



HAL
open science

Theory, methodology and design as an insightful bundle: a case of dual eye-tracking student-tutor collaboration on an embodied mathematical task

Anna Shvarts

► To cite this version:

Anna Shvarts. Theory, methodology and design as an insightful bundle: a case of dual eye-tracking student-tutor collaboration on an embodied mathematical task. Eleventh Congress of the European Society for Research in Mathematics Education, Utrecht University, Feb 2019, Utrecht, Netherlands. hal-02418086

HAL Id: hal-02418086

<https://hal.science/hal-02418086>

Submitted on 18 Dec 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Theory, methodology and design as an insightful bundle: a case of dual eye-tracking student-tutor collaboration on an embodied mathematical task

Anna Shvarts

Utrecht University, the Netherland; a.y.shvarts@uu.nl

Keywords: Eye movements, research methodology, epistemology.

While the importance of reflection on methodological dimension for the networking theories was already stated (e.g. Bikner-Ahsbals & Prediger 2014), here we claim that educational design is another essential dimension in distinguishing a phenomenon that might be unattainable as far as it has not been lit by a particular theory-methodology-design bundle. In this poster, we explore a bundle of a culture-historical approach, dual eye-tracking (DUET) method, and action-based interactive design; we argue that these three aspects being taken together form a lens that manifests in the teaching/learning process a *perception-action system* that is *distributed* between the tutor and student. The argument is based on multimodal data from student-tutor collaboration on interactive activity, where a student was required to discover a parabola in an embodied way as a set of points equidistant from the focus and directrix (Shvarts & Abrahamson, 2018).

Theory-methodology coupling. A culture-historical approach provides us both with the theory and methodology for investigating the psyche's development, and yet they are interconnected. Vygotsky proposes an "experimental-genetic method" that aims to restore the development process and to expose the higher psychic functions in the form of moving, "flowing flood" (Vygotsky, 1978). This method involves the active participation of a researcher in interaction with a pupil that, unlikely to natural science, do not distort the data, but on the contrary allow the genesis of mathematical functions to emerge. A theoretical presumption here is the social nature of psychological functions that emerge in intersubjective interactions. In our study, an experimenter interacts with the student as a tutor, and later interaction is reproduced between the just-instructed participant and a new pupil. DUET appears to be a perfect way to investigate this collaboration: while often eye-movements are interpreted with the presumption of the *eye-mind hypothesis*, the data from DUET might be perceived as evidence of a psychic function as distributed between a student and a tutor. Then *joint attention* is not a result of initiation or response by single participants, but a functional end that emerges from "the multiple pathways" (Yu & Smith, 2016, p. 18) within their system.

Theory-design coupling. Traditionally from Vygotsky's point of view, communication between a student and a teacher is considered as mediated by some cultural artifacts, signs. However, Roth argues that in his late writing Vygotsky departs from the mediation as a primary mechanism that serves communication (Roth, 2018). This embodied character of collaboration is particularly accessible in an activity which is deliberately designed so that introduction of mathematical notations is postponed to the moment when a student has experienced mathematical concepts in an embodied way (Abrahamson, Shayan, Bakker, & van der Schaaf, 2015). The involvement of a student and a tutor in a motor problem that required formation of a new sensory-motor coordination allowed us to trace this function as socially distributed.

Method-design coupling. As eye-tracking let us observe oculomotor spatially articulated activity, we shall involve the participants in the design that benefits from an eye-tracking observation. The embodied action-based design is particularly suitable as it provides an opportunity for the learner to elaborate mathematical knowledge at first in the form of sensory-motor coordination. It is through eye-tracking we may gather empirical evidence of *attentional anchors* — the perceptual aspects of sensory-motor coordination that serves the efficiency of movement (Abrahamson et al., 2015).

Theory-methodology-design bundle. A combination of all three couplings let some phenomena surface; we present the one phenomenon that seems to be of great importance for educational science. While the students' eye-movements manifested emerging *attentional anchors*, the same was found in the tutors' oculomotor behavior, whether they were a researcher or an instructed participant. Thus, we obtained evidence of embodied coupling between the student and tutor: The tutor's perception is *as if* it regulates the student's action. While de facto it is the student who conducts the movements, the tutor enacts these movements in their imagination thus anticipating student's progress in learning and sensing her *micro-zone of proximal development*. This coordination between student's action and tutor's perception allows us introducing *intersubjectively distributed perception-action system* that evolves in the teaching/learning process.

Shall this be a local phenomenon of particular activity under the particular lens? We argue that this theory-methodology-design bundle does not limit generalization of the findings: The phenomenon of an intersubjectively distributed perception-action system is made spatially articulated due to the design settings, visible through dual eye-tracking methodology and understood under the light of Vygotsky's theory of irreducibly collaborative teaching/learning. Finally, it becomes influential far beyond particular experimental settings just like the phenomenon of diffraction of light and its dual wave-particle nature goes far beyond the settings in which it was spotted.

Abrahamson, D., Shayan, S., Bakker, A., & van der Schaaf, M. (2015). Eye-Tracking Piaget: Capturing the Emergence of Attentional Anchors in the Coordination of Proportional Motor Action. *Human Development*, 58(4–5), 218–244.

Bikner-Ahsbals, A., & Prediger, S. (2014). Networking as research practices: Methodological lessons learnt from the case studies. In *Networking of theories as a research practice in mathematics education* (pp. 235–247). Cham, Switzerland: Springer International Publishing.

Roth, W.-M. (2018). Birth of Signs: A (Spinozist-Marxian) Materialist Approach. In N. Presmeg, L. Radford, W.-M. Roth, & G. Kadunz (Eds.), *Signs of signification: Semiotics in mathematics education research* (pp. 37–53). Cham, Switzerland: Springer International Publishing.

Shvarts, A., & Abrahamson, D. (2019). Dual-eye-tracking Vygotsky: A microgenetic account of a teaching/learning collaboration in an embodied-interaction technological tutorial for mathematics. *Learning, Culture and Social Interaction*, 22, doi.org/10.1016/j.lcsi.2019.05.003

Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. Oxford, England: Harvard University Press.

Yu, C., & Smith, L. B. (2016). Multiple sensory-motor pathways lead to coordinated visual attention. *Cognitive Science*, 41, 1–27.