REASONING COMPETENCY AND THE LINK BETWEEN GEOGEBRA AND ORIGINAL MATHEMATICAL SOURCES

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This poster presents an in-progress PhD study concerning how middle school students (10 to 12 years old) can combine the study of original mathematical sources with a geometrical content and work within dynamic geometry environments in ways that support the development of their mathematical reasoning competency. The study focuses on the students' mathematical argumentations and proofs from an epistemic point of view when using digital tools.

Keywords: GeoGebra, original mathematical sources, reasoning competency and epistemic purpose

The mathematics education literature is rich on studies addressing the use of digital technologies (DT) as well as the use of historical, original sources in the teaching and learning of mathematics. Yet, the intersection between the two has rarely been described (exceptions are e.g. Chorlay, 2015; Kidron & Tall, 2015; Zengin, 2018). The PhD study concerns this intersection and will mainly use the dynamic geometric software in GeoGebra (GG) and a selection of Euclid's propositions. It emphasizes how students work with GG to support their mathematical learning and understanding of the general mathematical reasoning and deductive proofs in the original sources. The aim of the study is to design didactical guidelines for the potential interplay between original sources and GG as a means to support the development of students' mathematical reasoning competency.

Mathematical reasoning competency is defined according to the Danish competency KOM-framework (Niss & Højgaard, 2011). It concerns "knowing and understanding what a mathematical proof is and how this differs from other forms of mathematical reasoning" and it also "consists of the ability to devise and carry out informal and formal arguments (on the basis of intuition) and hereby transform heuristic reasoning to actual (valid) proofs" (p. 60).

Artigue (2002) distinguishes between DT serving a pragmatic and an epistemic value for the students. The PhD study focuses on how students can learn about this distinction and acknowledge whether they are working with GG in an epistemic way that supports their mathematical understanding or when they are using DT in pragmatic ways as an effective tool to solve a given task. Students are often convinced by empirical examples (EMS, 2011). When teaching primarily focuses on empirical examples, it can weaken students' learning of how to understand and perform general reasoning and proofs (Harel & Sowder, 2007). A predominantly pragmatic use of DT makes this situation worse (Jankvist & Misfeldt, 2015). Working with original sources is known to potentially support the students' development of mathematical competencies (Jankvist & Kjeldsen, 2011). Working with the interplay between GG and original sources may support students' understanding and reading of original sources and in the same time contribute to the students' using DT in both a pragmatic and epistemic way (Olsen & Thomsen, 2017).

The PhD study consists of three different parts:

1) A review of empirical research and theoretical constructs within the subfields of technology and history in mathematics education focusing on the reasoning competency. The aim is to consider potentials and challenges of using different types of original mathematical sources and choose appropriate original mathematical sources for the interplay with GG to support the students' development of mathematical reasoning.

2) A quantitative analysis of selected Danish mathematical textbook systems and topic-oriented web portals for 4th to 6th grade addressing how they set the stage for the students' work with GG to support their development of reasoning competency. This will provide insight into how the interplay between original sources and GG may qualify existing teaching materials.

3) New teaching approaches are developed and the connection between these and students' competency development and use of GG as an epistemic purpose are explored. This part of the project will follow a Design-Based Research approach, based on outcomes of 1 and 2 above, and complete three iterations in two different lower secondary classes. This will be the take-off for development of new theory and didactical guidelines. These guidelines will e.g. focus on 1) how to support students understanding, devising and phrasing of mathematical argumentations and proofs while working with the intersection between original sources and GG and 2) how to support students getting insight in "the nature of mathematics as a subject area" (Niss & Højgaard 2011, p. 27).

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