Mathematical Literacy on Statistical Measures
A Design Research Study

Christian Büscher

Statistics education research is a growing discipline incorporating diverse theoretical perspectives and distributed across all levels of education (Petocz, Reid, & Gal, 2018). The practice of teaching statistics, however, does not seem to have changed accordingly (Ben-Zvi, Gravemeijer, & Ainley, 2018). Recently, this has resulted in calls for statistics education to increase emphasis on Design Research (Ben-Zvi et al., 2018) and to construct coherent learning trajectories (Arnold, Confrey, Jones, Lee, & Pfannkuch, 2018).

Some design research has already been carried out in statistics education research (e.g. Bakker, 2004). The fact that practice does not seem to have changed can possibly be explained by the time resources allocated to statistics education in practice: in most countries, statistics education takes up only a small part of mathematics classrooms (Zieffler, Garfield, & Fry, 2018). The required Design Research thus needs to limit itself to few lessons and only the most important learning contents in order to be applicable to classrooms with limited time resources for statistics education.

This thesis engages with this research gap by designing and researching a *compact teaching-learning arrangement* for 7th Grade statistics in Germany. In order to specify centrally important statistical learning contents, it adopts the construct of *mathematical literacy* for statistics education research. Central to this thesis is the identification of two distinct sides of mathematical literacy: the *mathematizing side* of mathematical literacy concerns the individual's ability to use mathematics for structuring phenomena (e.g. Freudenthal, 1973). The *reflective side* of mathematical literacy concerns its ability to evaluate the role mathematics has in society and world (e.g. Skovsmose, 1994). Both sides of mathematical literacy comprise a distinct set of learning goals, in particular the development of specific *mathematizing concepts* and *reflective concepts*. For the teaching-learning arrangement, this thesis identifies *statistical measures* as a central mathematizing concept to be developed by learners.

The utilized framework of Topic-Specific Didactical Design Research (Prediger & Zwetzschler, 2013) allows this thesis to produce interrelated theoretical as well as empirical results. Regarding theoretical results, this study provides:

- A conceptualization of statistical measures as a structured learning content for statistics education
- A formulation of a hypothetical learning trajectory that connects beginning students' situative reasoning to the goals of mathematical literacy
- A descriptive framework for students' situative reflections in learning processes

Regarding empirical results, this study provides:

- The design of a compact teaching-learning arrangement on statistical measures
- Empirically refined design principles, in particular an elaboration of the role of the context of a teaching-learning arrangement for students' learning processes
- A micro level analysis of students' processes of developing statistical measures
- An existence proof for students' reflections in learning processes along with an analysis of the relationship between student' activities of mathematizing and reflecting

References

Arnold, P., Confrey, J., Jones, R. S., Lee, H. S., & Pfannkuch, M. (2018). Statistics Learning Trajectories. In D. Ben-Zvi, K. Makar, & J. Garfield (Eds.), *International Handbook of Research in Statistics Education* (pp. 295–326). Cham: Springer International Publishing.

Freudenthal, H. (1973). *Mathematics as an educational task*. Dordrecht, the Netherlands: Reidel.

Ben-Zvi, D., Gravemeijer, K., & Ainley, J. (2018). Design of Statistics Learning Environments. In D. Ben-Zvi, K. Makar, & J. Garfield (Eds.), *International Handbook of Research in Statistics Education* (pp. 473–502). Cham: Springer International Publishing.

Petocz, P., Reid, A., & Gal, I. (2018). Statistics Education Research. In D. Ben-Zvi, K. Makar, & J. Garfield (Eds.), *International Handbook of Research in Statistics Education* (pp. 71–99). Cham: Springer International Publishing.

Prediger, S., & Zwetzschler, L. (2013). Topic-specific Design Research with a Focus on Learning Processes: The Case of Understanding Algebraic Equivalence in Grade 8. In T. Plomp & N. Nieveen (Eds.), *Educational Design Research - Part A: An Introduction* (pp. 409–423). Enschede, the Netherlands: SLO.

Skovsmose, O. (1994). *Towards a Philosophy of Critical Mathematics Education*. *Mathematics education library: Vol. 15*. Dordrecht: Kluwer Academic Publishers.

Zieffler, A., Garfield, J., & Fry, E. (2018). What is Statistics Education? In D. Ben-Zvi, K. Makar, & J. Garfield (Eds.), *International Handbook of Research in Statistics Education* (pp. 37–70). Cham: Springer International Publishing.