Mathematical Knowledge Requirements for Learning Activity Design Supported by ICT

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Introduction

As part of an ongoing project in a lower secondary school related to the teaching and learning of mathematics supported by Information and Communication Technologies (ICT), I am currently engaged in the collaborative design of a specific mathematical learning activity with a focus on algebra. In this project, I work together with three mathematics teachers, following the methodology of co-design (Roschelle, Penuel, & Shechtman, 2006). One reason for using this approach is the need for combining expertise in the areas of mathematics, pedagogy and especially technology.

Initial discussions with the teachers have resulted in the need to highlight the mathematical knowledge needed by teachers for their participation and contribution to this specific project. We specifically address the following research question: *What mathematical knowledge is required of a teacher in order to participate in the co-design of a mathematical learning activity supported by ICT?*

Theoretical background

As a theoretical framework I have used the MKT model (Figure 1), which provides a categorisation of Mathematical Knowledge for Teaching (Ball, Thames, & Phelps, 2008). This model does not explicitly address the issue of using ICT in mathematics teaching. Thus I have integrated elements from the framework for Technological Pedagogical Content Knowledge (TPCK: Koehler & Mishra, 2008). The MKT model and the TPCK framework are both based on Schulman's notion of PCK and address complementary issues of knowledge needed for teaching mathematics.

CCK: Common Content Knowledge
HCK: Horizon Content Knowledge
SCK: Specialized Content Knowledge
KCS: Knowledge of Content and Students
KCT: Knowledge of Content and Teaching
KCC: Knowledge of Content and Curriculum

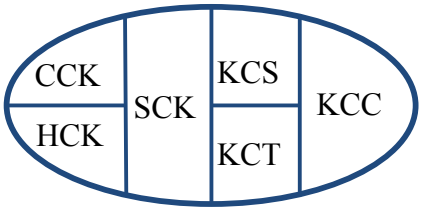

Figure 1: The MKT model

The TPCK framework focuses on knowledge about the affordances and constraints of technologies (Koehler & Mishra, 2008). Within the subject domain of mathematics, we specifically needed to consider affordances for representation and communication (Hegedus & Moreno-Armella, 2009). Technologies provide representational affordances for multiple and multi-modal representations, simulations, manipulation of data, and conversions of representations (Koehler & Mishra, 2008). They also provide affordances for communication, which may be regarded primarily as an issue within Specialized Content Knowledge (SCK) (Potari, Zachariades, Christou, & Pitta-Pantazi, 2008).

Preliminary results and analysis

Parts of a specific conversation with one of the teachers concerned the students' inability to make sense of the distributive law. The teacher was asked to explain how the equality could be justified. The only explanation the teacher could provide was an instruction, illustrated by arrows, how to manipulate and "move" the a in the expression $a\,(b + c)$ onto b and c and thus forming the expression $ab + ac$. Furthermore, the three teachers seemed to favour certain representations before others, and their choice of representations seemed to be based on individual taste rather than mathematical considerations.

The theoretical background emphasizes the role of representations. With this in mind, the preliminary results imply that teachers' mathematical knowledge requirement would be to consider and be able to judge and compare the didactical value of various representations in order to move forward and explore the affordances for representations provided by ICT. In this case I see a need for competence development of the SCK in terms of mathematical representations.

References

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