Intertwining theory and practice: Design of planning phases in PD training to support effective teacher planning processes

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Professional development (PD) represents an opportunity to enhance teaching quality and transfer innovations throughout the school system. For this, PD must meet certain quality criteria, such as intertwining theory and practice. In this study, a practical phase lies between two PD training sessions, and a 30-minute planning phase is embedded within the PD training itself. This study aims to investigate how the design of the planning phase can facilitate teachers' planning actions. In an explorative study, 11 groups (N=28) of teachers were observed and videotaped. The interviews were transcribed and categorized by applying qualitative content analysis. First results indicate that substantial planning includes interlinked quality criteria of good (mathematics) teaching and an explanation of actions. Also, not every group of teachers seems to achieve complete and finalised planning due to several framework conditions. Thus, the design of the phase requires adaptation.

Keywords: Professional development, facilitators, planning phase, mathematics, primary school.

Introduction and Theoretical Background

Professional development (PD) in tertiary education is an important part of enhancing the quality of teaching. PD allows addressing the constant change and evolvement of schooling conditions (Fussangel et al., 2016). These changes are reflected in, for example, new curricula, digital media, and new didactic findings. To encounter these changes and design and plan effective lessons, both general didactic and specialized didactic quality criteria for good (mathematics) teaching were developed. General didactic criteria include mainly organizational and methodological aspects, which may be applied to every subject (Meyer, 2018). These include, among others, the proportion of learning time, clarity of content, competence orientation, variety of methods, and promotion of meaningful communication by proper tasks. In addition, subject-specific didactic content must also be included when planning good mathematics lessons. Prediger et al. (2022) have identified five quality criteria for this and point out that lessons should be designed with a *conceptual focus* and a *cognitive demand*, be planned considering *longitudinal coherence*, take into account students' heterogeneity, and, thus, allow *adaptivity* to the learners' level of knowledge, and enhance content-specific *communication* between the students.

Teachers should be constantly trained to meet these standards for high-quality mathematics teaching. PD is one way to do so. To ensure the effectiveness of PD training, several quality criteria have been developed based on various studies (Barzel & Selter, 2015; Desimone & Garet, 2015; Lipowsky, 2020). All researchers agree on the following four criteria of effective PD training (Knaudt et al., 2023), although naming them differently: (1) learning in professional learning communities and stimulation of cooperation, (2) intertwining of theory and practice, (3) experiencing the effect of one's actions, (4) case reference and participant orientation. Also, PD training should be designed for the long term and enable coaching and feedback, guide understanding of the profession, focus on students' competencies, and enable input (Darling-Hammond et al., 2017; Desimone & Garet, 2015).

It is important to note that when applying these criteria, they should be combined to provide effectiveness and not be understood as standalone measures (Sims & Fletcher-Wood, 2021). One way to address these different criteria and integrate them into PD training is to incorporate a practical phase between PD training sessions and embed a 30-minute planning phase within the PD training itself (Knaudt et al., 2023). Yet, in current research, it remains open how a planning phase should be structured and how concrete tasks should be designed for the effective planning of lessons.

A previous study analyzed the content of planning phases and its qualitative impact on the design of the phase. Knaudt et al. (2023) found that a planning phase was mainly used to review the material and then to focus on ‘what to teach’ rather than ‘how to teach’. It was also observed that during the planning phase, the teachers pursued different aims depending on the compositions of the teacher teams. For instance, the practical phase can be implemented directly in one's lessons if the teachers have their class or it must first be transferred to colleagues, if not. The authors recommended changes in the design of the planning phase. However, it remained open whether or not these changes led to effective or purposeful planning of mathematics lessons.

Research and Design Questions

This design-based study builds on these previous findings by addressing the new design of the planning phase and by investigating whether or not a certain structure or task leads to effective planning. It aims to investigate whether the design of the planning phase is conducive to the objective or whether other elements should be changed. This leads to the following questions:

- Research question: To what extent do teachers plan a practical phase purposefully with the tasks and material provided to them in the planning phase of the PD training?
- Design question: How should the design of the planning phase be adapted to best support teachers in planning and implementing the practical phase in the classroom?

Design of the Study

This study was conducted within the broader project ‘School makes strong’ ['Schule macht stark']. One aim of this project is to foster the basic mathematical competencies of primary school students by developing and carrying out various PD training modules. One module covers the basic numeracy skills of third- and fourth-graders. Each module consists of six training sessions, and in between are inserted a practical phase, transfer to the teaching staff, and digital self-study modules (Figure 1).

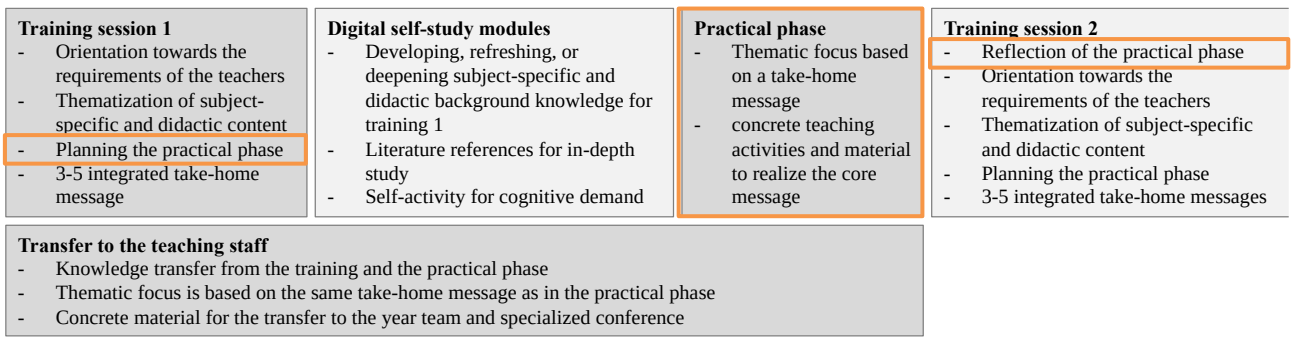

Figure 1: Professional development series and its elements

During the **planning phase**, the practical phase should be planned for implementation in the class. The practical phase includes an activity that can be integrated into any mathematics lesson. This ensures that the activity can still be implemented independently of the series of lessons, and the teachers are supported in their knowledge acquisition. Therefore, this phase fulfils certain features:

- Take-Home Message (THM, core content in one sentence): The practical phase relevant for this study deals with analogies of place values promoting the THM 'I promote a material-based understanding of analogies of place values through action-prompting activities'.
- Mathematical content: Analogies of place values mean that the simple task 3+4 also helps with supposedly difficult tasks such as 30+40 or 3000+4000.
- Mathematical activity: The activity includes a ritualized initial game in which students are required to solve a challenging task with the assistance of a relatively straightforward one. They may draw upon the analogy of place values in doing so. (Figure 2).
- Material package: All material relevant to the THM is bundled in a material package, which includes a mathematical activity, language support, further tasks, digital and haptic materials.

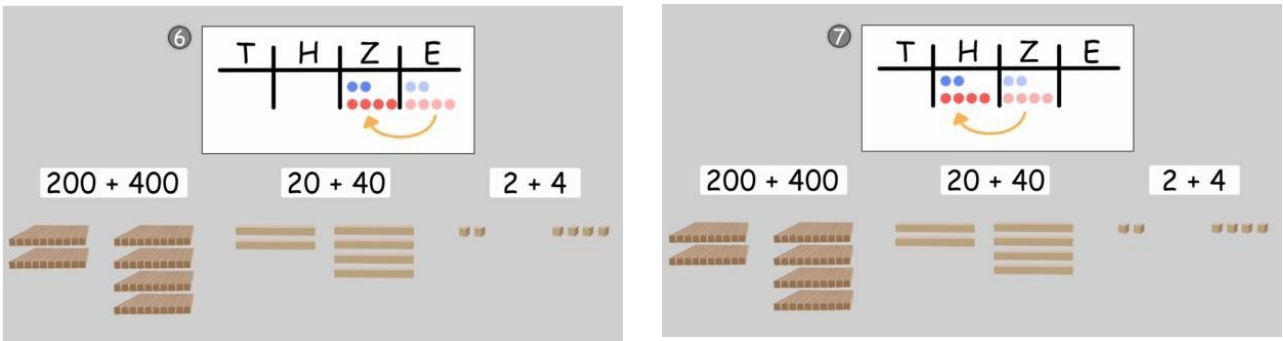

Figure 2: Approach with a place-value chart and the Dienes-material

The planning phase follows a certain **design structure**. It is 30 minutes long and embedded at the end of each training session. This phase aims to implement the practical phase in a lesson the next day without the need to start the planning process anew. The teachers may choose their objective: (1) plan the implementation of the activity from the practical phase for their class, or (2) plan the transfer of material to the teaching staff. It is necessary to address these different objectives in the planning phase due to the considerable heterogeneity of the participating teachers. Independent of their chosen objective, they can (1) gain an overview of the material package, (2) use a focused planning instruction to plan its implementation (e.g., 'If not all of the prerequisites (e.g. tenfold) have been met, how should this be addressed? What specific forms of support are provided during difficulties (stimuli, materials, etc.)? How is linguistic support provided to the children when using analogies?', and (3) clarify questions.

Data Collection

The data of this study was collected and analyzed in the second of two cycles. 11 planning phases with two to four teachers in a group (total of 28 teachers) were observed and videotaped (Figure 3). Each group consisted of teachers from one teaching staff; hence, they were not mixed. Each planning phase lasted between 20 and 30 minutes (a total of 280 minutes) and was fully transcribed.

Additionally, the facilitators (N=4) who led PD training sessions were interviewed guideline-based about the practical and the planning phases. Those interviews were videotaped and fully transcribed.

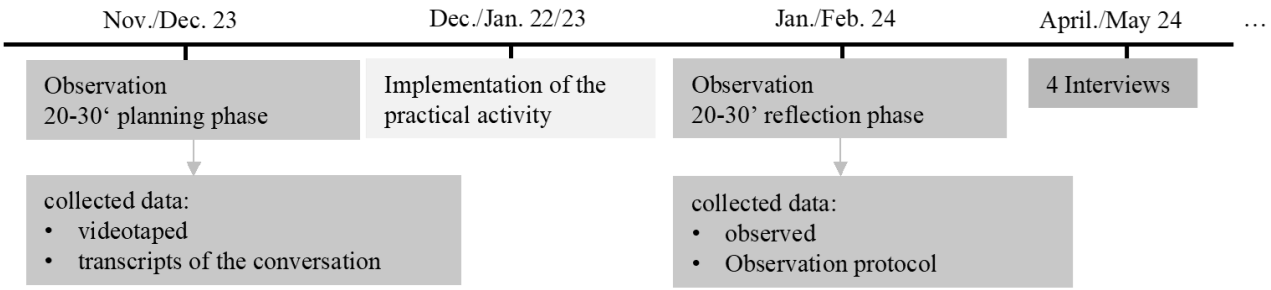

Figure 3: Timeline of the data collection in the second cycle

Data Analysis

All transcripts were analyzed using a coding system (Table 1) (Knaudt et al., 2023). This system is based on deductive codes of effective (mathematics) teaching (see C1 and C2) and inductive codes generated through the observation of the planning phases (see C0 and C3) (Kuckartz & Rädiker, 2020). Applying these categories and their subcategories to the provided data allows for categorizing and analyzing all teachers' statements. After that, all coding of each planning phase was illustrated within progress plans (Figure 4), which show in which order and at which point in the conversation the statements were coded. This way, those diagrams provide an overview of the data and allow investigations into the interconnectedness of the coded categories and their relative frequency to each other.

Table 1: Overview of categories

Category	Description	Example
C0: No planning	Statements that did not result in planning	‘I had forgotten again that someone was listening to us.’ (Teacher C, transcript 27)
C1: Planning good teaching	This includes all planning statements that were made on a general didactic level.	‘Or you make groups of four, that they do such a group work and then …' (Teacher B, transcript 40)
C2: Planning good mathematics teaching	Statements that refer specifically to the planning of mathematics lessons.	‘… Some children may see the balloons, some may see, well, everyone has a different focus.’ (Teacher A, transcript 25)
C3: Framing planning actions	Statements that framing the planning actions, like overview the material package.	‘Oh no, open the planning grid first.’ (Teacher B, transcript 4)

Results

A review of the data revealed three research findings that have a significant impact on the design.

Research Results

Figure 4 exemplifies four of the 11 progress plans and shows typical distributions of the categories. Some groups (Team I) planned in terms of general didactics (C1), subject didactics (C2), and framing (C3) during the planning phase. Others (Team III) concentrated on planning good (mathematics) teaching (C1 or C2), while others (Team II and IV) focused on framing planning actions (C3).

Figure 4: Progress plan of planning actions of four in-service mathematics teacher groups

Addressing the transfer to the teaching staff within the planning phase is used meaningfully. Following the results of the previous study, the transfer was included in the planning phase. It has now been confirmed that this design change is a beneficial addition. Analyzing the progression diagrams, frequent coding of framing planning activities (C3) is revealed. For example, Team II focused on transferring the material to the teaching staff. Due to unknown reasons, they cannot carry out the activity by themselves. Instead, they must pass on the content and consider how this is best realized (C3, light berry). Within the planning phase, discussions are then held on the content level (C2). For example, the teachers talk about specific actions and tasks for the children (line 72). Also, they included the organizational level (C1), talking about the presentation to their teaching staff (line 57) by distributing the take-home message and the corresponding material package.

57	Person 1:	Present the slides. Alternatively, print out individual ones [reads out]. But we can throw that on the wall. That would now be the first slide you throw on the wall, say: "The take-home message", So what's it about?
72	Person 1:	Exactly, then first, actually, with this visualization. The one becomes a ten, and the colleagues then also guess, 'Let the children lay it out, the small task and then the big task'

Planning good teaching (C1) and planning good mathematics teaching (C2) are mutually interlinked and result in a substantial planning phase. Comparing the four teams, the categories for effective teaching (C1) and those specific to mathematics teaching (C2) occur throughout the planning phase, indicating interlinked planning actions of the teachers. However, their frequency varies. Both categories alternate or can be double-coded. If a teacher's statement can be double-coded, the focus is on 'how to teach'. The double-coding provides a more detailed explanation of the implementation process. For example, in line 111 (Team II), the teacher's objective is to adopt a long-term perspective on understanding (C2) and, at the same time, to promote this through a structured activity (C1). In line 112, the conceptual focus ("building understanding") and longitudinal coherence ("regular practice") in good mathematical teaching are emphasized. Thus, the double coding continues. The categories for good teaching are interlinked with those for good mathematics teaching.

111	Person 2:	Yes, and as I said, with the children, it is also more likely that you repeat this two to three times every day.
112	Person 1:	A ritualised introduction, actually, nh? Building understanding is not about, I'm going to do this once anyway, but about regular practice. And then initially without bundling and unbundling, right? Because thirteen plus eight or something (Person 2: or eight plus five) is difficult.

In contrast, the following statement (line 30) is coded in only one category. The teacher considered the levels of knowledge (C2) based on the heterogeneity of the students. However, it remains unclear how the activity could be adapted to address this. The planning would be richer if the teacher interlinked the thought of adaptivity (C2).

30	Person 2:	So, my fear now is that if I only do it [the activity] with tiles, the children won't understand it.

Statements that allow double-coding show more substantial planning actions than the ones that can only be coded with one category.

Prevailing circumstances determine the extent to which the planning phase can be completed in a meaningful and aim-oriented way. Due to several reasons, some teams do not consider the practical phase and the *corresponding* planning phase as meaningful. The progression diagram of Team IV reveals a high frequency of framing planning activities (C3, dark berry). Yet, their emphasis is different from Team II. They have already covered the content in class, do not see a need in the activity given, and instead use the planning phase to report on previous experiences. Thus, they focus on sharing experiences (Team IV, line 31) and not on planning the activity.

31	Person 2:	I had the same thing today in my fourth year at school. There were tasks where the aim was to do clever maths, i.e. to use strategies. And then there were always tasks like plus 599, and the children then really had to calculate plus 600 and minus one. And then I took out the Dienes-material again to lay it out.

Furthermore, in interviews with the facilitators, they reported several factors that prevent teachers from engaging in those planning activities. For instance, only single teachers are present at the PD training session instead of the entire team. They also report on materials that are missing or not available for their class, e.g., mathematics textbooks. Further, they mention that the timing of school content does not always match the timing of our PD training sessions. If the content is covered too early or too late in the PD training, the activity cannot be planned properly. The current objective of

the planning phase is to plan an activity for one's lessons in 30 minutes to be implemented on the next day. The facilitators' interviews indicate that a planning phase can only be effective with a more flexible objective. Possibly, the effectiveness of the planning phase is higher when planning is initiated within a PD training but finished within a school team.

Design Result

The three research results prompted the redesign of the planning phase. First, based on the positive results of the transfer, the transfer to the teaching staff should be planned by all teams and not offered as an alternative objective. Hence, the planning phase is divided into two 15-minute slots to plan the transfer to the teaching staff and to plan the practical phase. Second, the focus of the planning phase should be on planning good (mathematics) teaching. Therefore, general didactic criteria for effective teaching and subject-specific didactic criteria for effective mathematics teaching should be directly addressed within the planning process. To achieve this, the task within the phase is formulated more precisely, and the focus is directed towards one of the five quality criteria of good mathematics teaching. Third, the high frequency of framing planning activities (C3) enriched with the facilitators' report resulted in a modification of the timeframe from 30 minutes to 15 minutes. The mathematical activity is integrated into an activation phase within the PD training session, which allows addressing initial questions promptly. This way, teachers may start content planning immediately. The planning phase itself is limited to 15 minutes, and the objectives of the planning phase are more flexible concerning the timing of when to carry out the practical phase or the transfer to the teaching staff. This way, the planning is not finalized within the PD training, but the implementation of the activity is initiated. In sum, with these design changes in the planning phase, teachers should be enabled to use the planning phase meaningfully and aim-oriented for themselves without perceiving it as unnecessary.

Discussion and Conclusion

Considering the generalizability of the findings in this study, two main limitations should be taken into account. The results are specific to the mathematical content and structure of the PD training in the broader project. Also, only a small number of teachers participated in this study. Nonetheless, the results of the current study hold implications for future research and teacher education.

The aim of this study was (1) to gain a profound understanding of planning actions undertaken by teachers during a planning phase integrated into a PD training program and (2) to ascertain how the structure of this phase can facilitate the planning process. Studies have already shown that the connection between theory and practice is important (Barzel & Selter, 2015; Desimone & Garet, 2015; Lipowsky, 2020), which can be confirmed by our results. The results of this study indicate that a high connection between planning good teaching (C1) and planning good mathematics teaching (C2) leads to rich planning actions. Yet, a simple existence of the planning phase to provide an opportunity to connect theory and practice (Darling-Hammond et al., 2017; Lipowsky, 2020) is not sufficient. Instead, the planning phase needs to be integrated into a regular activity within PD training. Also, the participants' needs concerning their school curriculum and other circumstances should be considered. A flexible but obligatory way of planning has to be found. Based on the research findings of this study, the design of the task, structure, and timeframe of the planning phase were modified.

Future research should ascertain whether these modifications lead to better planning actions. Additionally, it would be of interest to observe the implementation of the practice phase after planning to identify factors to support teachers during the planning phases. In this study, integrated planning phases of practical phases exemplify the implementation and purposefulness of the quality criterion 'intertwining theory and practice' of effective PD programmes by demonstrating qualitative insights. It remains open whether this leads to a transfer of PD content into the teacher's lessons and whether the results can be transferred to other PD concepts and content.

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References

Barzel, B., & Selter, C. (2015). Die DZLM-Gestaltungsprinzipien für Fortbildungen [The DZLM design principles for training courses]. *Journal Für Mathematik-Didaktik*, *36*(2), 259–284. https://doi.org/10.1007/s13138-015-0076-y

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute. https://doi.org/10.54300/122.311

Desimone, L. M., & Garet, M. S. (2015). Best practices in teachers' professional development in the United States. *Psychology, Society and Education*, *7*(3), 252–263.

Fussangel, K., Rürup, M., & Gräsel, C. (2016). Lehrerfortbildung als Unterstützungssystem [professional development as a support system]. In H. Altrichter & K. Maag Merki (Eds.), *Handbuch Neue Steuerung im Schulsystem 7* (pp. 361–384). Springer VS. https://doi.org/10.1007/978-3-531-18942-0_13

Knaudt, K., Herold-Blasius, R., & Selter, C. (2023). Teachers' interactions in the joint planning of a teaching experiment. In P. Drijvers, C. Csapodi, H. Palmér, K. Gosztonyi, & Kónya, E. (Eds.), *Proceedings of CERME13* (pp. 3411–3418). Alfréd Rényi Institute of Mathematics and ERME. https://hal.science/hal-04421621v1

Kuckartz, U. & Rädiker, S. (2020). *Qualitative content analysis: Methods, practice and software*. (2nd ed.). Sage.

Lipowsky, F. (2020). Merkmale wirksamer Fortbildungen [Characteristics of effective training]. *Pädagogik*, *8*, 51–55. https://doi.org/10.3262/PAED2008051

Meyer, H. (2018). *Was ist guter Unterricht? 13. Aufl.* [What is good teaching? 13th ed.]. Cornelsen.

Prediger, S., Götze, D., Holzäpfel, L., Rösken-Winter, B., & Selter, C. (2022). Five principles for high-quality mathematics teaching: Combining normative, epistemological, empirical, and pragmatic perspectives for specifying the content of professional development. *Frontiers in Education*, *7*, 1–15. https://doi.org/10.3389/feduc.2022.969212

Sims, S., & Fletcher-Wood, H. (2021). Identifying the characteristics of effective teacher professional development: A critical review. *School Effectiveness and School Improvement*, *32*(1), 47–63. https://doi.org/10.1080/09243453.2020.1772841