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Aspects of teachers' analysing competence in the domain of DPaCK – Digitality-related requirements and vignette-based approaches

For the mathematics classroom, the notion of digitality implies more than the use of digital tools for solving mathematical problems. Over the last ten years a majority of mathematics education publications has mainly focused on the use of digital tools and software-based learning environments (cf. e.g. MEDA proceedings), whereas challenges related to digitality – in particular as far as mathematics teacher expertise is concerned – have been acknowledged to a lesser extent. Similarly, the TPaCK model by Koehler, Mishra and Cain (2013, Fig. 1) mainly concentrates on components of technology-related professional knowledge. The model is based on Shulman (1986) and shows professional knowledge areas in the form of intersecting sets, combining technological knowledge with pedagogical knowledge, content matter knowledge, and PCK (pedagogical content knowledge).

Huwer and colleagues (2019) argue that the limited focus on specific aspects of technology-related knowledge does not sufficiently take into account key demands resulting from digitality for STEM classrooms. A key feature of the notion of digitality is the interplay of digitally mediated and non-digitally mediated realities, an interplay in which both can be merged (cf. Huwer et al., 2019). Phenomena linked with digitality such as referentiality, community, and algorithmicity (Stalder, 2016, 2018) highlight demands for STEM classrooms and teachers' professional knowledge beyond technology-related aspects. For referentiality, the construction of a mostly digitally mediated sphere of experiences with a dense network of interrelated units of meaning is in the foreground, which impacts on the individual perception of reality. Such perceptions of reality are often shared in communities, whose members may reinforce the selective construction of meaning and reality, which contribute to the self-definition of the corresponding community. Such processes are also facilitated by algorithms which select information according to assumed interests of the users of digital tools or environments – the notion of algorithmicity hence points to the role of digital mediation for triggering information made selectively available to individuals. Consequently, as digitality can impact on the individual perception of reality, such phenomena need to be considered in the context of teaching and learning, both of these being embedded in reality as well.

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Corresponding demands for mathematics teachers' expertise arise – beyond the consideration of technology only.

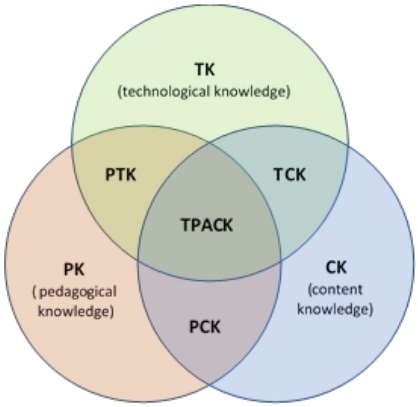

Fig. 1: TPaCK model
(Koehler, Mishra & Cain, 2013)

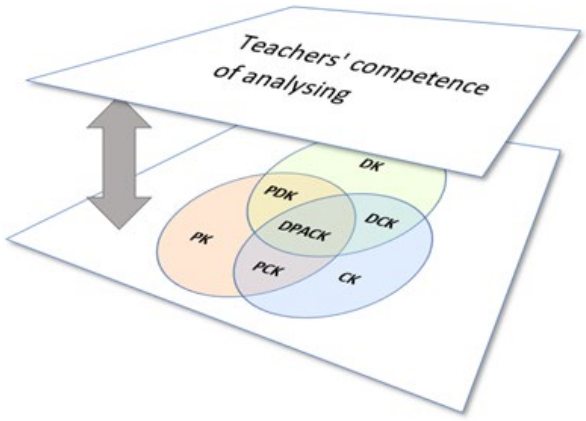

Fig. 2: Teachers' competence of analysing based on (in particular digitality-related) professional knowledge

However, the professional requirements arising from digitality for mathematics teachers are diverse. The DPaCK model suggested by Huwer and colleagues (2019, Fig. 2) provides a rough orientation. This model not only concentrates on professional knowledge, but on aspects of the teachers' competence in knowledge-based analysis. Against the background of rapid changes related to digital innovations and subsequent developments in society, it is particularly meaningful for teachers' expertise that they are competent in constantly revising their own professional knowledge, so that they are able to analyse new digital tools as well as digitality-related phenomena in a criteria-based and critical way. The teachers' digitality-related analysis hence draws on components of their professional knowledge and can also impact on professional knowledge development (more detail information is provided in Huwer et al., 2019, such as digitality-related examples of analysis questions). The need of teachers' digitality-related analysis can be meaningfully illustrated by classroom situations represented in vignettes.

Approaching aspects of teachers' analysis through vignettes

Vignettes showing classroom or learning situations are representations of practice (Buchbinder & Kuntze, 2018) which afford eliciting teachers' knowledge-based analysis. Vignettes can be used as a stimulus for professional learning, and they can be used for research into teachers' competence of analysing (e.g. Kuntze & Friesen, 2016; Kuntze, Dreher & Friesen, 2015). The project coReflect@maths (co-funded by the EU, see also below for further information) focuses both on vignette-based opportunities for professional learning and vignette-based research. Figure 3 shows a vignette from the project with an analysis question designed to involve several components of digitality-related professional

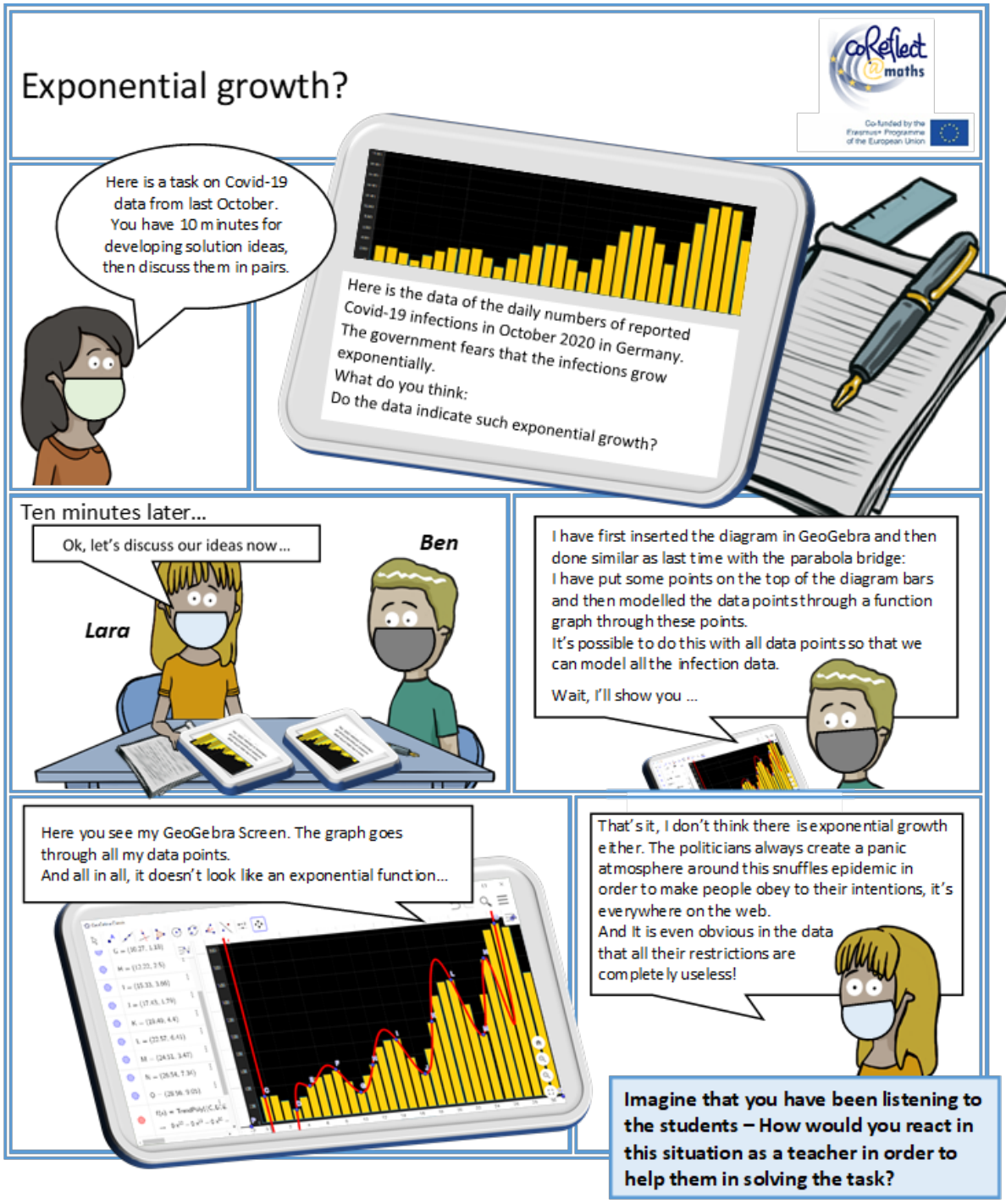

Fig. 3: Vignette with analysis question

knowledge. The students are asked to solve a task with modelling requirements on the base of a set of data. Ben reports on his attempt of solving the task by an interpolation tool, an approach which rather does not correspond to the modelling question (for checking for exponential growth, the (weekly) variation in the data has to be dealt with, e.g. by considering week sums). To help Ben, technology-related professional knowledge can be considered as key, as a response can focus on how to use digital tools productively for finding a solution.

The comment of Lara however suggests that the views blocking her problem-oriented thinking may stem from a digitality-related social phenomenon probably rooted in self-reinforcing online communities who have developed negative views related to rationally and reflectively dealing with the given data and its context. For providing help to Lara, technology-related professional knowledge only is clearly not sufficient.

Although this single vignette example cannot cover all possible professional knowledge components in the DPaCK model and all corresponding analysis requirements, both the theoretical model and the vignette point to the need of further examining digitality-related challenges teachers will have to face in the mathematics classroom. The vignette also shows how representations of practice may elicit teachers' digitality-related analysis through stimuli for connecting classroom situations with relevant professional knowledge.

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