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Integrative Model of Statistical Literacy

Data and statistical information have never been more present in our daily lives than today. Teaching statistical literacy is therefore one of the main challenges of modern education (Schreiter et al., 2024). Statistical literacy is defined as the competence to draw conclusions as well as to make and justify decisions with the help of statistical information by considering and critically evaluating the collection, processing and evaluation of data (Gal, 2002). Due to the interdisciplinary and complex nature of statistical literacy, many different approaches have been taken to model statistical literacy. Some approaches focus more on the statistical-mathematical side, while others focus on the development and hierarchical structure of statistical literacy. The diversity of models calls for an integrative model that takes into account and relates the different approaches. As a result, a more holistic view of statistical literacy can be provided.

The model presented on the poster integrates six of the most popular models of statistical literacy. The core element is the cycle of data processes combined with statistical ideas. It shows two possible ways in which a person might engage with data. The inductive way (shown in lighter colors) shows how an empirical researcher ideally engages with data, and the deductive way (shown in darker colors) shows how a citizen might engage with data. Successful engagement with data requires an understanding of statistical ideas such as variability (Burrill & Biehler, 2011). The framing elements consider the developmental and hierarchical structure of statistical literacy.

The integrative model shows both overlaps and additions to the six models. Further work on the model could provide clear definitions of competencies regarding statistical literacy.

Literature

- Burrill, G. & Biehler, R. (2011). Fundamental Statistical Ideas in the School Curriculum and in Training Teachers. In: C. Batanero, G. Burrill & C. Reading (Ed.), *Teaching Statistics in School Mathematics-Challenges for Teaching and Teacher Education* (pp. 57–69). Springer Dordrecht. <https://doi.org/10.1007/978-94-007-1131-0>
- Gal, I. (2002). Adults' Statistical Literacy: Meanings, Components, Responsibilities. *International Statistical Review* 70(1), 1–25. <https://doi.org/10.2307/1403713>
- Schreiter, S., Friedrich, A., Fuhr, H., Malone, S., Brünken, R., Kuhn, J., & Vogel, M. (2024). Teaching for Statistical and Data Literacy in K-12 STEM Education: A Systematic Review on Teacher Variables, Teacher Education, and Impacts on Classroom Practice. *ZDM Mathematics Education* 56, 31–45. <https://doi.org/10.1007/s11858-023-01531-1>

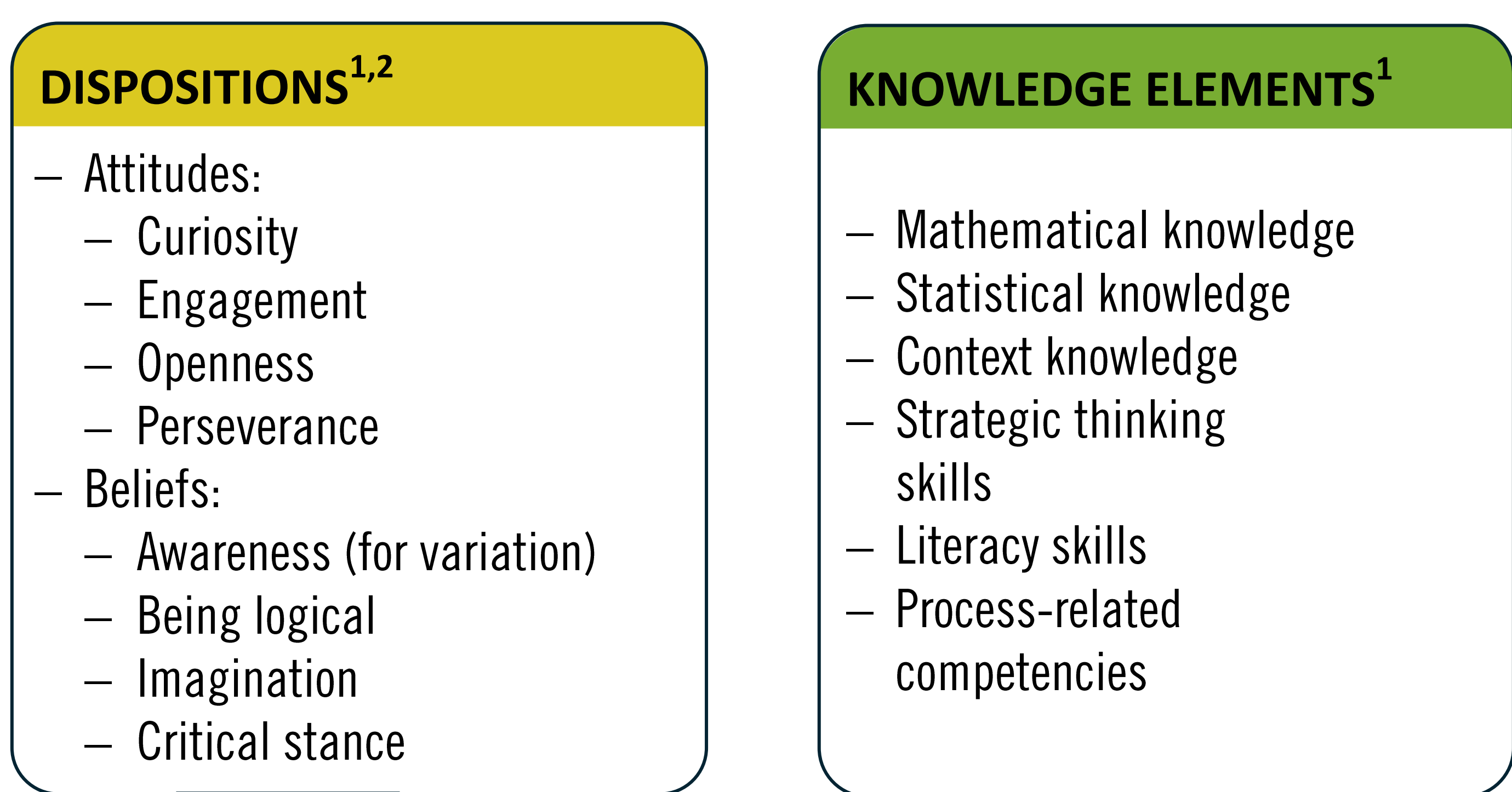
In: L. Schick, M. Platz & A. Lambert (Hrsg.),
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STATISTICAL LITERACY

Statistical literacy is defined as the competence to draw inference as well as to make and justify decisions with the help of statistical information. To do this, a statistically literate person must consider and critically evaluate the collection, the processing and the evaluation of data.¹ Many approaches to statistical literacy have led to different definitions that overlap in some areas and differ in other. The presented model integrates the most common theories and approaches on statistical literacy. Its structure allows a more general application of the referenced models and enables a new view on existing research.

FRAMING ELEMENTS

The framing elements are divided into dispositions, knowledge elements and levels of hierarchy. *Dispositions* support the engagement with statistical information as well as the thoroughness with which the engagement takes place.^{1,2} *Knowledge elements* are a necessary requirement for successfully overcoming hurdles during the cycle of data processes.¹ The *level of hierarchy* determines the complexity of data comprehension (from data as a pointer up to data as an aggregate) and the ability to criticise. To be considered statistically literate an individual must reach at least the critical level.⁵



CYCLE OF DATA PROCESSES

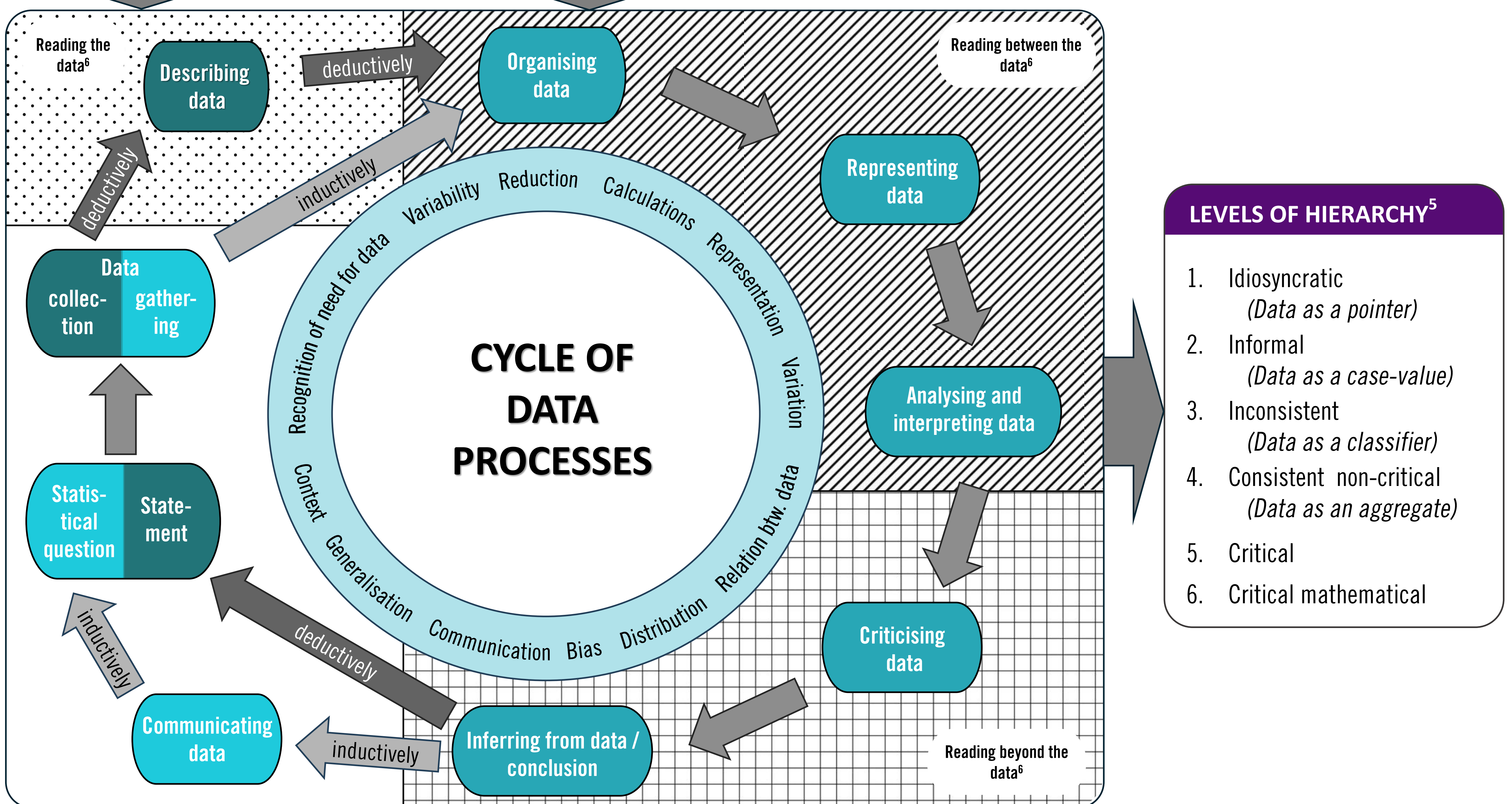
The cycle of data processes shows the typical order in which data is operated with. There are two ways for engaging with statistical information. The *inductive way* starts with a statistical question that is to be answered during the steps of the cycle.² The *deductive way* works with already existing data and seeks to apply it to a personal context. It includes processes that statistically literate people should ideally go through in their everyday lives when confronted with statistical information.³ Even though the main goal is different, the data processes organising, representing, analysing and interpreting, criticising and inferring from data are part of both ways.

STATISTICAL IDEAS

The statistical ideas consist of important concepts when dealing with statistical data and information.⁴ Statistical ideas are part of every data process – either explicitly or implicitly. Some ideas such as *calculations* or *representations* refer to statistical knowledge because one must know of possible calculations before applying or evaluating them when looking at statistical data. Ideas such as *variation* or *recognition of the need for data* refer to statistical thinking in general and the question of the need of statistics.² Other ideas such as *reduction* or *generalisation* strongly relate to modelling with data. Knowing, applying and considering each idea throughout the cycle of processes influences the level of hierarchy of the processes.

READING LEVELS

The reading levels originate from a definition of graph comprehension.⁶ Although the model is not limited to data represented in graphs, they are an essential part of statistical literacy. Ranging from *reading the data* (extracting obvious information from a graph) to *reading between the data* (interpreting and integrating information from a graph) to *reading beyond the data* (using information from a graph for inference or predictions) the complexity of the engagement with statistical information rises.⁶ Therefore, the processes associated with each reading level also require different levels of understanding.



IMPLICATIONS / CONCLUSION

The model provides a holistic view on statistical literacy. Using it for a review could shed some light on aspects of statistical literacy that have rarely been the focus of research, as well as aspects that have been the focus of much research.

Teachers might use the model to get an overview of the possibilities of statistics. For the model to be usable as a competency model, a next step would be the definition of each process at the different levels of hierarchy.

LITERATURE

¹ Gal, Iddo (2002). Adults' Statistical Literacy: Meanings, Components, Responsibilities. *International Statistical Review* 70(1), S. 1–25. DOI: 10.2307/1403713.
² Wild, Chris J. & Pfannkuch, Maxine (1999). Statistical Thinking in Empirical Enquiry. *International Statistical Review* 67(3), S. 223–248. DOI: 10.2307/1403699.
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⁴ Burrill, Gail & Biehler, Rolf (2011). Fundamental Statistical Ideas in the School Curriculum and in Training Teachers. In: Carmen Batanero, Gail Burrill & Chris Reading (Hg.), *Teaching Statistics in School Mathematics—Challenges for Teaching and Teacher Education*, Bd. 14. Dordrecht: Springer Netherlands, S. 57–69.
⁵ Watson, Jane & Callingham, Rosemary (2003). Statistical Literacy: A Complex Hierarchical Construct. *SERJ* 2(2), S. 3–46. DOI: 10.52041/serj.v2i2.553.
⁶ Friel, Susan N., Curcio, Frances R. & Bright, George W. (2001). Making Sense of Graphs: Critical Factors Influencing Comprehension and Instructional Implications. *Journal for Research in Mathematics Education* 32(2), S. 124–158. DOI: 10.2307/749671.

