COMPUTATIONAL THINKING AND MATHEMATICAL THINKING: DIGITAL LITERACY IN MATHEMATICS CURRICULA

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In technology-rich mathematics education, teachers nowadays experience the challenge to foster both mathematical thinking and computational thinking. To address this issue, the main research question is: How can a teaching-learning strategy, focusing on the use of digital tools, support 16-17 years old pre-university students in developing computational thinking skills related to mathematical thinking in pure and applied mathematics courses?

Keywords: computational thinking, mathematical thinking, digital technology

INTRODUCTION

Mathematics teachers in the Netherlands are facing two different, though related, challenges: how to foster mathematical thinking (e.g., Drijvers, 2015), central in the new mathematics curricula, in their teaching, and how to include computational thinking (Wing, 2006), stressed in the informatics curricula, but also apparent in national educational policies such as the ongoing curriculum.nu reform. These challenges emerge in the context of the growing use of digital technology in mathematics education that goes beyond the regular graphing calculators and includes for example software for statistics and the very popular software GeoGebra for graphs, geometry and (computer) algebra.

When exploring the notions of computational and mathematical thinking in the frame of using digital technology, for example coding, several questions arise. First, how can the concepts involved be better defined and delimited? Previous research has investigated different facets of embedding computational thinking in mathematics education (Benakli, Kostadinov, Satyanarayana, & Singh, 2017; Barcelos, Munoz, Villarroel, Merino, & Silveira, 2018; Grover & Pea, 2013; Weintrop et al., 2016). However, the common core concepts involved in computational and mathematical thinking are still to be explored. Second, while interesting initiatives are undertaken to use programming to address the interface of informatics and mathematics at university level, theoretically and empirically validated practice-oriented approaches for secondary education are lacking. Consequently, the knowledge gap addressed in this study concerns the need to identify aspects of computational thinking that match with the notion of mathematical thinking and the need for theory-based concrete technology-rich learning activities that involve coding in an effective way in secondary mathematics education.

The main research question of our study is: How can a teaching-learning strategy, focusing on the use of digital tools, support 16-17 years old pre-university students in developing computational thinking skills related to mathematical thinking in pure and applied mathematics courses?

RESEARCH PLAN

As the research topic is innovative, and teaching materials are not available, we use a theory-informed design-based research setup to answer the research questions (Bakker & van Eerde, 2015). The study is carried out by a consortium, consisting of five schools, two universities and a curriculum development institute. The study's design includes four phases: (1) an inventory phase, (2) a first design cycle phase, (3) a second design cycle phase, and (4) a concluding phase. In the inventory phase, we aim to identify the common core aspects of computational thinking and mathematical thinking based on a literature study and a Delphi interview study. A pilot study is conducted this spring with a first trial of a learning activity about root finding algorithms. In the first design cycle, we will design and field test learning activities using digital tools in pure and applied mathematics courses. The second design cycle resembles the first one, but focuses more on the learning gains and will be applied in a larger scale. In the concluding phase, the results from the partial studies will be summarized into an answer to the main research question and into guidelines for teaching practice.

AIMED OUTCOMES

The project's results will include:

1. A literature-based, but practice-oriented identification of key elements of computational thinking that relate to mathematical thinking and are suitable to be addressed in technology-rich mathematics teaching to upper secondary pre-university education students;
2. A set of empirically validated learning activities for upper secondary pre-university education students in pure and applied mathematics courses that involve the use of sophisticated digital tools and address key aspects of computational and mathematical thinking;
3. A set of assessment instruments to assess the learning outcomes of the learning activities;
4. A guide for mathematics teachers who design or carry out learning activities targeting computational thinking and mathematical thinking using digital tools.

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Published in: 14th International Conference on Technology in Mathematics Teaching 2019

DOI: 10.17185/duepublico/70781
URN: urn:nbn:de:hbz:464-20191121-154755-8