

## IASE 2020 ROUNDTABLE DISCUSSANT SUMMARY: TOPIC 5

Discussant: Gail Burrill & Chair: Daniel Frischemeier  
Michigan State University, United States, & Paderborn University, Germany  
[burrill@msu.edu](mailto:burrill@msu.edu)

### TOPIC 5: The changing nature of data visualization and implications for the curriculum

	Title	Presenter
Short paper	<i>An investigation of statistical reasoning skills of middle school students about distribution</i>	Balkaya, Tuğçe (Turkey)
Long paper	<i>Data scientists' epistemic thinking for creating and interpreting visualizations and the impact for students' data visualization literacy</i>	Bolch, Charlotte (United States)
Long paper	<i>Visualizing multivariate data: Graphs that tell stories</i>	Engel, Joachim (Germany)

### PRELIMINARY RESEARCH QUESTIONS

- How can different data visualizations help develop students' conceptual understanding of key statistical ideas?
- How do student-generated data visualizations support the development of students' understanding of key statistical ideas?

### KEY DISCUSSION THEMES

Tuğçe Balkaya used the RISM framework to examine 11-13 years old students' statistical reasoning skills throughout the modeling process. She reported that when students develop a global view, they realize the center and the variability of the distribution. Charlotte Bolch described the use of Delphi panels to investigate data science researchers' skills and strategies for creating and interpreting visualizations. Insights from her study are the agreement among the experts across various research fields about common skills and strategies. One conclusion from her research is that components of data literacy such as visualization may not be domain specific. Joachim Engel reported on work from an EU Erasmus+ Project ProCivicStat on how to visualize multivariate data and about graphs that tell stories. He highlighted the potential of data visualizations to enhance students' capacity to handle and understand complex data with examples ranging from historical to modern (with data visualizations using digital tools)

The discussion in Topic 5 returned to the notion that the world is multivariable, where visualization is the key to understanding the data and their stories. According to Engel, data visualizations require basic numeracy and critical thinking to question the legitimacy of statements and make sense of the visualizations. Questions that emerged in the discussion included: When people see a new visualization, how do they think about what is happening in the graph? Because people from different fields think of visualization differently, how do we conceptualize data science and visualization? Can we structure the process of building data visualization literacy? Bolch's work identifying the skills needed to create and interpret visualizations seemed promising in starting to provide answers, although it was pointed out that care needs to be taken to ensure the experts represent a wide set of people with different perspectives. The consensus strategies can provide structure for students on what they should

be thinking about when creating or interpreting visualizations. Instructors can model this structure when interpreting visualizations from news articles and in teaching students how to create new visualizations. A next step might be a “think aloud” study as experts constructed their visualizations.

Several themes emerged with respect to how data visualizations can help develop students’ conceptual understanding of key statistical ideas. Visualizations provide access for more students and for different levels of students to engage with data, with more emphasis on statistical thinking, distributions, and variation. This can begin in early grades with exploration of data in students’ lives; in middle school students can explore concepts such as distribution using technology and use a variety of strategies to engage in multivariate thinking. Digital tools encourage statistical thinking in meaningful contexts (Engel et al.). These tools included data/graph sources such as Gapminder; Our World in Data, ProCivicStat (<http://iase-web.org/islp/pcs/>), American Statistical Association/New York Times (What's Going on in this Graph?), Financial Times, Population Pyramids, CoVid-19 graphics, Article, etc.). Technology tools provide opportunities to teach concepts such as randomization for informal inference or decision trees more easily. In particular, technology such as *CODAP*, R, Tableau, TinkerPlots, Jupyter Notebooks (Python), interactive dynamic handhelds, mobile phones maximizes opportunities for visualization.

An issue raised in the discussion was the importance of disposition- accepting new ways of thinking, willing to look outside of tradition, consider issues from different perspectives and engage in statistical stories. While disposition was highlighted as a necessary component of statistical literacy, changing disposition is difficult. Strategies suggested to improve disposition and motivation included the use of meaningful data and contexts, good visualizations, compelling examples, hot issues, and giving students/teachers a choice along with a structure.

The discussion highlighted the need to teach statistical literacy and the capacity to understand graphs because these ideas bridge all disciplines. Yet such ideas have no real curricular home in most countries. Curriculum guidelines may give general statements, but in reality, little or nothing is in place. The issues: multivariate thinking beyond linear is not in the secondary curriculum; mathematics teachers are not trained to facilitate discussion processes that involve context, values and personal experience instead of right or wrong; other teachers are math phobic and want to avoid statistics; many disciplines do not deal well with variability. One suggestion was to recruit teachers who do mathematics but also have experience in a second subject where they have to experience the messiness of the reality.