



HAL
open science

How and why facilitators adapt the core ideas of professional development activities on dividing natural numbers

Victoria Shure, Bettina Roesken-Winter, Birte Pöhler, Esther Wensing

► To cite this version:

Victoria Shure, Bettina Roesken-Winter, Birte Pöhler, Esther Wensing. How and why facilitators adapt the core ideas of professional development activities on dividing natural numbers. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Alfréd Rényi Institute of Mathematics; Eötvös Loránd University of Budapest, Jul 2023, Budapest, Hungary. hal-04420743

HAL Id: hal-04420743

<https://hal.science/hal-04420743>

Submitted on 26 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

How and why facilitators adapt the core ideas of professional development activities on dividing natural numbers

Victoria Shure¹, Bettina Roesken-Winter¹, Birte Pöhler² and Esther Wensing³

¹Humboldt-Universität zu Berlin, Germany; victoria.shure@hu-berlin.de

²Potsdam Universität, Germany

³University of Cologne, Germany

Research has highlighted the importance of facilitator expertise for ensuring the quality of professional development (PD) programs. The manner in which facilitators plan and adapt PD, however, can impact the content of PD. We present the adaptations to a PD on dividing natural numbers by a tandem of facilitators and the resulting consequences to the PD. By omitting certain PD activities and creating new PD activities, the tandem changed the mathematical core of the PD by shifting the focus away from connecting the unitizing language of division to the partitive and quotative division interpretations and different means of representing division. Data from an interview with the facilitators highlight the tandem's awareness of both students' and teachers' difficulties with understanding the interpretations of division and thus provides insights into the tandem's justifications for the adaptations.

Keywords: PD facilitator, PD activities, adaptations, division, conceptual understanding.

Introduction

Innovations in mathematics education can only reach the classroom through scaling-up professional development (PD) on essential aspects for mathematics teachers. Thereby, the quality of PD is dependent on the preparation of facilitators of PD and the resulting expertise that they develop to lead PD and adapt PD materials. The German Center for Mathematics Teacher Education (DZLM), in which context this study is located, pursues three strategies: a material, a personnel, and a systemic strategy (Roesken-Winter et al. 2021). The personnel strategy encompasses preparing PD facilitators for conducting PD sessions. Particularly, the creation of a research base to inform this strategy is at the center of the DZLM's work. In this study, we thus focus on facilitator adaptations to teacher PD materials and activities. In addition, we focus on the facilitators' justifications for adaptations, to not only examine the changes to the PD but also why the facilitators considered certain changes necessary. In the following, we first review the research literature related to facilitator adaptations and present adaptation practices. Second, we elaborate on essential aspects of facilitators' expertise, specifically regarding preparing and conducting PD on dividing natural numbers. We then investigate the adaptations of a pair of facilitators, the consequences of their adaptations to the PD, and the pair's justifications for their adaptations.

Theoretical framework

Facilitators' adaptations

In recent years, some studies provided information on essential aspects when preparing facilitators to use and adapt PD material. Specified PD programs not only provide PD facilitators with slides that

can be used in a PD course, but offer also information on, for instance, teachers' learning goals and learning pathways, and the role of the activities used during the PD for teachers (Karsenty et al., 2023). Nevertheless, PD for teachers is never one size fits all, but needs to take participating teachers' pre-requisites in terms of their knowledge, beliefs, and their needs into account. Keeping the necessity of adaptations in mind, Jacobs et al. (2017) stress that at least the core activities and learning goals of the original PD should be stated very clearly (for the facilitators) to allow for productive adaptations, while maintaining the core of the PD. Otherwise facilitators' adaptations risk not supporting teachers to engage in rich discussions and to connect the PD activities to the targeted PD content (Roesken-Winter et al., 2021). For such modifications, Leufer et al. (2019) analyzed and revealed several categories for characterizing facilitators' adaptation practices for PD.

FOLLOW, e.g., following one thematic block of the material as originally designed; OMIT, e.g., omitting a certain activity or thematic block; MODIFY, e.g., modifying a module, which always implies other adaptation actions on the material elements of which the module consists (one module can consist of several thematic blocks); SORT, e.g., modifying a module by resorting its thematic blocks into a new order; CREATE, i.e., developing a new activity within a thematic block. (p. 4)

Categorizing PD facilitators' adaptations by the aforementioned FOMSC scheme allows for a better understanding of the quality of facilitators' adaptations.

Facilitators' expertise

Research concerning facilitators of PD for mathematics teachers, particularly for specific PD content, is still an emerging field, with facilitators' expertise having been shown to be central for the quality of PD programs (Borko et al., 2011). Existing frameworks for investigating and conceptualizing facilitators' expertise have been lifted from the teacher level to the facilitator level (Prediger et al., 2019), for instance, the ROG model to the ROGI framework (Karsenty et al., 2022). Prediger et al. (2022) also took a framework for teacher expertise (Prediger, 2019) as starting point for a framework for content-related facilitator expertise, combining a cognitive and situated perspective (as suggested for example by Borko et al., 2014). The framework contains jobs as typical and often complex situational demands of facilitating specific PD content, and practices as recurring patterns of facilitators' utterances and actions for handling the jobs. Facilitators' practices can be specified by underlying categories, pedagogical tools, orientations, and situative goals. For this paper, the categories in terms of the knowledge that filters and focuses the categorial perception and thinking of the facilitator play a central role. This includes content knowledge on the PD-level (CK-PD), comprising the following knowledge areas (Figure 1): Generic pedagogical knowledge on the classroom level (GPK-C), pedagogical content knowledge on the classroom level (PCK-C, for example about students' mathematics learning; see oval in Figure 1) and content knowledge on the classroom level (CK-C, sophisticated understanding of the relevant mathematical concepts).

Aims and research questions

In order to analyze the facilitators' adaptation practices for dealing with the jobs of preparing, conducting and reflecting upon the PD activities on dividing natural numbers, we pursued the following research questions:

RQ1: a) What adaptations processes concerning PD activities regarding the mathematical core are visible for dividing natural numbers? b) What are the consequences of adapting the PD activities regarding the mathematical core of dividing natural numbers?

RQ2: What justifications are provided for the adaptations of the PD activities regarding the mathematical core of dividing natural numbers?

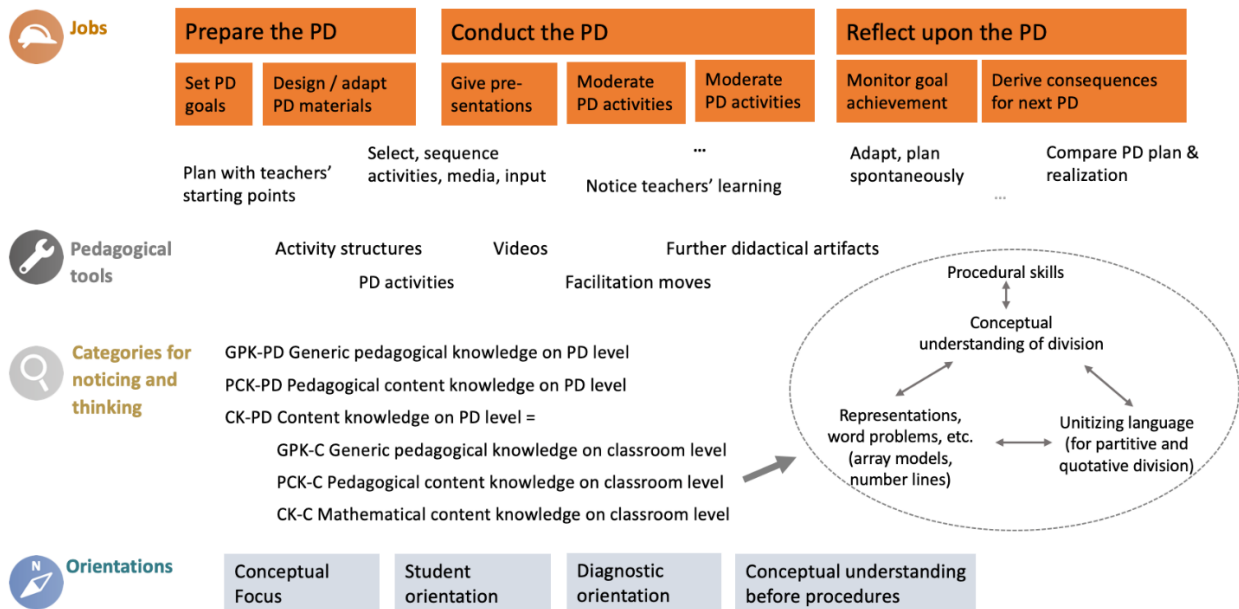


Figure 1: Facilitator expertise with categories for noticing and thinking specified for CK-PD related to core ideas on dividing natural numbers.

Methodology

Context, participants, and PD activities

The participating PD facilitators led PD in the *Mastering Math* program, which aims to support and promote mathematics teachers' expertise for fostering students' understanding of basic concepts. The group of PD facilitators ($n = 14$), who are also practicing teachers, were prepared over the course of a year with regard to the *Mastering Math* program. In pairs, they were provided with PD materials, including PowerPoint slides and activities with accompanying commentaries regarding the didactical goals of the activities, which, in rotation, one facilitator pair first adapted and then discussed with their colleagues. Thereafter, each pair further adapted the materials prior to conducting the PD. In the study at hand, we draw on data from one pair of facilitators, Tracy and Emily, who conducted the PD together on conceptual understanding of division. The *Mastering Math* program contains PD activities that were designed to enable teachers to learn to better promote student communication and increase conceptual understanding, allowing students to construct meaning behind procedures (Prediger et al., 2019). The following PD activities were originally developed by the PD designers for a session on developing understanding of the mathematical core ideas for multiplying and dividing natural numbers.

An activity titled “Multiplication and division movement game” (Figure 2) provides the teachers with the opportunity to practice unitizing through movement around the PD room, as students would in the classroom. This activity allows teachers to think about one of the mathematical core ideas of the PD, namely the unitizing structure in each type of situation, and develop a deeper conceptual understanding of unitizing in different situations, considering what represents the pre-determined unit and the quantity that is being measured in the different situations. In such quotative division situations, the number of students in each group represents the unit while in partitive division situations, the size of the group is unknown (Greer, 1992). Teachers could also consider the connections to multiplication, particularly the many-to-one correspondence (with a certain number of students in one group) and the number of groups being established (groups of a certain number).

After participating in and discussing the results of the “Multiplication and division movement game” on the classroom level, the teachers would participate in a version of the activity on the PD level to analyze the didactical potential of the game and formulate discussion points to support the development of students’ conceptual understanding of these operations. Thereby, they consider the importance of counting in groups (unitizing) and the language that accompanies the different situations and discuss the situation of dividing the group of students into a certain number of groups and what happens when the students are divided into groups with a certain number of students, thus focusing on the classroom-level pedagogical content knowledge (PCK-C).

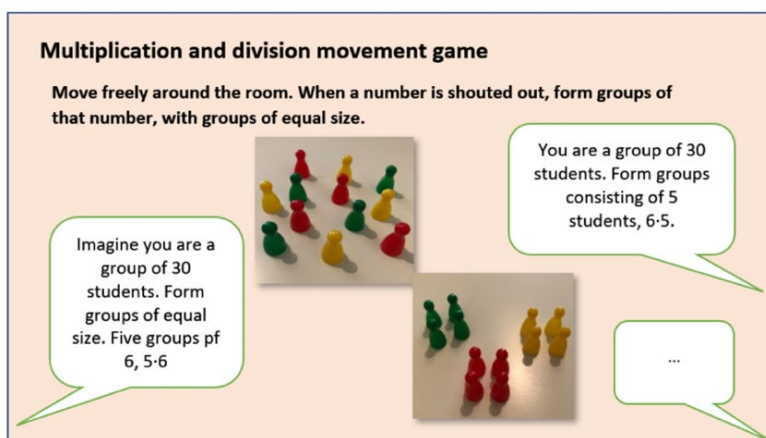


Figure 2: Multiplication and division movement game.

The subsequent activity “Engaging in the bus stop” was conceptualized to enable teachers to deepen their understanding of how to connect different representations and make connections between multiplication and division tasks in relation to unitizing. The activity consisted of two different tasks concerning the formation of groups: either 24 children should be divided into 12 groups, or 24 children should be divided into groups of 12. Each task requires a) a visual representation, b) an explanation of how the groups can be formed, and, c) corresponding arithmetic problems. The teachers would be provided with a worksheet with these two tasks and engage in a bus stop activity. In doing so, the teachers would each complete one of the tasks, then find a partner who completed the other task and present and compare their tasks with each other. In the reflection of the activity, the teachers would have the opportunity to deepen their understanding of the verbalizations for each type of task and the discussion points that pursue the main idea of unitizing in relation to the operations.

Data collection and analysis

The PD session was video recorded and the resulting video data were transcribed. To capture facilitators' justifications for adaptations of the given PD material, each video-recorded PD session was triangulated using a video-based debriefing session during which the pair of facilitators discussed the PD with a member of the research team. These debriefing sessions were also transcribed. The transcription of the PD session was used in conjunction with a comparison of the original and adapted versions of the PD slides to consider the adaptations that were undertaken as well to illuminate how the facilitators led the PD using their PD adaptation. Analysis of the adaptations was informed by the FOMSC framework (Leufer et al., 2019). The analysis to answer research questions 1b and 2 was based on the categories for thinking and noticing from the facilitator expertise framework (Prediger et al., 2022). Consensual intercoder agreement (Creswell, 2014) was achieved in the research team in discussion of the coding of the data.

Results

Adaptation processes

In response to the first research question concerning the adaptation processes regarding the PD activities for dividing natural numbers, the analysis of the video data and different versions of the PD slides highlighted that Tracy and Emily's emphasis on the PCK-C shifted to a focus mainly on the partitive and quotative interpretations of division. In both of the adaptations of the PD activities, the bus stop activity and the reflection of the bus stop activity were omitted and the multiplication and division movement game was omitted in adaptation 2. In adaptation 1, the group of facilitators developed the PD activity "Getting to know partitive and quotative division" and then Tracy and Emily (adaptation 2) developed "Differentiating the basic concepts of division," with both activities emphasizing the two interpretations of division. Figure 3 below provides a visualization of the changes that resulted in the first adaptation of the PD activities that the group of facilitators developed (adaptation 1) as well as Tracy and Emily's version of the PD (adaptation 2).

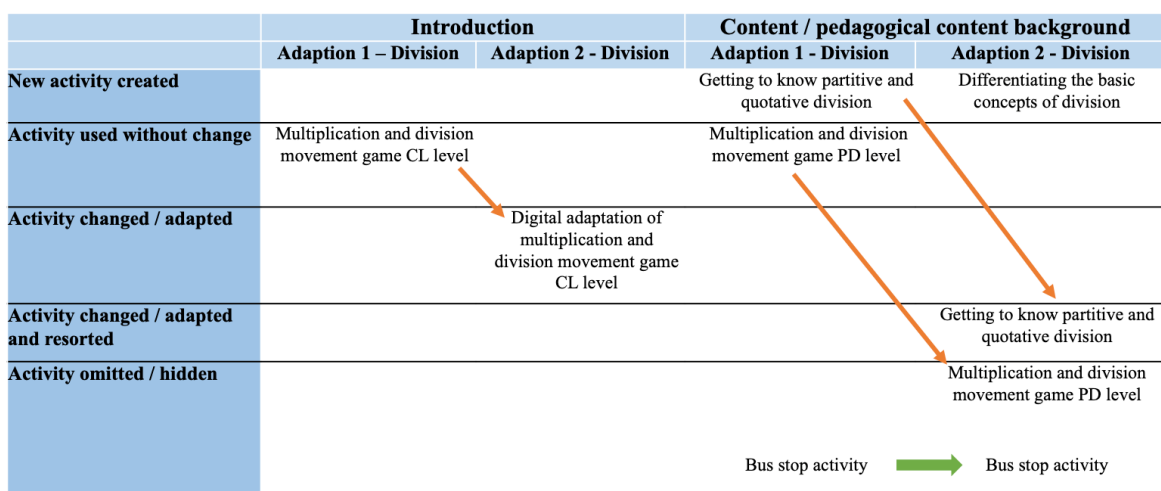


Figure 3: Adaptation processes of the PD activities (orange arrows for changes).

With the omission of the reflection of the movement game (PD level), the teachers participating in the PD no longer had the opportunity to reflect on the didactical potential and possible discussion

points they could utilize with students. As a result of these changes, the teachers did not engage in a discussion considering the basic concepts of division that are supported by playing the game and how these basic concepts can be incorporated and reinforced in instruction through language. With the omission of this PD activity, the original PCK-C emphasis concerning developing students' language related to unitizing was no longer the main focus of the PD. Instead, in the "Getting to know partitive and quotative division" activity that was added in the first adaptation to the PD, the teachers worked in small groups to complete a worksheet on getting to know partitive and quotative division. The worksheet included a table comprising of three different representations: one visual, one arithmetic problem, and one word problem. Thereafter, the teachers were supposed to work in pairs or small groups and compare their results. The activity was followed by "Differentiating the basic concepts of division" (from adaptation 2), in which the teachers were requested to identify different tasks as either examples of partitive or quotative division and match the task accordingly to the correct conceptualization of division (using an online learning application). Examples of tasks included: "At a camping ground, there are 36 children. There are 4 children sleeping in each tent" and "Charleen invited 6 children to her birthday part. She baked 22 cupcakes." This shift in PD focus predominantly reflected a change in the PCK-C concerning the two interpretations of division, first as Tracy led the teachers in the digital adaptation of the movement game. When a teacher used the term "unitizing" in relation to a situation in the game, Tracy and Emily moved the discussion back to the partitive and quotative interpretations of division, with Tracy underlining the importance of the two interpretations:

Tracy: Quotative division, yes exactly! Here we have the second interpretation. We have the – the partitive division and quotative division, which we are quite often not so aware of in everyday life, but which is very important for mathematics."

While Tracy stressed the importance of the two interpretations of division for mathematics, a discussion specifically about what is important, however, is not initiated, nor are the interpretations connected to the unitizing language for division and the comment the teacher made during the game. This emphasis on the two interpretations of division is further evident at a later point in the PD, with the introduction of the newly-created activity, "Getting to know partitive and quotative division." When showing the slide of the activity, Tracy expressed how challenging the two interpretations of division can be: "Yes, but here we are exactly at the point that is really not easy to distinguish [partitive from quotative division] and that even as adults it is sometimes very difficult for us and that is why we have thought about the next work phase for you." In the ensuing and also newly-created PD activity, "Differentiating the basic concepts of division," this change in focus of the PD is also apparent in the subsequent reflection discussion of the activity:

Tracy: Good, so how was it? Was, was it difficult? How did you find the learning app? Some short feedback would be great.

Teacher 1: The app is good. But somehow, we are all fairly tired. We've had quite a discussion, is it partitive or quotative division?

Emily: That is not easy.

Teacher 1: But it was fun.

Teacher 2: I can echo that. We couldn't figure out [...] what exactly that was due to, our existing [knowledge], or whether it's really so complicated with partitive and quotative division. But in any case, we were confused.

Emily: Both.

- Tracy: It's a combination of both. And um, so to speak, that's what you tried earlier [...] I've also always tried to do both, so to speak, to one, to one type of task and I think that also makes it a bit more difficult. So practically doing partitive and quotative division with one situation...
- Emily: And as I said, just do the movement game in class. Already there you will notice that it's totally difficult for you linguistically.

The discussion about the newly-created PD activity reflects the change in emphasis of the PD regarding PCK-C. The PD participants are asked about their experience using the learning app and the discussion surrounding their feedback centres on the interpretations themselves and not about the aspects related to incorporating the unitizing language about these interpretations in instruction.

Explanation for adaptations

In terms of the second research question concerning the facilitators' justification of the adaptations, the debriefing session illuminated what the facilitators emphasized in the PD session and why. In the following excerpt, Tracy provides justifications for the focus on the division interpretations:

- Tracy: ...we placed more emphasis on partitive and quotative division than perhaps was actually intended, but basically, I myself have had the experience, when I was not yet so aware of it, that I always wondered why the children don't understand what I want from them. And since I have this as a background, so to speak, and then practice specifically, um, that is, I think that is, um, so, that is also easier for the children, because they then know better what I want from them and um, and um, one has also said with the participants in the feedback, yes, 1, 2, yes, that was not yet so conscious for them...And as I said, so these are often those who have not studied math, I have even studied math and with me it has never played a role in my studies. And somehow, as I said, I used to sit there quite often and think, why don't [students] understand what I want from them. And it wasn't until I was confident in my math skills that I really became aware of this. And that's why I think it's important to place a bit more emphasis on this and to do it...

Thus, Tracy's justification for the emphasis on two division interpretations is, in part, her teaching experiences, in which students struggled in understanding the interpretations, as well as experiences with teachers in PD who also did not have an awareness of the interpretations. Tracy also displays an understanding that generalist primary teachers who may not have a background in mathematics may have difficulties with the interpretations, as she herself took time to develop an awareness of what makes understanding partitive versus quotative division situations challenging.

Discussion and conclusion

In focusing almost entirely on the PCK-C concerning the partitive and quotative interpretations of division and not emphasizing the PCK-C concerning the unitizing language related to these two interpretations and how to enable students to develop the language related to unitizing, the PD's emphasis shifted fundamentally away from its original design. While the development of PCK-C concerning these interpretations is also an essential part of instruction, the original focus of the PD PCK-C concerning the unitizing language was gone. The transcript of the PD served to further underline this shift and the accompanying consequences. As the scaling up of PD is essential for reaching more teachers, an increasing number of facilitators will need to be prepared to lead PD. An important aspect of this preparation thereby includes explicit discussions of the implications of PD

adaptations with facilitators, as highlighted by this study, and specifically, the potentially resulting changes to the emphasized PCK-C when such adaptations are undertaken.

Acknowledgment

The research was conducted within the German Center of Mathematics Teacher Education (DZLM), which is a common endeavour of the Leibniz Institute for Science and Mathematics Education (IPN), Humboldt-Universität zu Berlin, and other university partners and is funded by Leibniz Association.

References

- Borko, H., Koellner, K., Jacobs, J., & Seago, N. (2011). Using video representations of teaching in practice-based professional development programs. *ZDM Mathematics Education*, 43(1), 175–187. <https://doi.org/10.1007/s11858-010-0302-5>
- Borko, H., Koellner, K., & Jacobs, J. (2014). Examining novice teacher leaders facilitation of mathematics professional development. *Journal of Mathematical Behavior*, 33, 149–167.
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative and mixed methods approaches* (4th. Ed.). Sage.
- Greer, B. (1992). Multiplication and division as models of situations. In D.A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 276–295). Macmillan.
- Jacobs, J., Seago, N., & Koellner, K. (2017). Preparing facilitators to use and adapt mathematics professional development materials productively. *International Journal of STEM Education*, 4(1), no page numbers. <https://doi.org/10.1186/s40594-017-0089-9>
- Karsenty, R., Pöhler, B., Schwartz, G., Prediger, S., & Arcavi, A. (2023). Processes of decision-making by mathematics PD facilitators: The role of resources, orientations, goals, and identities. *Journal of Mathematics Teacher Education*, 26(1), 27–51. <https://doi.org/10.1007/s10857-021-09518-z>
- Leufer, N., Prediger, S., Mahns, P., & Kortenkamp, U. (2019). Facilitators' adaptation practices of curriculum material resources for professional development courses. *International Journal of STEM Education*, 6(24), 1–18. <https://doi.org/10.1186/s40594-019-0177-0>
- Prediger, S., Roesken-Winter, B., Stahnke, R. & Pöhler, B. (2022). Conceptualizing content-related PD facilitator expertise. *Journal of Mathematics Teacher Education*, 25(4), 403–428. <https://doi.org/10.1007/s10857-021-09497-1>
- Prediger, S. (2019). Promoting and investigating teachers' pathways towards expertise for language-responsive mathematics teaching. *Mathematics Education Research Journal*, 31(4), 367–392. <https://doi.org/10.1007/s13394-019-00258-1>
- Prediger, S., Roesken-Winter, B. & Leuders, T. (2019). Which research can support PD facilitators? Research strategies in the three-tetrahedron model for content-related PD research. *Journal of Mathematics Teacher Education*, 22(4), 407–425. <https://doi.org/10.1007/s10857-019-09434-3>
- Roesken-Winter, B., Stahnke, R., Prediger, S. & Gasteiger, H. (2021). Towards a research base for implementation strategies addressing mathematics teachers and facilitators. *ZDM – Mathematics Education*, 53(5), 1007–1019. <https://doi.org/10.1007/s11858-021-01220-x>