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Four steps on the way to create argumentation competence supported by technology

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Extending the spiral curriculum which is originally focused on content matter areas dealing with typical mathematical activities we create a competence-based four step model to develop arguing. According to the four levels, the use of technology has different purposes: from exploring at the beginning to explaining at the end of the search for mathematical reasons. This cannot only prove but also enlighten certain problem areas.

Keywords: Argumentation competence, use of technology, reasoning, proof.

ARGUMENTATION AND PROOF

The Austrian educational standards for Mathematics at grade 8 define competences such as “cognitive abilities which are available for a longer time (and the readiness to make use of them)”. Moreover, they define standards descriptors within four content areas and four types of mathematical activities/processes that students should make use of when making use of their content related competence (IDM, 2007). One of these activities is, as with many other mathematical standards *Reasoning and Proof*. To be able to reason and prove requires continuing development. For that we propose to extend the spiral curriculum with its main ideas (revisiting topics, increasing complexity) to typical mathematical activities. Accounting this we generated a four level model to develop arguing on mathematical topics from grade 5 to grade 12.

A competence based four level model for arguing

Based on the forgoing our model includes several levels. All levels can occur in a specific field of arguing. Each level should be dealt with in one particular grade or even across grades.

Level 1 (Disposition): Disposition to engage in mathematical tasks that demand (simple) reasoning.

Level 2 (Comprehension): Ability to understand, comprehend and explain prescribed reasons. An important aspect in this context is to identify the frame of reference.

Level 3 (Communication): Ability to explain and argue completed mathematical proof in communication situations.

Level 4 (Autonomy): Finding a reason for a (mathematical) statement/conjecture, including the choice of the frame of reference, autonomously.

The four levels in a specific field

The Pythagorean Theorem is an example for a broad field for reasoning and proof with various possibilities to use a paper and pencil approach as well as technology. Applets like the one shown in Figure 1 (left) can engage students in reasoning tasks (Level 1) as well as explaining and arguing a proof (Level 3). Figure 1 (right) addresses Level 2.

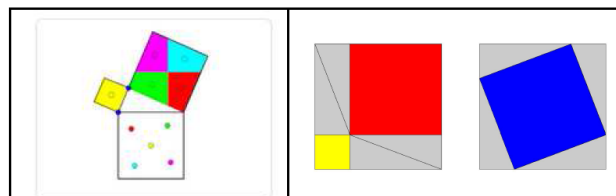


Figure 1: <http://tube.geogebra.org/student/b615817#>; Proof by Zhou bi suan jing

Here technology fosters the exploration and generation of conjectures.

The four levels across several grades

In grade 6 students explore triangles and construct particular points of a triangle. These points have in-

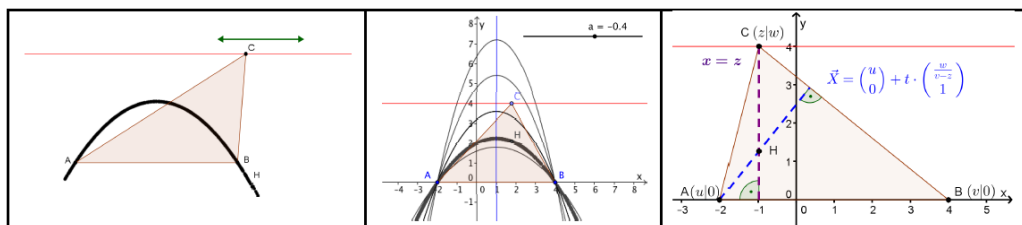


Figure 2: The trace of the orthocentre H and the embedded triangle ABC

interesting traces under certain conditions. The exploration of the shapes of these traces leads from Level 1 to Level 4 if one starts with the following task (Figure 2): Assume vertex C of triangle ABC moves on a line parallel to AB and observe the trace of the orthocentre H (Figure 2, left). In grade 6 on Level 1 students should explain why the trace of H always intersects the vertices A and B . Here technology helps to explore the phenomenon. In grade 9 and on Level 3 students should find a quadratic function that describes the trace of the orthocentre H , a parabola. Here a slider helps to find the fitting parameter of the function (Figure 2, middle). Also in grade 9 on Level 2 students should understand the analytic description of the trace of the orthocentre H . For that purpose the triangle is embedded in a coordinate system. Here technology helps to see that the movement of C is just a numerical variation of the coordinate z (Figure 2, right). After finishing these levels it is possible to reach Level 4. At this level students should find an analogous result for the circumcenter (low requirement) or the incircle (high requirement).

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