], but generally, data comics' main goal is to communicate insights through the medium itself. Bach et al. [BWF*18] propose a set of design patterns for data comics which highlight how techniques native to this comic medium (e.g., panel size and order) can guide readers and shed light upon data visualizations. Data comics have been studied in terms of effectiveness and engagement [WWF*19], and efforts have been made to facilitate their creation, such as creation frameworks [WRZ*21] and authoring tools [KHRB*19, gra19]. Recently, the potential of interactivity in Data Comics has also been explored [KHM*21, WRC*22]. Seeing that many visualizations only reach their full potential with interactive exploration possibilities, we believe that incorporating interactive data comics into such visualizations can also facilitate learning.

Data Vis + Teaching = Visualization Literacy: The topic of visualization literacy gained increased attention in the last years [BHH*21]. For example, efforts have been made to teach visualization skills early in elementary schools using tablet applications, e.g., [BZP*20]. Firat et al. [FDL20] developed a pedagogical interactive treemap application to help students learning the visualization in a more effective way than through slides. Huron et al. [HBHK] also emphasize the importance on hands-on activities over sole didactic learning. Attempts to help users in taking full advantage of complex visualization tools have been made in visualization onboarding research [SWG*ss] as well as in user assistance and guidance in visual analytics contexts [SCW*22].

4. Conclusion and Future Work

We see potential in teaching visualization with data comics and explored the research landscape around the topic. Our next step is to expand the systematic literature survey and to address open questions that arise from the combination of the dimensions seen in Figure 2, such as using comics to teach how to read/navigate/interact with visualizations, similar to Figure 1, which explains the formation of a spiral chart from a line graph as an example. How to facilitate the creation of such comics as well as how to evaluate them are directions worth exploring. Finally, with hands-on tools to enhance visualization literacy emerging, integrating interactive comics as a method of onboarding seems promising as well.

Acknowledgements

We would like to thank Benjamin Bach for his valuable feedback. This work was funded by BMK under the ICT of the Future program via the SEVA project (no. 874018), by the Austrian Science Fund as part of the Vis4Schools project (I 5622-N), and by the GFF NÖ as part of the dissertation project VisToon (SC20 - 014).

References

- [BHH*21] BACH B., HURON S., HINRICH S. U., ROBERTS J. C., CARPENDALE S.: Special issue on visualization teaching and literacy. *IEEE Computer Graphics and Applications* 41, 06 (2021). 2
- [BKH*16] BACH B., KERRACHER N., HALL K. W., CARPENDALE S., KENNEDY J., HENRY RICHE N.: Telling Stories about Dynamic Networks with Graph Comics. In *Proc. of CHI* (San Jose California USA, May 2016), ACM, pp. 3670–3682. doi:10.1145/2858036.2858387. 2
- [BMBH16] BÖRNER K., MALTESE A., BALLIET R. N., HEIMLICH J.: Investigating aspects of data visualization literacy using 20 information visualizations and 273 science museum visitors. *Information Visualization* 15, 3 (2016), 198–213. doi:10.1177/1473871615594652. 1
- [BRCP17] BACH B., RICHE N. H., CARPENDALE S., PFISTER H.: The Emerging Genre of Data Comics. *IEEE Computer Graphics and Applications* 37, 3 (2017), 6–13. doi:10.1109/MCG.2017.33. 2
- [BWF*18] BACH B., WANG Z., FARINELLA M., MURRAY-RUST D., HENRY RICHE N.: Design Patterns for Data Comics. In *Proc. of CHI* (Montreal QC Canada, 2018), ACM, pp. 1–12. doi:10.1145/3173574.3173612. 2
- [BZP*20] BISHOP F., ZAGERMANN J., PFEIL U., SANDERSON G., REITERER H., HINRICH S. U.: Construct-a-vis: Exploring the free-form visualization processes of children. *IEEE TVCG* 26, 1 (2020), 451–460. doi:10.1109/TVCG.2019.2934804. 2
- [Far18] FARINELLA M.: The potential of comics in science communication. *Journal of Science Communication* 17, 01 (Jan. 2018), Y01. URL: https://jcom.sissa.it/archive/17/01/JCOM_1701_2018_Y01, doi:10.22323/2.17010401. 2
- [FDL20] FIRAT E. E., DENISOVA A., LARAMEE R. S.: Treemap Literacy: A Classroom-Based Investigation. In *Eurographics 2020 - Education Papers* (2020), Romero M., Sousa Santos B., (Eds.), The Eurographics Association, pp. 29–38. doi:10.2312/eged.20201032. 2
- [gra19] Gramener Comicgen: Comic Creator, 2019. URL: <https://gramener.com/comicgen/>. 2
- [HBHK] HURON S., BACH B., HINRICH S. U., KECK M.: IEEE VIS Workshop on Data Vis Activities to Facilitate Learning, Reflecting, Discussing, and Designing. 4. 2
- [HH21] HOLTZ Y., HEALY C.: From data to viz | find the graphic you need, 2021. Library Catalog: www.data-to-viz.com. URL: data-to-viz.com. 1
- [int] Introducing Books - Graphic Guides. URL: <https://www.introducingbooks.com/graphic-guides/>. 2
- [Iss18] ISSA S.: Comics in the English classroom: a guide to teaching comics across English studies. *Journal of Graphic Novels and Comics* 9, 4 (July 2018), 310–328. URL: <https://www.tandfonline.com/doi/full/10.1080/21504857.2017.1355822>, doi:10.1080/21504857.2017.1355822. 2
- [KHM*21] KANG D., HO T., MARQUARDT N., MUTLU B., BIANCHI A.: ToonNote: Improving Communication in Computational Notebooks Using Interactive Data Comics. In *Proc. of CHI* (Yokohama Japan, 2021), ACM, pp. 1–14. doi:10.1145/3411764.3445434. 2
- [KHRB*19] KIM N. W., HENRY RICHE N., BACH B., XU G., BREHMER M., HINCKLEY K., PAHUD M., XIA H., MCGUFFIN M. J., PFISTER H.: DataToon: Drawing Dynamic Network Comics With Pen + Touch Interaction. In *Proc. of CHI* (Glasgow Scotland UK, 2019), ACM, pp. 1–12. doi:10.1145/3290605.3300335. 2
- [MHSD21] MATUK C., HURWICH T., SPIEGEL A., DIAMOND J.: How Do Teachers Use Comics to Promote Engagement, Equity, and Diversity in Science Classrooms? *Research in Science Education* 51, 3 (June 2021), 685–732. doi:10.1007/s11165-018-9814-8. 2
- [raw] Rawgraphs. URL: <https://rawgraphs.io/>. 1
- [Rib20] RIBECCA S.: The data visualisation catalogue. <https://datavizcatalogue.com/>, 2020. Accessed: 2020-03-12. URL: <https://datavizcatalogue.com/>. 1
- [SCW*22] STOIBER C., CENEDA D., WAGNER M., SCHETINGER V., GSCHWANDTNER T., STREIT M., MIKSCH S., AIGNER W.: Perspectives of visualization onboarding and guidance in VA. *Visual Informatics* (Mar. 2022), S2468502X22000134. URL: <https://linkinghub.elsevier.com/retrieve/pii/S2468502X22000134>, doi:10.1016/j.visinf.2022.02.005. 2
- [Shn20] SHNEIDERMAN B.: Data visualization’s breakthrough moment in the covid-19 crisis. <https://medium.com/nightingale/data-visualizations-breakthrough-moment-in-the-covid-19-crisis-ce46627c7db5>, 2020. Accessed: 2020-09-14. 1
- [SLL*21] SUH S., LATULIPE C., LEE K. J., CHENG B., LAW E.: Using Comics to Introduce and Reinforce Programming Concepts in CS1. In *Proc. of SIGCSE* (Virtual Event USA, Mar. 2021), ACM, pp. 369–375. doi:10.1145/3408877.3432465. 2
- [SR14] SWABISH J., RIBECCA S.: The graphic continuum: A poster project for your office. <https://policyviz.com/2014/09/09/graphic-continuum/>, 2014. Accessed: 2020-03-25. URL: <https://policyviz.com/2014/09/09/graphic-continuum/>. 1
- [SWG*ss] STOIBER C., WAGNER M., GRASSINGER F., POHL M., STITZ H., STREIT M., POTZMANN B., AIGNER W.: Visualization Onboarding Grounded in Educational Theories. In *Visualization Psychology*. Springer Nature, in Press. URL: <http://arxiv.org/abs/2203.11134>. 2
- [voy] Voyager 2. URL: <https://vega.github.io/voyager2/>. 1
- [WII*12] WOOD J., ISENBERG P., ISENBERG T., DYKES J., BOUKHELIFA N., SLINGSBY A.: Sketchy Rendering for Information Visualization. *IEEE Transactions on Visualization and Computer Graphics* 18, 12 (Dec. 2012), 2749–2758. URL: <http://ieeexplore.ieee.org/document/6327281/>, doi:10.1109/TVCG.2012.262. 2
- [WRC*22] WANG Z., ROMAT H., CHEVALIER F., RICHE N. H., MURRAY-RUST D., BACH B.: Interactive Data Comics. *IEEE Transactions on Visualization and Computer Graphics* 28, 1 (Jan. 2022), 944–954. URL: <https://ieeexplore.ieee.org/document/9552591/>, doi:10.1109/TVCG.2021.3114849. 2
- [WRZ*21] WANG Z., RITCHIE J., ZHOU J., CHEVALIER F., BACH B.: Data Comics for Reporting Controlled User Studies in Human-Computer Interaction. *IEEE TVCG* 27, 2 (Feb. 2021), 967–977. doi:10.1109/TVCG.2020.3030433. 2
- [WSMRB20] WANG Z., SUNDIN L., MURRAY-RUST D., BACH B.: Cheat Sheets for Data Visualization Techniques. In *Proc. of CHI* (Honolulu HI USA, Apr. 2020), ACM, pp. 1–13. doi:10.1145/3313831.3376271. 2
- [WWF*19] WANG Z., WANG S., FARINELLA M., MURRAY-RUST D., HENRY RICHE N., BACH B.: Comparing Effectiveness and Engagement of Data Comics and Infographics. In *Proc. of CHI* (Glasgow Scotland UK, May 2019), ACM, pp. 1–12. doi:10.1145/3290605.3300483. 2
- [ZME15] ZHAO Z., MARR R., ELMQVIST N.: Data comics: Sequential art for data-driven storytelling. In *HCIL Technical Report HCIL-2015-15* (Oct. 2015), University of Maryland, College Park. URL: <http://www.cs.umd.edu/hcil/trs/2015-15/2015-15.pdf>. 2