Chapter 3
“Click, Drag, Think!”
Posing and Exploring Conjectures with Dynamic Geometry Software

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ABSTRACT

The author points out that to fully exploit the heuristic potential of Dynamic Geometry Software (DGS) and to increase the heuristic literacy of students, extant DGS teaching units have to be ameliorated in several ways. Thus the author develops a twofold conceptual framework: heuristic reconstruction and heuristic instrumentation of problems. Its origin is rooted in the literature, its use is demonstrated by various examples, and its value is made plausible by an introductory teaching unit an advanced case study.

OVERVIEW

DGS has become an established tool in the mathematics classroom. Though its heuristic value is often stressed, the literature on DGS usage reveals some shortcomings in its existing use. To see what is missing, we first reconsider models of problem solving and proving by Polya and Boero. With these theoretical tools, we can state our main idea: to further success in problem solving, a heuristic reconstruction of tasks is suitable, which we design analogously to Polya’s problem solving scheme. To support learners, the heuristic instrumentation of problems has also to be considered, especially for best practice in utilizing DGS. We develop a framework for
this by refining Arzarello’s list of dragging modalities. Both schemes are illustrated by detailed examples from teaching material of our ongoing research on DGS based problem solving. Readers that are more interested in concrete suggestions for DGS-based teaching may skip the theoretical framework and start the subsection “Heuristic Reconstruction of a Concrete Example,” using the material before for later reference if necessary.

We also sketch an ongoing empirical study that will serve to evaluate our approach. Meanwhile, we point out its possible merits by an advanced case study that illustrates how far learners’ heuristic abilities may evolve when heuristic strategies are properly instrumented.

THEORETICAL BACKGROUND

Dynamic Geometry Software as a Heuristic Tool

Dynamic Geometry Software (DGS) is widely recognized as a tool of visualization that may further students’ progress; see Laborde & Laborde (1995). From the beginning its heuristic role was stressed: “The changes in the solving process brought by the dynamic possibilities of Cabri come from an active and reasoning visualization, from what we call an interactive process between inductive and deductive reasoning” (Laborde & Laborde 1992). Teaching material that draws on this capability was subsequently developed by Elschenbroich (1997). Meanwhile, the literature contains a plethora of proposals for the utilization of DGS even in nongeometric situations (e.g. Gawlick 2003).

However, in a critical review of the literature, Hölzl (2001) concludes a closer look leads one to question whether the software is really used in a methodical and activating way of knowledge acquisition. Rather, it seems that DGS is used in a solely verifying manner in that the learners need only vary more or less prefabricated geometric configurations to confirm empirically more or less explicitly stated conjectures (e.g. that the altitudes in a triangle always meet in one point). In contrast, Hölzl reports on the long-term application of DGS as an integral part of the learning environment that DGS possesses a considerable heuristic potential, especially for transformation geometry. Yet, the application of DGS requires thorough consideration: “Dynamics per se is not a didactical advantage” (Hölzl, 1999). It will be most favorable where an objective instrumental requirement meets advanced mathematical experience. Students were observed using the drag mode as a graphic tool, as test mode, or as a search mode—but the use as a test mode remained shaky even after two years.
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