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Programming in mathematics teacher education – a collaborative teaching approach

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The digitalization of modern society is having a major impact on schools and schooling, and in recent years, programming and algorithmic thinking is increasingly seen as topics to be included in curricula at all levels. In Sweden, for instance, the National Agency for Education have instigated a revision of the national curricula to emphasize what they denote as “digital competence” (Skolverket, 2017a, b). In particular, the mathematics curriculum now includes the use of algorithmic thinking and programming as tools for problem solving. Since these topics have not been a mandatory part of the education of mathematics teachers in Sweden, this creates a need for such courses aimed both at practicing and prospective teachers. Given the direction taken in the revised curriculum, these courses will need to take an integrated approach, focusing on how programming and algorithmic thinking can be used to learn mathematics and to solve mathematical problems. This places particular demands on the instructors teaching these courses. Not only do they need to have knowledge of programming, but also of mathematics and mathematics education. Most probably, courses in programming aimed at practicing mathematics teachers will attract teachers from all levels of the educational system, placing additional demands on the mathematical competence of the instructors. In the light of these challenges, we are considering the idea of collaborative, or team, teaching. Having mathematicians and/or mathematics educators collaborating with computer scientists can provide different viewpoints on the topics considered and problems posed in the course, thus serving to more closely connect the programming to the mathematics. Moreover, having two teachers in the classroom naturally leads to discussions, showing by example the type of questions experts pose when engaging with a topic, and hopefully fostering a classroom climate where students also engage in discussion. Before outlining the planned project, we sketch what team teaching is about, and exemplify how it has been used in university mathematics education.

Various forms of collaborative teaching are already used in schools, where teachers collaborate on course preparation, implementation, and assessment. There are several models for collaborative teaching (Friend, Cook, Hurley-Chamberlain & Shamberger, 2010, p. 12), ranging from “one teacher, one assistant” models, via parallel and alternative teaching through to team teaching proper, with two teachers in the classroom together, taking shared responsibility for content. The research literature on team teaching of mathematics at the university level mostly consists of case studies in the context of teacher education. For instance, Clarke and Kinuthia

(2009) describe a project where two lecturers collaborated on the planning of courses on mathematical methods and instructional technology, emphasising the cross-disciplinary character of the courses. However, one teacher for each course did the actual teaching. What we aim to do is slightly different. A team of instructors with backgrounds in mathematics/mathematics education and computer science will co-teach a course on programming in a mathematical context, sharing responsibility for content, planning and assessment. For part of the course, two teachers will lecture jointly, presenting and discussing content together, providing different perspectives on programming in school mathematics. For instance, in the context of probability theory, the computer scientist can show how to program simulations of probabilistic experiments, with the mathematician pointing out how the underlying mathematical ideas influence the design of the simulation. The mathematician can then go deeper into the mathematical theory, with the computer scientist highlighting the algorithmic aspects. In this way, we aim to provide students with opportunities to develop a deeper understanding of how to integrate programming and computational methods in their mathematics classes. The programming course is still in its planning stages, but we are currently piloting the team teaching approach in the context of a first-year calculus course within the engineering programs.

From a research perspective, taking a discursive view on learning (Sfard, 2008) we wish to investigate to what extent the team teaching might support students' active participation in mathematical and computational discourse. We are also interested in how the discourse of the students develops through participation in such a course, particularly concerning the interplay of mathematical and programming discourse. Furthermore, we view team teaching as having great potential for teacher development, with participating teachers being able to learn from one another as well as jointly developing innovative teaching practices.

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