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Digital support for proving arithmetic relationships - insights from the DigiMal.nrw project

Annika Raßbach¹, Kira Karras², Daniel Walter², Marcus Nührenböcker¹ and Karina Höveler²

¹TU Dortmund University, Faculty of Mathematics, Dortmund, Germany; annika.rassbach@tu-dortmund.de; marcus.nuehrenboeger@tu-dortmund.de

²University of Münster, Faculty of Mathematics and Computer Science, Germany; kira.karras@uni-muenster.de; daniel.walter@uni-muenster.de; hoeveler@uni-muenster.de

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Theoretical Background

The proof of arithmetical relationships is a mathematical content that causes difficulties especially for pre-service primary school teachers (Kempen & Biehler, 2019). They often encounter typical difficulties when carrying out proofs, formal transformation errors in terms as one example (Moore, 2016). In addition, pre-service teachers have problems when changing representations and showing completeness or generality (Kempen & Biehler, 2019).

To counter these difficulties targeted measures are needed to support pre-service teachers in constructing proofs. Besides analogue support, digital support may be helpful since it offers further specific potentials: For example, automated product-oriented feedback, as well as informative feedback, are possible (Hattie & Timperley, 2007). Furthermore, the synchronicity of presentations offers a high subject-specific didactic potential (Ainsworth, 1999). The production of explanatory videos may positively affect knowledge acquisition (Fiorella & Mayer, 2014), since they offer pre-service teachers to try out their future teacher role as an ‘explainer’, and their digital competencies can be promoted (Feurstein, 2017). As digital support in the context of proving is currently not widespread (Stylianides & Stylianides, 2017), this development project aims at creating and evaluating digital support materials for proving elementary statements on number theory. The findings are taken into account in the development of support options.

The project DigiMal.nrw and its subproject ‘Arithmetics’

The project DigiMal.nrw (eng.: digital mathematics teacher training) aims at improving the quality of leading mathematics courses in pre-service teacher training (focus on primary schools and special education) with the help of digitally supported measures. In addition to teaching-related challenges, the project addresses the core contents of elementary school mathematics. As part of the DigiMal.nrw sub-project ‘Arithmetics’, corresponding teaching-learning opportunities in digital self-checks, and video-based learning environments for developing and working with explanatory videos are being developed and evaluated at the University of Münster and the TU Dortmund University.

The poster focuses on the following two questions: (1) How do pre-service teachers develop their mathematical and didactical knowledge of proof when working with video-based learning environments? (2) How do they perceive the subject-related feedback in the digital self-checks on the topic of proof?

Two first prototypes and their evaluation

On one hand, a video-based learning environment is being developed. Pre-service teachers prove the statement ‘The sum of two consecutive square numbers is always odd’ and deal with fictitious incomplete proofs. To deepen their knowledge, they create explanatory videos for ‘fictitious pre-service teachers of the first semester’. The pre-service teachers analyse and reflect on their videos produced. They receive feedback from fellow students and lecturers. On the other hand, digital self-checks are being developed. They address the typical difficulties in proving. With the help of drag-and-drop tools, pre-service teachers deal with term transformations and their legitimation. Besides, pre-service teachers are given the task of deciding which formal and iconic representations fit a verbally given expression in different task formats. After completing the interactive elements, they receive automated feedback and have the opportunity to get further explanations via videos and texts.

The prototypes of the first survey cycle were evaluated with questionnaires due to their suitability for a large number of participants (Bortz & Döring, 2016). The evaluation of the video-based learning environment showed that pre-service teachers engaged more intensively with proofs and their explanations (RQ1). The evaluation data for the self-checks point to the effectiveness of the digital learning opportunities, especially since the majority of students rated their learning gains as ‘high’ or ‘rather high’ and indicated that the informative feedback supported their understanding of the content (RQ2). Based on the evaluation, the prototypes will be further developed.

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