Bardy, T., Gorrengourt, S., Holzäpfel, L., Barzel, B., & Prediger, S. (2023). Learning to integrate reflections on the classroom level and teacher professional development level: A step in novice facilitators' growth In P. Drijvers, C. Csapodi, H. Palmér, K. Gosztonyi, & E. Kónya (Eds.), *Proceedings of the Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13)* (pp. 4750–4757). ERME / HAL.

Learning to integrate reflections on the classroom level and teacher professional development level: A step in novice facilitators' growth

Thomas Bardy[1,2], Silvan Gorrengourt[1,2], Lars Holzäpfel[1,2], Bärbel Barzel[1,3] and Susanne Prediger[1,4]

[1]DZLM network–German Center for Mathematics Teacher Education, Berlin, Germany

[2]University of Education, Freiburg, Germany; lars.holzaepfel@ph-freiburg.de

[3]University Duisburg-Essen, Germany

[4]IPN Leibniz Institute for Science and Mathematics Education, Berlin, Germany

When experienced mathematics teachers enter preparation programs to become facilitators of mathematics teacher professional development (TPD), many of them mainly reflect on their own classroom practices. Thus, extending their reflections towards teachers' learning on the TPD level has been described as important, so it was focused in our design research study on our one-year facilitator preparation program. In a qualitative analysis, we investigate the changes of 18 novice facilitators' reflective focus (on classroom and TPD level) by comparing two small group discussions in the beginning and the end of the preparation program. The analysis reveals that facilitators can be supported by structured series of activities to shift their reflective focus from the classroom level to the TPD level, and over a year, develop familiarity to integrate both levels in one reflection.

Keywords: Novice facilitators, teacher professional development, facilitator preparation.

Introduction

In many countries, novice mathematics teacher educators are recruited among experienced mathematics teachers, with more or less structured preparation for the new role and a crucial transition to be mastered.

> As experienced, accomplished teachers they have many skills and much knowledge about teaching. However, when these experienced teachers become […teacher educators], they become novices again—an experience that can be uncomfortable and often confusing to navigate. Understanding this critical transition is important for facilitating the development and support of effective […teacher educators] (Chval et al., 2010, pp. 192–193).

The transition was empirically investigated for different groups of mathematics teacher educators, e.g., for mathematics coaches by Chval et al. (2010), for university educators by Dinkelman et al. (2006), and for facilitators who lead TPD by Schwarts et al. (2023), the latter is our target group as well. All three studies provide first indications that a successful transition does not leave classroom teaching experiences completely behind. This transition results in expert teacher educators who integrate reflections on the classroom and the TPD level. We contribute to this body of research by investigating the following research questions in a design research study for facilitator professional development (FPD):

How can novice facilitators extend and integrate their focus of reflection in an FPD program by carefully structured sequences of FPD activities (RQ1), and over time by gaining experience with reflection on two levels at the same time (RQ2)?

Theoretical background: Transition from mathematics teachers to facilitators

Nested complexity on the classroom level, the TPD level, and the FPD level

Teachers' planning and reflections for classroom instruction have often been characterized in instructional triangles or tetrahedrons that relate the classroom mathematical content to students and teachers as well as classroom resources (e.g., Cohen et al., 2003). Analogically, facilitators' planning and reflections can be characterized in a lifted instructional triangle (Zaslavsky & Leikin, 2004) or a tetrahedron that relates analogical components, now with teachers as learners and facilitators as instructors. The Three-Tetrahedron Model in Figure 1 (Prediger et al., 2019) indicates that there is a second relation between the classroom and the TPD level, besides the structural analogy: The classroom tetrahedron in its whole complexity is nested within the TPD content, so that critical aspects of the classroom tetrahedron need to be unpacked in TPD. Analogically, the FPD level can be captured by a tetrahedron, and research on FPD should comprise also the unpacking of the FPD content.

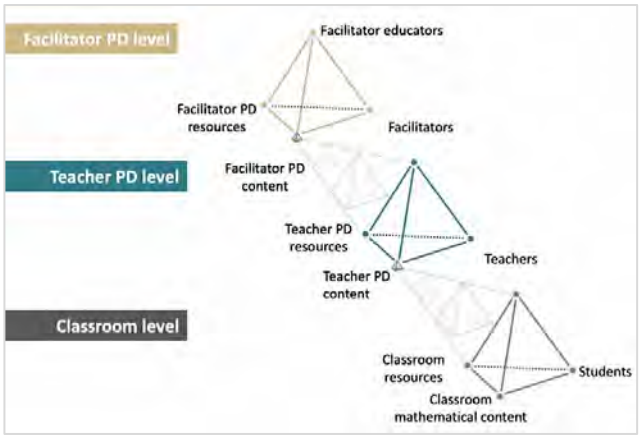

Figure 1: Three-Tetrahedron Model for capturing complexities on three levels (Prediger et al., 2019)

Goals of FPD programs: Developing facilitator expertise to plan and reflect TPD

One central goal of FPD programs is to enable novice facilitators to successfully plan and implement TPD sessions, drawing upon reflections on general design features of effective TPD programs (Yoon et al., 2007), and on critical aspects of the TPD content in view. This requires facilitators' deep knowledge about the TPD content (content knowledge on the classroom level and pedagogical content knowledge on the classroom level), but also pedagogical content knowledge on the TPD level (here abbreviated PCK-PD). Researchers continue to strive for characterizing the PCK-PD in more detail (e.g., Borko et al., 2014; Lesseig et al., 2017; Zaslavsky & Leikin, 2004).

Transition of identities, reflective focus, and necessary connections of levels

Dinkelman et al. (2006), Chval et al. (2010), and Wilhelm et al. (2019) have disentangled challenges in the transition from mathematics teachers to mathematics teacher educators. Chval et al. (2010) locate these challenges in initially strong teacher identities, Wilhelm et al. (2019) describe how the focus on own teaching experiences on the classroom level first hindered the facilitators from thinking about other teachers' thinking and learning. In these studies, the novice teacher educators successively learned to reflect also about the TPD tetrahedron, in particular about teachers' learning

of the TPD content and the potentials of TPD resources for promoting it. All three studies characterize the necessary transition not as a complete shift of focus to the TPD level, but as a growth by extending the focus, and they describe in general terms that teacher educators successively learn to integrate their reflections on both tetrahedrons. But so far, the modes of integrations were not described in detail, partially because the research focus was more on identities than on the reflective focus itself.

In their study of novice facilitators in their first year of TPD facilitation, Schwarts et al. (2023) refine this idea by identifying three different modes in which facilitators reported to draw on their classroom teaching experiences for facilitating TPD: (I) enacting a familiar classroom routine on the TPD level, (II) delimitating the classroom level from the TPD level by (II.1) naming substantial differences or (II.2) questioning the relevance of a routine for the TPD level, and (III) importing classroom aspects into new TPD routines (e.g., by illustrating arguments with the classroom level). These modes inspired our work for another occasion, analyzing and reflecting TPD activities which we trace in a longitudinal perspective throughout an FPD program.

Methods

Research context: DZLM design research for FPD programs

The presented study is conducted within the DZLM, the German Center for Mathematics Teacher Education, and its joint research agenda (Prediger et al., 2019). It is part of an ongoing design research project on the FPD level that combines two goals, (a) designing and successively optimizing an FPD program for novice TPD facilitators, and (b) investigating the initiated processes of facilitators' professional growth to identify conditions for content-related design features. The current study was motivated by the practical problem that in earlier FPD design experiment cycles, we found that future facilitators often stayed exclusively on the classroom level reflecting their own teaching experiences, although FPD activities tried to engage them in reflecting on other teachers' learning on the TPD level. As this hinders the facilitators to exploit learning opportunities on the TPD level (Wilhelm et al., 2019), we wanted to redesign our FPD activities to overcome the challenge and to understand better the complexities of learning to integrate reflections on two levels. As the practical problem resonated with the state of research on transition processes, we chose this focus for the current study.

Redesigned FPD activities in the one-year facilitator preparation program

We situated our design research study in a one-year DZLM facilitator preparation program that prepares future facilitators for later working in different TPD programs within 60 working hours. Due to pandemic closures, the FPD program was conducted online in four basic modules (each module comprised 10 hours of synchronous work and about 3 hours of asynchronous work in own studies or practical experiments) and elective modules (of 6 hours each) and the practical experience of experimenting with one TPD session in a face-to-face setting. In all FPD materials and activities, the addressed classroom level, TPD level, and FPD level were always explicitly marked in standardized colour codes to support the clarity of expectations. Additionally, the sequence of activities was carefully chosen to scaffold participants' reflections integrating the classroom and TPD level. We investigated the outcome of such a series in Session 1 of Module 1 (Thurm et al., 2023), in which the FPD participants (1a) worked independently on a textbook task (classroom activity), (1b) discussed a classroom video of two students' learning processes while solving the task with a digital tool (TPD

activity to reflect upon classroom processes), and (1c) reflected on a potential TPD activity to engage teachers in a simulated discussion about how to continue after the scene in the video (FPD activity with a focus on teacher learning). After that, (1d) the participants were invited to discuss in small groups: "Discuss the potential of such a three-step activity for our main TPD goals. How would you use (and adapt, if you want) the three-step sequence of activities in a TPD program?" By the long preparation in (1a)–(1c), we hoped to scaffold facilitators' integrated reflection on the classroom and the TPD level. Between Module 3 and 4, groups of three participants (4a) planned and (4b) conducted their own three-hour PD session; in the last session, they were invited to (4c) reflect on it with three other participants who observed their TPD session, with two open questions: "What has positively attracted your attention in the conducted/observed TPD session? Which open question (e.g., about 'sticking points') would you now like to discuss together?".

Methods of data gathering

In order to pursue the research questions RQ1 and RQ2, we investigated the collective reflection processes initiated by the redesigned FPD activities in the beginning and the end of the one-year FPD program, in Activity 1d (from the first PD session) and Activity 4c (from one of the last PD sessions). We focused small-group discussions because they allow for spontaneous statements and flexible action, they are hence a good way to capture collective reflections. The sample of these FPD design experiments consisted of 18 prospective facilitators (11 female; 7 males; all are still practicing middle and high school teachers), divided in three small groups of six. The small group discussions were video-recorded online, Activity 1d took 30 min, Activity 4c took 45 min. Video recordings were then transcribed for both activities, including sentence breaks, gap fillers, or pauses when they were deemed important to the context of meaning.

Methods of data analysis

To analyze in how far the sequences of activities supported the novice facilitators to extend and integrate their focus of reflection (RQ1) and promoted a growth in the facilitators reflection during the year (RQ2), the transcripts of the six discussions of Activity 1d and 4c were segmented into sense-making utterances, coded, and systematically compared. A coding scheme was deductively developed and inductively refined. For each reflective utterance (selected according to working on the posed reflective questions), we coded whether no (explicit or implicit) reference to the classroom and TPD level, one or several references on the same or on different levels were identified, and whether they were just juxtaposed (mentioning two independent ideas) or were really linked. In order to further scrutinize the kinds of (implicit or explicit) links between classroom and TPD level, further codes were assigned to differentiate four ways of linking classroom and TPD level according to different directions of view in the Three-Tetrahedron Model (see examples below in Table 1). We coded delimitation when the levels were delineated from each other by means of concrete or abstract described practices (e.g., by describing a different understanding of roles depending on the levels). We coded top-down links when novice facilitators integrated aspects of the upper TPD level into the lower classroom level, e.g., by describing how to use a task from the TPD in one's own classroom.

We assigned the code bottom-up link when novice facilitators imported a practice from the classroom level into the TPD level (e.g., by describing how student solutions to tasks from their own classes are

to be addressed in a TPD session), and reciprocal link when the statements address both levels mutually integrated (e.g., by addressing a teaching method as useful at both levels).

The interrater reliability was determined for a random selection of transcribed utterances (covering 32 out of 172 codes) with three raters, it yielded substantial agreement with a Fleiss-Kappa of .70.

Empirical insights into novice facilitators' reflection and their growth

The case of Anne Bauer's development: More, extended, and more integrated reflection

We first present the case of one novice facilitator whom we name Anne Bauer, here. In Table 1, five of her utterances are printed that can exemplify most of the codes. In Activity 1d in the first FPD session, she contributed only two utterances in 30 minutes, both of them only addressing the TPD level without link to the classroom level. Her contributions in Activity 4c in one of the last FPD sessions were much richer, with 22 utterances in total in 45 minutes. We observe that she has (a) more reflections, (b) more extended reflections to both levels, and (c) more integrated reflections, with even all four kinds of links that we identified in the whole data corpus.

Table 1: The case of Anne Bauer's growth in reflection: Coded example utterances

Activity 1d in the beginning of the FPD (2 utterances in total; only TPD level is addressed)	
Only TPD level addressed	"But then I find that our PD program here is [only] three hours long. For me, the problem is rather that I already have far too many ideas for these three hours. Then you would have to leave out a lot of other things. So that would be […] a challenge for me."
Activity 4c in the end of the one-year FPD (22 utterances in total: 8 x only on one level, 4 x two levels without linking; among the 10 with links: 2 x delimitation, 5 x bottom-up links, 2 x top-down links, 1 x reciprocal links)	
Delimitation	"I know this situation [time problem in class]: somehow you have to teach everything, as a teacher you have to give the input or you have to do this and that, then you somehow lose the focus and […] my feeling here [in the TPD] is different […], it is better [in a TPD] to really go into depth on one thing and to unravel the different facets that make a topic new, instead of covering so many things."
Top-down link	"[After the TPD], they should take a look at their [school] curriculum material and choose the good materials they have [got in the TPD]. Of course, this is of no use for a one-time TPD program."
Bottom-up link	"Or bring student errors on worksheets to the event [the TPD] - as an assignment. Four weeks before, they should then collect good student errors and bring them [to the TPD]."
Reciprocal link	"If I take the topic 'find algebraic expressions and equations' [for the TPD]- why don't we develop a little teaching sequence for [dealing with the suggested model]. Like a lesson plan or something- how could you work with it? Then offer a second model- then that has more potential. Ok, if you realize that can't be represented in the model. But that's not a problem. These are two insights. First, I can't represent them in the model- that means I learn the limits of the model. Secondly […] we can reflect on how to formulate good prompts, there would have been the potential for a long conversation."

Quantitative overview on novice facilitators' growth of reflection

While Anne Bauer is only one case out of 18 participants, Table 2 documents the absolute and relative frequencies of codes for all utterances in the overall six small group discussions, three in the beginning, and three in the end of the FPD. Absolute frequencies indicate richer discussions in total and the relevance facilitators assign to a link, whereas relative frequencies capture their relations.

With respect to the scaffolding potential of the design of FPD Activity 1d at the beginning of the FPD program (RQ1), Table 2 reveals a remarkably small number of utterances addressing only the classroom level (only two out of 44 utterances). It seems that the design of the sequenced FPD

Activity 1a/b/c before 1d was successful in initiating new novice facilitators' reflections on the TPD level, already in the first FPD session. We assume that imagining a simulation for the TPD contributed to this result that exceeded our expectations to really extend facilitators reflective focus also to TPD. However, as expected, not all other utterances already reached the targeted reflection quantity and quality. In total, the 30 minutes-long small-group discussions revealed only 44 utterances that were coded in our coding scheme, most of them still with lighter links, namely delimitation (9.1%) and hopes of top-down transfer effects from the TPD into the teachers' classrooms (18.2%). In only 18.2% (8 utterances), the novice facilitators already articulated stronger reciprocal or bottom-up links.

Table 2: Facilitators' utterances coded for addressed and linked levels (beginning and end of the FPD)

	Addressed levels			**Two levels linked**	**Modes of linking two levels**			
Total of codes in utterances	Only classroom level	Only TPD level	Classroom & TPD level		Delimi-tation	Top-down	Reci-procal	Bottom-up
Activity 1d n = 44	2 (4.5%)	18 (40.9%)	21(47.7%)	20 (45.5%)	4 (9.1 %)	8 (18.2 %)	4 (9.1 %)	4 (9.1 %)
Activity 4c n = 235	5 (2.1%)	134 (57.0%)	79 (33.6%)	73 (31.1%)	9 (3.8%)	27 (11.5%)	8 (3.4%)	29 (12.3%)

In research question RQ2, we asked for the longitudinal changes which are captured here by comparing the reflections in Activity 1d to Activity 4c in the end of the FPD. Although talking a little longer, the participants contributed a total of 235 reflective utterances coded with respect to our coding scheme, more than five times as many as in Activity 1d. The number of utterances only on the classroom level was already low and further decreased (from 4.5% to below 2.1%). In contrast, the number of utterances that addressed only the TPD level increased absolutely and relatively (from 18 to 134, from 40.9% to 57.0%). The number of combined references in which two levels were addressed quadrupled, with a relative decrease (from 21 to 79, from 47.7% to 33.6%), as well as those with links. All links increased absolutely (with a relative decrease for delimitation, top-down, and reciprocal links). In total, we interpret these figures as a good first indication for the facilitators' growth, even if both activities were not completely equal.

Heterogeneity of growth pattern

The growth was not equally distributed over all 18 facilitators. Out of the 18 observed facilitators, 12 had a higher ratio of utterances with level links to no level links at the end of the FPD compared to the beginning. For no participant, the ratio between statements with and without level links is the same over time, and for six participants, the ratio decreases during the FPD.

In more detail, the changes in all 18 facilitators' reflective focus are visualized by the Sankey diagram in Figure 2, in which all pseudonyms of participants are listed in the middle, with the links they have set in Activity 1d depicted on the left and in Activity 4c on the right. The flow of changes visualizes that participants who initially did not show any sign of linked reflection in relation to the two levels (listed in the top of the diagram, e.g., Nora Boesch or Leon Pfeiffer) developed predominately top-down and bottom-up links. Participants who initially articulated one type of level links expanded their repertoire of integrating levels, e.g., Elisabeth Schneider who started with only the top-down link and Anne Bauer who initially articulated only the TPD level, both expanded to all four level links. Participants who already initially articulated different links between the two levels (e.g., Ivonne

Ritter, Nicole Bader, and Elfi Haas) showed heterogeneous patterns (decrease in linkages for Nicole Bader with finally no delimitation and reciprocal link, Ivonne Ritter with finally consolidation of linkages, and increase of linkages for Elfi Haas).

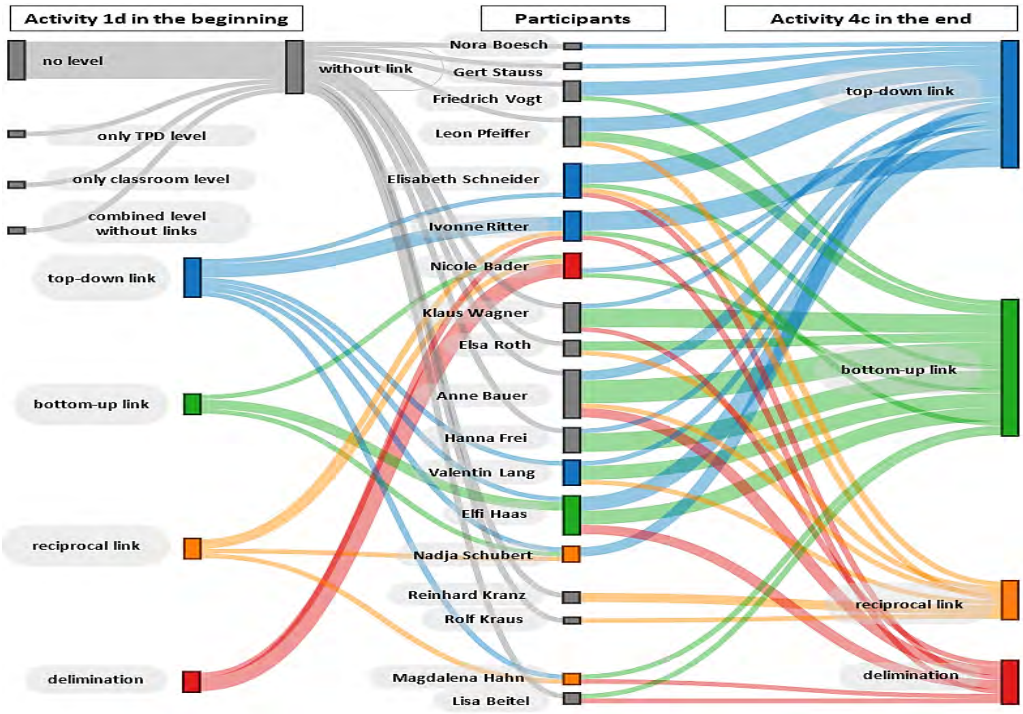

Figure 2: Sankey diagram on the changes of links and modes of links articulated by 18 novice facilitators

Conclusion

Dinkelman et al. (2006) and Chval et al. (2010) generally describe that teacher educators can learn to integrate the classroom and the TPD level in their reflections. Like many teacher educators, our novice TPD facilitators show heterogeneous reflections at the beginning of our FPD program: 50% of the participants do not mention any or only one level in their reflections about simulated and analyzed TPD activities and do not make any connection between the two levels. The FPD activity 4c at the end of the FPD program was slightly more inviting to address the TPD level (reflecting a real TPD experience). But beyond this expectable outcome, it has apparently led to the more frequent mention of both levels by all 18 participants. We can interpret this as an indication that some familiarity to integrate both levels in a reflection has been developed. These participants have learned to expand and integrate their focus of reflection, through carefully structured sequences of FPD activities (RQ1), and to simultaneously frame reflection at the classroom and TPD level (RQ2).

The disentanglement of four kinds of linkages (namely delimitation, top-down, bottom-up, reciprocal) can inform our future FPD programs by providing the base for targeted reflection questions: Already in an early stage, the simulation and analysis of TPD activities can elicit some reciprocal reflective linkages which can be leveraged. By continuous targeted reflective prompts, we hope to support the growth in even more targeted ways and investigate it in the future with more refined instruments that guarantee, among others, a better comparability of pre-post FPD activities.

Acknowledgment

The research is conducted within the DZLM, the German Center for Mathematics Teacher Education. We thank the Department of Education in Hamburg for funding the FPD program QuaMaMo and in particular Astrid Deseniss (Landesinstitut für Schule Hamburg) for the wonderful cooperation.

References

Borko, H., Koellner, K., & Jacobs, J. (2014). Examining novice teacher leaders' facilitation of professional development. *Journal of Mathematical Behavior, 33*, 149–167. https://doi.org/10.1016/j.jmathb.2013.11.003

Chval, K. B., Arbaugh, F., Lannin, J., Van Garderen, D., Cummings, L., Estapa, A. T., & Huey, M. E. (2010). The transition from experienced teacher to mathematics coach: Establishing a new identity. *The Elementary School Journal, 111*(1), 191–216. https://doi.org/10.1086/653475

Cohen, D. K., Raudenbush, S. W., & Ball, D. L. (2003). Resources, instruction, and research. *Ed. Evaluation and Policy Analysis, 25*(2), 119–142. http://www.jstor.org/stable/3699546

Dinkelman, T., Margolis, J., & Sikkenga, K. (2006). From teacher to teacher educator. *Studying Teacher Education, 2*(2), 119–136. https://doi.org/10.1080/17425960600983155

Lesseig, K., Elliott, R., Kazemi, E., Kelley-Petersen, M., Campbell, M., Mumme, J., & Carroll, C. (2017). Leader noticing of facilitation in videocases of mathematics professional development. *Journal of Math. Teacher Ed., 20*(6), 591–619. https://doi.org/10.1007/s10857-016-9346-y

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

Schwarts, G., Elbaum-Cohen, A., Pöhler, B., Prediger, S., Arcavi, A., & Karsenty, R. (2023). The servants of two discourses: How novice facilitators draw on their mathematics teaching experience. *Ed. Studies in Math., 112*(2), 247–266. https://doi.org/10.1007/s10649-022-10182-0

Thurm, D., Ebers, P., & Barzel, B. (2023). Professional development for teaching mathematics with technology: Fostering teacher and facilitator noticing. In A. Clark-Wilson, O. Robutti & N. Sinclair (Eds.), *The mathematics teacher in the digital era*. *Mathematics Education in the Digital Era, 16*, 1–29. Springer. https://doi.org/10.1007/978-3-031-05254-5_1

Wilhelm, N., Zwetzschler, L., Selter, C., & Barzel, B. (2019). Vertiefung, Erweiterung und Verbindung von Wissensbereichen im Kontext der Planung einer Fortbildungsveranstaltung [Deepening, expanding and combining areas of knowledge in the context of planning a training event]. *Journal für Mathematik-Didaktik, 40*(2), 227–253. https://doi.org/10.1007/s13138-019-00143-1

Yoon, K. S., Duncan, T., Lee, S. W.-Y., Scarloss, B., & Shapley, K. (2007). Reviewing the evidence on how teacher professional development affects student achievement. *REL 2007: Issues & Answers Report, Vol. 033*. U.S. Department of Education. http://ies.ed.gov/ncee/edlabs

Zaslavsky, O., & Leikin, R. (2004). Professional development of mathematics teacher educators: Growth through practice. *Journal of Mathematics Teacher Education, 7*(1), 5–32. https://doi.org/10.1023/B:JMTE.0000009971.13834.e1