MATHEMATICAL COMMUNICATION COMPETENCY IN INTERPLAY WITH DIGITAL TECHNOLOGIES

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An ongoing PhD-project examines the interplay between the mathematical communication competency and digital technologies. The project aims to describe the interplay theoretically using constructs from the field of mathematics education, including the Danish competency framework: KOM. To combine the theoretical constructs with mathematics education, networking of theories and design research are both applied.

Keywords: Networking of theories, communication competency, representation competency, design-based research, digital technologies.

This poster describes an ongoing PhD-project, which is a part of a larger study, including two other PhD-projects. The overall study aims to investigate the interplay between the use of digital technologies and mathematical competencies due to the increased focus of both digital technologies and mathematical competencies in mathematics education (Trouche, Drijvers, Gueudet & Sacristán, 201; Niss & Højgaard, 2019). The KOM-framework is an analytical tool describing mathematical activity and defines mathematical competency as "someone's insightful readiness to act appropriately in response to *a specific sort* of mathematical *challenge* in given situations" (Niss & Højgaard, 2019, p. 14). KOM consists of eight mathematical competencies, among them: the communication competency. This PhD-project focuses mainly on the interplay between students' communication competency and their use of GeoGebra in lower secondary schools in Denmark. Then, the research question for the ongoing PhD project is: *What is the interplay between students' (aged 14-16) mathematical communication competency and their use of GeoGebra?*

The communication competency concerns the interpretation of others' mathematical expressions and one's ability to express oneself. According to KOM, mathematical expressions include "written, oral, visual or gestural […], in different genres, styles, and registers, and at different levels of conceptual, theoretical and technical precision" (Niss & Højgaard, 2019, p. 17). Several perspectives on language and communication exist within the field of mathematics education. However, Sfard's (2008) *commognition* seems to include more aspects of the communication competency than a construct that only focuses on language. In Sfard (2008), communication is defined as "a rule-driven activity in that discursants' actions and re-actions arise from certain well-established repertoires of options and are matched with one another in a nonaccidental patterned way" (p. 146). Furthermore, it is word use, visual mediators, narratives, and routines that define a mathematical discourse. A mathematical discourse differentiates from colloquial discourses in its access to objects (Sfard, 2008). The objects in mathematics are only accessible by different representations in mathematics (Duval, 2017). As stated in KOM, being able to communicate mathematically involves using different representations and registers. The use of representations in communication means that a special relationship between the communication competency and the representation competency exists. The representation competency both concerns the ability to interpret, translate, and move between representations (Niss & Højgaard, 2019). Mathematical representations belong to different semiotic registers, e.g., natural language, symbolic systems, or graphic illustrations. Further, according to Duval (2017), it is not the use of the particular representations, which is essential but the transformation between them in mathematical activities. In this PhD project, commognition is utilised to analyse and assess students' communication competence and their ability to communicate within a mathematical discourse using different representations. However, Sfard (2008) does not concern the use of digital technologies and how it influences on students' mathematical communication. The project must also include perspectives on digital technologies because of the explicit focus on GeoGebra. A theoretical contribution to the use of digital technologies could be instrumental genesis, which describes how an artefact transforms into an instrument in a problem-solving activity. When an artefact is an instrument for a student, a reorganisation of a problem-solving activity happens (Guin & Trouche, 1998).

To investigate the interplay between GeoGebra and the communication competency in lower secondary schools, Networking of Theories and Design Research act together. Design research has both a practical and a theoretical aim (Barab & Squire). In three iterations, students' uses of GeoGebra and the communication competency are investigated. The content is functions, and teaching activities involve several problem-solving activities with multiple representations. These elements are fundamental in the preparation phase and the development of hypothetical learning trajectories (Bakker, 2018). A framework is developed based on existing research and theories from the field of mathematics education. Hopefully, the strategies from networking of theories are brought into play when theoretical perspectives are developed to describe the interplay. The goal of networking is to reach the strategy *integrating locally* in which a small number of theoretical perspectives are integrated and put together. In order to create a thorough framework, the theoretical contributions must be analysed with focus on compatibility and complementariness (Prediger, Bikner-Ahsbahs, & Arzarrello, 2008).

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