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# **Development and evaluation of primary school students' mathematical competencies via dynamic online environments**

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Mathematical competencies (Niss & Højgaard, 2019) have been developed and implemented in the Danish curriculum through the last two decades. At the same time, online assignment portals have gained considerable ground in the Danish elementary school. Denmark's largest portal alone, matematikfessor.dk, has 75% of the Danish primary and lower secondary schools as regular subscribers, and an average of DKK 1.5 million assignments are answered daily (EduLab, 2021). When Denmark was locked down on March 11, 2020, the number of daily completed tasks rose to approximately 6,000,000. During the lockdown, the number of unique daily logins rose from approximately 45,000 to 130,000 (Elkjær & Jankvist, 2021). Assignments in such portals, however, are mainly used for training students' basic skills. In the Danish context, a report from 2016 concludes that as many as 78% of the tasks that students in Danish primary and lower secondary schools encounter in mathematics teaching can be categorized as training tasks (Bremholm, Hansen & Slot, 2016).

The purpose of this ongoing project is to investigate to what extent it is possible to develop tasks for online assignment portals, so that students in the intermediate stage of primary school have the opportunity to develop mathematical representation competency as defined by Niss and Højgaard (2019). The tasks are to be designed in a way that supports the teachers' formative assessment of their students' mathematical representation competency. As the portal works now, the teachers receive information about the number of correct responses provided by each student. In addition to these information's, the aim is to inform teachers of the level of competency for each of their students.

The methodology of design-based research (Cobb, Jackson & Sharpe 2017) is used for both continuous development and adaptation of the competency-oriented tasks. The tasks are to be designed in clusters in a way that allows for student learning, while the student's answers inform the assessment tool without the student taking an actual test. The assessment tool is formative (Black & William, 2009) as knowledge of the students' representation competency within fractions will both inform the further work in the online assignment portal and support the teacher's formative assessment through a description of the student's competency level in terms of radius of action, degree of coverage and technical level (Niss & Jensen, 2019). A minimum of three design iterations are expected to be completed during the project.

During the first iteration, development of competency-oriented tasks for online assignment portals will be based on findings from a systematic literature review regarding task design with a focus on online assignment portals and mathematical competencies, respectively. Existing knowledge of the interfaces of these areas must result in a framework for how competency-oriented tasks are to be designed for an online portal.

During the second iteration, coding categories for the assessment tool are identified based on three dimensions of possessing and developing a competency: degree of coverage; radius of action; and technical level (Niss & Højgaard, 2019). Degree of coverage regards the extent to which the various aspects are covered. A person who can both interpret and understand relations between different representations and has knowledge about information loss and gain when shifting between representations has a higher degree of coverage- than a person who can only do the first.

Radius of action is the spectrum of contexts and situations in which the competency can be activated. The degree to which the student is possessing representation competency is to be measured by the extent to which the student can solve tasks in routine and/or new situations; in relation to internal mathematical situations and/or application-oriented situations; use fractions in different situations. The technical level deals with conceptually and technically advanced conditions and tools the person can activate the competence towards. The student's responses are used to identify development opportunities so that the student's next set of tasks can help further development the competencies radius of action.

During the third iteration, both task design and the assessment tool will be tested on a larger number of students to further inform both the task design and the assessment tool.

*Matematikfessor.dk* makes their online assignment portal available for testing of tasks and evaluation tool.

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