

RESULTS OF THE EMPIRICAL STUDY

Qualitative Data Analysis

OVERVIEW

The qualitative data is explored by content analysis. The chapter informs on that procedure in detail to keep the proceeding transparent. The approach encompasses explaining the process of content analysis, reporting about the gained dimensions of professional development explicitly from a teacher's point of view, and finally, discussing some final remarks.

THE PROCESS OF CONTENT ANALYSIS

The analysis of the quantitative data primarily follows a well-established algorithm. The more challenging question surely is, *How to present and report about the qualitative data?* In the following, this data is explored by applying content analysis to generate categories for the various descriptions and explanations provided by the interviewed teachers. Contrarily to the quantitative approach, the aim is not to identify a statistically representative set of responses, but to use the views of individual teachers to get a better understanding of the processes relevant in the context of professional development, particularly from a teacher's perspective.

Variants in content analysis are huge and have been discussed against different backgrounds in the research literature. The content analysis applied to the present interview data encompasses both: categories were initially derived deductively during a theory-driven approach to the data and inductively while supplementary emerging from the data. That is, the formulation of categories was guided by the research questions and the pre-existing dimensions as provided by the quantitative analysis. Newly emergent themes complemented the approach to reveal and describe patterns within the responses. Correspondingly, Kvale (1996) characterizes the intention of the qualitative analysis as follows:

The *analysis proper* involves developing the meanings of the interviews, bringing the subjects' own understanding into the light as well as providing new perspectives from the researcher on the phenomena. (p. 190)

Thereby the focus was on creating meaningful categories that serve as units of analysis (Cohen et al., 2007). When such decisions are made, the remaining challenge is to reduce the huge amount of written data, while ensuring its quality. The raw data consists of many quotations, and only those that were considered as essential were ultimately chosen to be translated into English, and to be presented in the subsequent

categorization. The qualitative data comes from the project *Mathematics Done Differently* and thus the conception of the initiative at least partly influenced the experiences of teachers. However, it was not in the decisive focus to qualitatively evaluate the program.

The information arising from the interviews varied, and was of different value for the subsequent analysis. In the following, participants' view on the phenomena under investigation will be presented, comprising important factors of teachers' professional development, also in terms of teacher demands and needs. Since the qualitative research interviews dealt with facts, opinions, and attitudes related to such factors, they also allude to what contributes to effectiveness of professional development events.

The analysis of the qualitative interviews encompasses the following steps as introduced by Lamnek (2005, p. 402):

- a) Transcription
- b) Single analysis
- c) General analysis
- d) Control phase

First, the interviews were transcribed by a student assistant, and then carefully scrutinized by the author of the thesis. That is, the transcripts were reread several times in order to quote verbatim the collected interview data. Secondly, all interviews were analyzed individually. This process included marking the significant text passages to make them accessible for the content analysis. The derived concentrated interviews were then commented with regard to their characteristics, particularities, and general features.

As a next step, a rather general view was taken while commonalities of all or some of the interviews were composed, which served for typifying the single statements. According to Lamnek (2005), this process was undertaken carefully to avoid artificially obtaining homogeneity with respect to content. In this regard, differences among the participants within the categories were also worked out. That is, both commonalities and differences led to tendencies that could be assigned to some of the interviewees. Finally, a control phase was established in order to prevent misinterpretation that might occur through the process of gradually reducing the data. Therefore, besides the concentrated interview transcripts, the original ones as well as the tapes were repeatedly considered, either through rereading or rehearing¹.

DIMENSIONS OF TEACHERS' VIEWS ON THEIR PROFESSIONAL DEVELOPMENT

In total, 74 statements alluding to teacher professional development were taken from the interview data that could be compressed into three categories. The dimensions that were initially derived deductively while theory-driven approaching the data serve as an overarching construct: teacher learning, teacher growth, and teacher needs. The next step of analyzing teacher statements more in depth yielded a fine-grained

categorization within the single dimension, which was inductively derived while supplementary emerging from the data. In the following, the sub-dimensions are labeled and thoroughly explained by giving some excerpts out of the teacher statements.

The dimensions are not discrete entities, and the statements were assigned to them according to the most relevant given explanations. All data will be presented as anonymized comments, i.e., the names that occur in the analysis are not the original ones. The interviews were conducted in the German language; the displayed commentaries and excerpts were very carefully translated into English.

Teachers' statements will not just simply be presented, but also commented with regard to both background information, that is helpful for the reader to understand the relevance of the single quotation, and theoretical positioning. As already mentioned, all interviewed teachers participated in the professional development program *Mathematics Done Differently*. Due to the range of the program, quite different types of teacher's involvement have to be considered. Nevertheless, since it is not the focus of this work to evaluate any characteristics of the program, no distinction regarding the different course offers was made while presenting the qualitative data.

As mentioned earlier, the program ranges from *supply* to *demand* oriented in-service training courses and one type of courses should not be favored at the expense of the other. All courses surely differ with regard to the degree of autonomy, but ultimately various aspects contribute to effective teacher professional development, and the interviews help to enlighten those. In case that participants raise specific aspects that strongly depend on the course design, the corresponding background information is given. However, not all teacher statements refer to courses provided by *Mathematics Done Differently*, but draw on their general experiences with in-service education.

In the following, the teacher statements are listed and assigned to the different dimensions and further distinguished to the categories within them. Finally, an overview on all the dimensions and their essential categories will be provided.

Teacher Learning

In the first dimension, the emphasis is on teacher learning and related processes. In particular, the focus is on lifelong and continuous learning. In this respect, teachers' views on their learning and the variables they consider as essential are in the focus. What is particularly elaborated on are issues that, from a teacher's point of view, contribute to effective professional learning and development. Finally, the role of the interplay between theory and practice in this learning context is enlightened.

Continuous learning. Teachers' views on their professional learning processes, whether in terms of continuous or of spontaneous learning, or the variables they regard as essential differ widely. The subsequent analysis hence is dedicated to list the most informative statements and to allude to some rather different positions that seem to be relevant in this discussion. Mostly, and not surprisingly, the interviewed teachers did not provide an elaborated view on their professional learning. As stated in

the research literature, not only we as researchers, but teachers, too, fight shy of using learning in relation to themselves, i.e., when it comes to their individual learning.

Edith organized two different in-service training courses for her school, which were part of the *à la carte* program of *Mathematics Done Differently*. The interview was held after she attended both courses. She provides the following information about how she views professional development:

Edith: What I see as the most important point is that one gets learning gains, which have to be fostered. Related to the in-service training course provided by *Mathematics Done Differently*, it is like this: the good thing is that one can do that together with colleagues, and to do so within a community, is also a different experience than to go anywhere alone to an in-service training course.

Edith rather vaguely refers to learning gains and at the same moment, she elaborates on in-service education as being a collegial endeavor. Aspects of in-service education, for her, are strongly connected to professional collaboration, an issue that she also stresses in the following remark:

Edith: Continuous learning, well, I think it must be a continuous process, so that one does it with colleagues and not alone, within the teaching staff or well allocated within the department, so that all colleagues develop further.

Again, Edith remains in the position of reflecting her learning not primarily individually but collegially, and provides a strong commitment to the department as a community. Another teacher, Pam, also refers to aspects of individual and collegial learning, but with quite a different focus. She organized an in-service training course *à la carte* for her group of teachers, which was composed to last four sessions. The interview was held after two of the courses were performed. At first, she describes her learning as given below:

Pam: And these little changes, these ideas I have to learn by myself. I can learn them. When I know in what direction it should go, how I should think, think differently.

Pam points out that she needs new insights and awarenesses, so that she can head for another direction in her learning. She emphasizes both learning as “a lone fighter”, as given below, and learning within a group of colleagues:

Pam: Meanwhile, I feel as part of a team, but of course also as lone fighter. But not any longer in the sense that I have the feeling I must fight. For me it is also that I learn incredibly much from it.

Another teacher gives the following remark while he was asked to reflect about professional development as a continuous process. Peter is part of a group of teachers who had applied for a course *on demand* that was explicitly designed for their needs. The interview had been conducted before the course took place.

Peter: Well, I must say that actually there haven’t been that many mathematics in-service training courses. We always have had, when curricula made

it necessary, an in-service training course. Concretely, for instance, while we also had to impart differential and integral calculus, we had an in-service training course specifically regarding this domain. In other respects, we haven't pursued a continuous process.

Obviously, the teacher does not possess an elaborated view on his personal professional development, but of a position, that is determined by an outside orientation. For him, professional development is something that is offered from outside, no connection to continuous and ongoing learning that actually takes place every day is made. From Peter's point of view, changes that are caused externally, like the introduction of new curricula, put a demand on him to further engage in professionalism.

Jack applied for a course *on demand* that was concerned with the use of the programmable calculator in the classroom. In his statement, he refers to the continuity of professional learning, but he also points to the same direction as Peter, when explicating the following:

Jack: Well, I do think that one always has to develop professionally. [...] There are many offers to attend in-service training courses. Then it was like this, topics were presented, single themes, and how to implement them in the classroom, examples of how to get any topics started. Well, basically, that is what has been offered.

Although Jack at first considers professional development as a continuous endeavor, he does not really address his learning processes, but he reflects on the continuously available offers for professional development throughout the course of his career. In the last two positions, interestingly, to engage in professional development is not seen as a self-determined and reflective process, but an other-directed one. Either demands are imposed because of general educational changes or professional engagement is oriented at available and given offers.

Some of the interviewed teachers link the continuity of learning to in-service education. That is, they stress the processes that were initiated by one or two of the courses that they had attended. These teachers consider applying for additional sessions, as mentioned in the subsequent statement:

Ann: To build up on this, we already thought, [...] that we would invite the two [the trainers] once again, or make use of other offers in the area of stochastics. Yes, in other respects, one certainly tries to take along from in-service training courses as much as one can, since finally the 'Bezirksregierungen², are no longer offering that much, and this is why one is actually in search of offers.

Not astonishingly, some teachers conceive professional development primarily in terms of in-service education, and therefore elaborate on respective issues. Representative for other teachers as well, Ann points out that attending a first course is in a way initiating continuous needs. The teacher's focus, hence, is not simply on the single event, but on several sessions, either to the same topic, as indicated above, or to different ones, as mentioned by other teachers.

However, some teachers contribute aspects, which were not expected in this context. The next commentary given by Kathryn, who belongs to Peter's group of

teachers reveals the following self-concept when being asked for her continuous professional learning:

Kathryn: Although I haven't been teaching that long, I do help my younger colleagues and we talk much about the issues that happen in the classroom, which experiences we've collected, where the problems are, etc. And then I go to the elderly colleagues with these problems, who then partly have acquired more experiences and I ask them how they deal with.

With respect to continuous learning, she firstly excuses herself for being short on experiences, but then she provides some information of how she exchanges with colleagues. Thereby, she continues to differentiate between elderly and younger colleagues while conceiving herself as a novice teacher.

Successful in-service training. Teachers were asked for what concretely makes professional development and, particularly, in-service training successful for them. In most cases, teachers provided elaborated statements, which indicate that they deal with these issues very reflectively. In the following, the floor is given to different positions of teachers. To start with, Deborah mentions a crucial point: in-service training courses should address very concretely the needs of teachers. She explains how teachers behave, when their needs are not adequately touched:

Deborah: That the motivation is right. That is, an in-service training that is imposed on teaching staff, per se gets the short end of the stick because everybody is particularly critical and the hands go like this [she demonstrates], they get crossed and then: let the one in front show what he then is able to do first. Then, it is really not easy to break this barrier that then exists, and to really break through for the one conducting the in-service training course. That is to say, a need must be there, emerging from inside the teacher. Then this need preferably ought to be concretely formulated, the person conducting the in-service training course should know it beforehand, so that he can orientate thereon concerning the contents, or that he places emphasis on.

Deborah is very concrete about necessary aspects of in-service training courses. She mostly underlines that teachers' attitude is decisive, and therefore she insists on the right motivation. Remarkably, she concretely values teachers' needs as decisive variable and that those need to emerge from inside. For a group of teachers, which Peter and Kathryn belong to, she ordered a course *on demand*. She further points out the following:

Deborah: The composition of the in-service training course should not only be a moderated presentation, it should indeed be an in-service training and not only a tapping of systemic existing knowledge that someone then just summarizes. It should really have the character of an in-service training course, i.e., I need an expert, someone who has to say something to us that we didn't know before, who can provide a new view on an issue. The second part of an in-service training course also means that one does not only get out and says: I've heard

that all, and what should I do with it now? But a gentle push into action must take place, an example, that the colleagues or a teacher in general can try out and test. That doesn't have to be the entire spectrum of the course, but the core issues should really attain to performance, like a kind of workshop character, whereby one definitely can introduce issues like group work.

In the statement given above, Deborah stresses various aspects relevant for effective in-service training courses: the course should provide new insights, the ideas should attain to performance, teachers need time and possibilities to try new things out and test them, teacher learning is active learning. Alan is also part of the teaching staff for which Deborah was the main organizer of the in-service training course. His remark given below refers to quite similar thoughts:

Alan: That is, well, it [the course] gave us what we expected, what we needed, and then one can very easily put it into practice. If it did not get across like that, then there is need for subsequent work, that one says, how do I deal with, what will I do now with it, and how can I apply it.

For Alan, it is important, that his needs and expectations are met and that he gets enough information to apply new things so that he is able to implement them in his teaching.

The aspect of getting new insights is also accented in other teacher statements like in the following one given by Ann:

Ann: Well, yes, certainly when new issues come. I have been working in school for ten years now, and specific issues are still new, or one doesn't have that much experience with them.

Another teacher also stresses that it is important to get new input, but moreover information how to implement these new awarenesses into practice. In the next statement, successful in-service training is thus characterized as follows:

Pam: When a mixture of theory and practice is provided. When it doesn't get stuck in theory, but goes into practice, when one goes into issues in detail. Thus, to see how I can implement it, how I can organize it for two different grades. [...] Then I find an in-service training successful. Thus, when one is able to perform on the basis of practical examples, which do not restrict me, so that I ultimately have to do them, but th

at they also provide degrees of freedom.

Pam particularly points to the different inputs given by theory and practice. She underlines the importance of feasible examples that do not restrict her too much, but are applicable to her teaching.

The next variable that is considered as being essential is the trainer's personality, as Ann points out below-mentioned:

Ann: Partly it always depends on the trainer, what I found as definitely being true in mathematics. It is often like this: we had an introduction for the graphic

calculator, at first for this graphic calculator so much time is needed when people don't know that device. [...] It is always a pity, when these things are so time-consuming til one gets to the actual topic.

Ann refers to personal variables while looking back to an in-service training course that was not really timed by the providing trainer. Implicitly included in this statement is the aspect that a trainer should know about the teachers' requirements that he will encounter. Otherwise, he cannot assure that his offer is adoptable to the needs of all the teachers in the group.

Edith lists some factors of successful in-service training courses that partly have already been mentioned:

Edith: Well, on the one hand, absolutely, the fascination for the subject mathematics. On the other hand, and what also makes [the course] successful, definitely is this tandem of research and school, this interplay, the exchange with colleagues, that one can experience it in companionship.

She highlights the tandem approach, i.e., the specific interplay of theory and practice, which is a constitutive parameter of all courses provided by *Mathematics Done Differently*. Besides also valuing the significance of collaboration with colleagues, she underlines an affective parameter, when referring to the fascination of mathematics.

Relationship of theory and practice. From their very conception, the courses provided by *Mathematics Done Differently* are sure to combine theory and practice since a tandem of a university teacher and a schoolteacher provide them together. This relationship has already been touched in the section above, the statements given below offer some further information. The interviewer asked Edith for the importance of the teacher within this tandem, and she gives the following comment:

Edith: Incredibly important, since he has the experience, he knows what's going on in school. Yes, he knows what he is talking about and this experience, that he possesses, one can't simply appropriate it to oneself. One has to go through it in order to understand it and to pass it on.

Most of the teachers particularly value the role of the schoolteacher within the trainer tandem, who in some sense ensures that all issues are well practice-oriented and practice-related. However, teachers also acknowledge the role of the university teacher who stands for research knowledge and theoretical aspects. Accordingly, Pam reflects about the relationship between theory and practice as follows:

Pam: Well, these aids that Paul and Thomas [the trainers] provided, well, they have such a wholesome mixture of theory and practice. [...] Thus, this mixture is really helpful. [...] Well, this practical part, I could do that as well, but what I don't have is this theoretical background.

For Pam, the interaction between the university teacher and the schoolteacher is important. Moreover, she explicitly appreciates to get theoretical information and

background. Accordingly, Agnes comments on the significance of the university teacher as follows:

Agnes: Well, of course, I find this combination of theory and practice really great. Well, at first it is good that people lean back, they get an input from somebody who is working at the university, and so on, and they listen to it, and then they discuss mathematics a bit, these school teachers.

Agnes is a very engaged and experienced teacher who applied for a course *on demand* out of the program of *Mathematics Done Differently*. At first, she describes that it is important for teachers to get input from someone working at the university. Then, a bit sardonically, she points out that this encounter also initiates teachers' discussion on mathematics on a meta-level.

However, in contrast to the other teachers, Ann does not draw a sharp distinction between theory and practice while pointing out that there is also theory behind practice:

Ann: I would say, well, there is also theory behind the practical site. Claus [she refers to the school teacher as part of the tandem] also sits at home and then this course is also theoretically worked out and prepared, like he also did it at the university. But he can also say, in this moment the students will react one way or the other and that is useful for teaching. And he even knows how it is in the classroom, and insofar it was really important for us, to get this feedback how we can implement the new techniques there.

Interestingly, she also conceived of the schoolteacher as providing theoretical input and information.

Thus, teachers experience the *tandem* approach differently. Most of them explicitly and positively value this conception of a trainer *tandem* bringing together expert knowledge from research and practice, while a few of them emphasize more the important role of the school teacher.

Teacher Growth

In this section, teachers' growth processes are enlightened while in particular the role of previous experiences with professional development and in-service education are presented. In the light of their experiences, crucial aspects that depend on teachers' beliefs and their attitude towards professional development are discussed. Formed over a period, it is mostly these strongly held beliefs that impede any change processes and developments, and even when unconsciously held, give rise to a considerably reserved attitude. Finally, issues of sustainable professional exchange and collaboration will be broached from a teacher's perspective.

Previous experiences. Deborah ordered an in-service training course for her mathematics department that was clearly a demand-oriented course, designed for the specific needs of her school. She looks back on different experiences with in-service training, and she firstly states the following:

Deborah: Once again, I surely expect a new attempt from the in-service training course.

She then explicates some previous experiences of the staff with in-service training and she states the following:

Deborah: In this respect, we had an in-service training course before, whereby the younger colleagues thought rather positively: hm, this is something for me and the elderly ones thought: I won't go there any longer. Therefore, they didn't even participate in the next course because they were partly not really met where they were. Unfortunately, no opening-up, in the sense that I had actually hoped for, did occur.

Deborah mentions a very interesting point, i.e., to meet teachers where they are. Undoubtedly, in-service education follows the rules of learning. According to this, teachers' experiences and in particular their hitherto existing knowledge is decisive for any process of accommodating new information. Based on her experiences, Deborah was very concerned with agreeing in advance what the specific needs of the group of teachers are, an issue that will also be elaborated under the headline of teacher needs.

Interestingly, Deborah's school is very experienced in the role of being a self-organized school. Issues of autonomously organizing professional development of the entire teaching staff are, therefore, endeavors that have already been practiced successfully. In this respect, the following quotation gives some illuminating hints to related experiences:

Deborah: Well, as a self-organized school we are used, well for five years now, to develop certain rights and duties. We've done that with enthusiasm related to different areas. In this context, we had compulsive in-service training. These courses provided many experiences for the colleagues, some of which they wanted and some of which they didn't want, some that pleased them and some that did not. And now, in retrospect, the head of the school takes the view that if we need in-service training courses then they need to be tailored to the colleagues or the department or the group. Now we've got that, this one is the third one we are organizing for ourselves. Not all went well, and with the one we get from you, we don't know yet. One went very well, and with one, we felt flat on our faces, although the agreements were very concrete. Again, that led to considerable resentment.

Based on previous experiences, Deborah now really orientates at the needs of the teaching staff and she is very concerned with preparing the in-service training course, in particular with regard to an adequate prearrangement. Deborah also raises an interesting point, namely that experiences in the field are also important for teachers to clearly define what they want and what they do not want. To reach a point where it is possible to announce individual needs is a process that takes time. She further explains the feelings of resentment, when the training course does not appropriately meet the needs of the teachers.

Interviewer: One is disappointed then.

Deborah: Yes, I was disappointed because I spent two hours to get the agenda and wishes of the teaching staff across very concretely, and for me it was an enormous disappointment that these wishes were not fulfilled. The colleagues

were also disappointed because again, they invested time and actually, they still stayed where they were.

In-service training is also time-consuming for teachers, and they feel like wasting their precious time. Deborah takes up this topic again, and explains further, why teachers are frustrated when in-service training courses do not meet their expectations and needs:

Deborah: Well, we all have a lot to do. That is exactly the point, I think, why teachers are very sensitive in case someone steals their time. It means that they have to stay here, that they have expectations, and that they want to take something with them. When there is nothing, they could have prepared their lessons in that time, or engaged in other forms of developing lessons.

Alan also refers to previous experiences with an in-service training course that went beyond the issues that were relevant for him and the group of teachers. He, thus, explains in few words what he is expecting from the upcoming course:

Alan: And, concerning this subject, we have already attended other in-service training courses, and now we've got this course, and we expect from it that it is better related to our situation, and that we can take something with us.

Alan feels frustrated because of the past events. For him, it is important that the next course will meet his expectations, however, he does not sound confident.

Beliefs. Expectations of teachers are high and, as the above-mentioned statements showed, they are mainly based on previous experiences. In this context, the decisive role of beliefs towards professional development should not be neglected. This aspect will be enlightened by the commentaries given below. However, it should be noticed that these experiences are mostly not acquired in relation to the initiative *Mathematics Done Differently*. Jack, for instance, a very experienced teacher, who has been teaching for 34 years now, was asked for the most important issue in the context of in-service education and he states the following:

Jack: Once again, to get this idea, to get new incitements.

At first, he generally refers to new incitements as being most central. But in the following, what can be understood from his words is how the previous experiences become decisive for his overall attitude towards in-service education. This attitude is obviously not only acquired with respect to hitherto attended in-service training courses, but reflects the whole conception of his learning:

Jack: What I consider important for an in-service training course is that someone tells me what one can do and not like this, "try it out and try it out again". [...] This is not effective.

By these previous experiences, beliefs are clearly accentuated. Jack is very disappointed by a specific type of in-service training. He was then asked for what has proved to be effective for him and he announces the following:

Jack: No, in former times I also learnt by listening to somebody who said something to me. [...] I listened to it and then I tried it on my own. That's how

we learnt at the university. We went to attend the lectures, then we got the exercises, we did the exercises together with colleagues, with students. Why should I change that?

He possesses strong beliefs about his learning processes and needs that emerge from that, and which have been built over a period, and even go back to his learning at university. Not surprisingly, he comments any process of change and development like follows:

Jack: I only have to work here for four more years, why should I change my methods?

This comment sounds quite disillusioning, but of course, there are developments that have led to such a perhaps unconciliabile position. In the course of the interview, Jack reports about the many changes that he has encountered in his teacher life and which were primarily set from outside. His resistance to change has been accompanied by trusting his own approach, which, as he indicates, has also proved to be very effective in terms of his students' performances. In the following remark, he tackles a very interesting point that has already been touched in the introduction of this work:

Jack: My elderly colleagues, who are just a bit older than I am, who just left, they always said: set theory came, set theory went.

By the comment he points out, how the teachers of his school reacted when they felt not really addressed and met by hastily placed educational changes. That is, one consequence that might occur when the needs of teachers are disregarded is that they nonetheless remain the same. In this context, Jack provides some interesting thoughts concerning the many current developments in education, which also contributes to a better understanding of his position.

Jack: Part of education are calmness and composure, one needs to have time, one has to deal with the children, the juveniles. One needs to have time, so that one helps them to advance, not only subject-specific, and that doesn't work when constantly, always something is adapted. And then there comes something new here and there, which is not properly thought through at all.

Professional development can have many facets and wears many hats; even a position like the one just mentioned is surely not just an individual opinion. Issues that do not reach the realm of the teachers, entail learning processes that might be contra-productive for those looking from an outside perspective, and at one time are very effective the other way round, i.e., from an inside perspective.

Beliefs are highly subjective and therefore vary according to the different bearers. In any discussion, beliefs can be differentiated with respect to the different objects they are attached to. Although the focus here is on how teachers view their professional development, a different but of course related object breaks its way through, i.e., how teachers are encouraged and incited to experience mathematics differently. However, the beliefs section so far has been concerned with rather negative influences

of belief. In the following, the inspiring effects and the creative power of beliefs are highlighted.

Edith, for instance, points out that she got some insights while attending the in-service training course, that were of course not relevant for her students, but led to new awareness for herself:

Edith: But for me, it was a mathematical highlight that once more pleased me. Well, that it is simply enlightened from a different view, so that one, not only preserves the overview from above, but that one sees, aha, there is something more than just the things we are doing, that is really important.

Interviewer: That one gets another view on mathematics?

Edith: Yes, that one has this meta-level.

Edith raises an interesting point that is clearly related to issues of beliefs when she mentions how she came to see mathematics in a different way. For her, looking at the subject from a meta-level provides essential awareness and information for her daily work, even though an immediate benefit in terms of concrete teaching advises is not provided. In the following, she explicates how her students avail from such an elaborated experience:

Edith: What teacher would I be if I said, “Math ohh”, but instead to make it clear for the students, I say, look at how beautiful it actually is and what things have to do with math, and this is nice, the inspiration. [...] But what is inside the students’ heads, is that in school mathematics, there are so many abstract issues, like formulas and calculating, and they don’t see where in real life math is included. They don’t open their eyes. So the course is nice and those are impulses that I even got for myself through the in-service training course.

Likewise, in many of the teachers’ statements, to get new insights and ideas is mentioned as a decisive aspect while attending an in-service training course. This aspect goes beyond simply obtaining new information, towards yielding a new viewpoint, or even a *higher* standpoint, as described in Edith’s statements above-mentioned.

Affective variables. Much research in the whole field is concerned with the cognitive domain, whether in terms of knowledge or partially in terms of beliefs. What is considerably neglected, is the affective domain. In the following, affective aspects are highlighted that underline how teachers’ positive attitudes are primarily influencing any process that takes place in the aftermath of a professional development event. The following excerpts point out some interesting coherences. Edith, for instance, describes the following experiences while attending the in-service training course:

Edith: I can really see that they [her colleagues] have had fun and that they were looking forward to, and they even said that they would look forward to, the next in-service training course.

Edith notices that her colleagues took much pleasure in engaging during the course, and on top of this, that they felt delighted to obtain an additional session. In the

following remark, she provides some more information about what processes took place after the course:

Edith: It is amazing, it is really amazing, this ‘flashlight’, it is such a pity that you [the interviewer] did not hear what the colleagues said at the end of the course, colleagues who initially were tired of attending in-service training courses.

Interviewer: Those who were actually tired of attending in-service training, what did they say?

Edith: Oh, it was terrific, and as I said, I am looking forward to the next in-service training course.

Interviewer: Fine.

Edith: Or that questions occur like, how can we do that, we could do some team teaching together. Yes, really new ways open up, that colleagues then say, oh couldn’t we teach such a lesson together.

In this short interview excerpt, Edith aptly describes that even colleagues that had actually not been very interested in attending an in-service training course, shifted their opinions and were open for getting involved with issues provided by the specific course.

Deborah also refers to affective variables in the area of professional development, but with a quite different focus:

Deborah: My department is extremely team-oriented. People support each other, nobody holds back something. What is even more positive is that everybody is allowed to complain. [...] Nobody has to be afraid, that one is looked at askantly and anyone thinks: no wonder with him or her, or what else it could be. Because the doors are closed, when you as a teacher disappear into the classrooms, and that I must say is outstanding. We are a group of very young colleagues, very open.

Deborah raises an important issue, i.e., that teaching at all is a lonely endeavor since the classroom doors are closed. Nevertheless, in her school, the barriers disappear due to exceptional collegial support that contributes to an atmosphere of trust. The in-service training course that will be offered according to the specific needs of this group of teachers will be implemented into an already existing supportive atmosphere. That is, teachers have been working together to support each other in enhancing their teaching, to sharpen the previously existing skills, or to try out new teaching approaches.

In the following, Deborah reports about two teachers, who do not possess real openness with respect to their professional development:

Deborah: Although, especially in mathematics the composition of the teaching staff is so that I have two very experienced colleagues that are teachers of the old school, who are not very courageous regarding new ideas, who rather in

the first place see the problem: that will go awry, or I would waste too much time on that, or they [the students] will not be able to do so, who are very critical towards others ways, and at the same time often complain that everything fails. To make this discrepancy apparent and to break it open is a difficulty that exists at the moment.

The teachers within the department are in their own way open to encounter new ideas, and Deborah's attitude is very sensitive to the different needs of the teaching staff. Obviously, teachers possess an elaborated value system, which makes them easily resistant to any change processes. Deborah describes this phenomenon aptly, when she states that those teachers at first rather see the problem than the good idea. Because of their a priori critical attitude, these teachers miss out on the chance to gain new discernments.

Changes that are initiated by an in-service training course sometimes might not lead to direct improvement, but entail developments of more global character. Edith, for instance, reports about the following incident that, among others, has arisen from the single in-service training course:

Edith: Well, that is really much, and what, for instance, is a good example is what has risen from this in-service training provided by *Mathematics Done Differently*, what has risen from that for us, [...], is that next year, for instance, we'll get the exhibition 'Mathematik zum Anfassen',³ to our school.

By this statement, the teacher illuminates what general movement was generated by the input of the course. As she further explained in the interview, the teaching staff did not only decide to apply for more in-service training courses, but agreed upon several specific events for the school. In particular, they arranged an appointment with the minister of education of North Rhine-Westphalia for visiting the school.

Professional collaboration. Another interesting aspect is how teachers value the role of professional collaborations, an issue that has also been touched in the aforementioned sections. Undoubtedly, this is the most uncritical dimension in the discussion of effective professional development, since positive influences have abundantly been documented and reported. However, the following teacher statements contribute some additional and interesting aspects. At first, Ann summarizes the following positive factors concerning professional collaboration:

Ann: And it was pretty good that we, as colleagues who are teaching the same subject, as a department, got the opportunity to attend it [the in-service training course], to swap ideas, or just to get the opportunities to look, ah, this is how the other schools do things. This also happened during the coffee breaks or at lunchtime, sort of active exchange took place, that was good.

The in-service courses provided by *Mathematics Done Differently* do address teachers from one school or neighboring ones. To meet teachers from a different school close by has been valued not only by Ann, but by other teachers as well. New networking

of teachers within the region of the school could be established by this requirement. Alan refers to the aspect of close collegial collaboration as follows:

Alan: I simply consider it as important that one then goes there [an in-service training course] together. More ears hear more. More eyes see more and afterwards one can better swap ideas.

Alan pragmatically gets to the point when stating that more ears hear more and more eyes see more, in particular, when teachers who are working together have a chance to reflect afterwards about the issues, that might of course be of different relevance for them.

Another teacher, Pam, very concretely reports about professional exchange of colleagues. The in-service training course that she organized was a *blended learning* course (Hellmig, 2008). That is, the course comprised four rather theoretical sessions with practical phases in between those. During the practical phases, the teachers had rich conversations and discussions via an Internet platform. By the following statement, Pam provides some insight on how the teachers exchanged their ideas:

Pam: Well, that is really important. Because colleagues are now involved who are teaching fifth graders for the first time and they could hardly deal with the new demands of a new learning culture. It is really difficult to catch up conceptually and then also methodologically. That they adopt many suggestions or ideas, and well, they say: I try that the way you did it. And so on, and then they report about that. And I really think that more and more colleagues will open up. One notices, their texts get longer, well, and one checks excitedly for new messages. And there are no longer such curt answers but it slowly opens up.

Pam reports that the teachers got increasingly used to discuss the issues via the Internet. She continues to describe the initiated process as follows:

Pam: I am really astonished that through this contact and this debate, curiosity is stirred up. And this curiosity, I think, one has to sense and to pick up and to give help to these people so that they can make it and do not get frustrated.

The author also had access to the discussion platform and noticed that at the beginning, the teachers were rather reserved to report about their ideas. But after a short while, the discussion became really substantial and teachers reflected their approaches together, and exchanged their teaching experiences. In particular, they put some of their ideas on how to implement specific issues into practice up for discussion and elaborated, for instance, on how their students reacted and what worked in classes and what did not.

Finally, Agnes, who made some experiences while being engaged as a teacher leader in the SINUS project adds some interesting aspects to the significance of professional collaborations:

Agnes: Of course, the colleagues have changed, they must change because of the new central exams, and so on, but for me that's too little. [...] Well, for me that's too little. I really have an itch to change. [...] For me personally, it is not going fast enough.

Although Agnes often underlined during the interview that she appreciates very much working together with colleagues, she reminds of an important factor, i.e., that teachers possess a different pace. Teachers develop in their own time, and she feels disappointed that they do not proceed equally effective. In the next statement, Agnes points out why she considers it really important to address the whole mathematics department of a school:

Agnes: Remember also, what happens by consequent in-service education, professional development, changes in interests when giving lessons, in comparison to someone who does not do so. It is simply that the gap between them is getting wider and wider. One should clearly see that, and actually, that should not happen.

In case that not all subject teachers from one school engage in in-service education, a negative effect can be that differences among the teachers increase.

Teacher Needs

Undoubtedly, to meet the needs of teachers is the biggest challenge when providing professional development opportunities. In the sections above, some information has already been provided about the negative effects that take place when teachers are not met where they are. In the following, teacher commentaries are displayed that enlighten aspects of need identification and adequate prearrangement of the individual in-service training course. Teacher needs are also reflected in their motifs, and in the support they require to pursue their professional development so that these aspects are accordingly subject of discussion in this section.

Need identification and prearrangement. Actually, the request to meet the needs of teachers is a trivial axiom in the field of professional development, not at least with respect to teacher motivation and engagement. However, in-service education mostly concentrates on the single event rather than on the prearrangement, which is a decisive parameter with respect to really considering the needs of teachers. In fact, the possibility to agree upon content and specific themes is mostly not even optional in traditional settings when courses are primarily provided in a predetermined way. The following statement given by Deborah illustrates that making special agreements before the event is essential to make the course appropriate to the needs of the group of teachers:

Deborah: We entered into a rough agreement that happened via e-mail, which I composed based on the talks held with the colleagues. Well, I've had my colleagues tell me exactly what they want, where we want to head and what shall happen in the course in order to make it fit precisely, and so that they really feel addressed and met where they are.

As Deborah points out, she spent much time to elicit the needs of the group of teachers, in order to make the course the best fit. By the following remark, Alan,

who is a teacher from the same school, refers to a previous course that did not meet the expectations of the teachers:

Alan: Right, there we also were optimistic and had pretty high hopes and unfortunately, these were not fulfilled.

The statement impressively underlines that professional development needs to be thought of from a teacher's perspective since that expectations are decisive. As mentioned above, the teacher has had some negative experiences with in-service courses that were not close enough to the specific needs of the group of teachers. And even though a detailed prearrangement does not assert an adequate course, it is at least an important parameter for meeting the needs of the teachers.

Another teacher, Edith, states the following while being asked for professional development needs:

Edith: Well, in-service education, just simply that one realizes needs over a period, which one has, where one is not fit enough, for instance, in stochastics it was like that, some colleagues even did not encounter stochastics during their studies.

Edith refers to some specific learning needs concerning a mathematical topic. As she was asked whether learning needs are of personal or rather collegial nature, she gave the following answer:

Edith: I think it is both, as well as that one sees on his or her own and that one then in conversations, during always too short breaks, talks to colleagues [...].

She remains rather vague in describing how she notices her learning needs, and distinguishes between aspects that she becomes aware of on her own, and others that emerge through conversations with colleagues. Other teachers provided detailed information about their individual needs or those of the entire teaching department. That is, they also mentioned designated themes and topics they were interested in, or which they are obliged to teach because of changes in education. Also interesting is the following remark given by Agnes:

Agnes: From my point of view, from educational changes, a great need for professional development emerges. But colleagues need to realize that they do have that need. And one can't assume that all colleagues overnight teach according to the new curricula, how it is arranged there.

She insists on the importance of *becoming aware* of a *need* for professional development. Obviously some of her teacher colleagues do not consider any necessity for engagement, although, for instance, new curricula constitute a corresponding demand. Closely connected to teachers' needs are teachers' motifs to apply for and ultimately attend in-service education, an issue that is elaborated on in the next subsection.

Teachers' motifs. Not surprisingly, teachers' motifs to attend in-service training courses differ, but at least two essential positions could be derived from the interview data. That is, teachers that are organizationally engaged in planning in-service

education within their school possess a different view compared to teachers that are not. The former position leans very strongly on a conception of professional development as an ongoing learning process that generally fosters developments in teaching, i.e., a strong link to school development in general can be stated. The latter position takes into consideration more thoroughly the individual needs or is based on the conception of professional development as being a personal process. Thereby, the interview excerpts that are aligned with the last category can further be distinguished with respect to different accentuations, an observation that is discussed in the following.

Giving corresponding teacher statements portrays the different positions. While Deborah is responsible for the development of the department, her motifs are strongly bound to aspects of staff and school development:

Deborah: It belongs to my job as ‘Bildungsbegleiterin,’⁴ in some way to think about what the department’s needs regarding in-service training are, in order to put developments in education into practice. And therefore one takes one or two themes again and again, either out of the colleagues circle itself, when they say, we want this and that, or because we were set designated tasks that we need to accomplish, or because it is, for instance, noticed from outside, that something should possibly be changed. There are different reasons for why one thinks about in-service training.

Deborah is very concerned with balancing the needs of her staff that emerge throughout the daily teaching practice, and those that are placed by developments in education. She further takes a position on a meta-level since she strongly considers the development of the teaching staff in terms of school development. Obviously, the course offer *on demand* that is provided by *Mathematics Done Differently* fits very well to the overall needs of this group of teachers. Correspondingly, Ann who works at a different school reports on how her department deals with issues of professional engagement:

Ann: And then, in the last year, we had a meeting of our department and then I presented the in-service training courses in mathematics that are available and then, within the department we reflected about what themes would be a possibility. [...]. We made the decision together in the department; while doing so all colleagues did participate.

Her department also agrees about topics for in-service education, thereby all subject teachers participate in taking the respective decisions. Ann concretizes in the statement given below how the school engages in professional development:

Ann: Well, we aspire, which is also fixed in the school program, to have a school-intern in-service training day per year. [...] Well, insofar, in-service education is closely linked to our school program. Therefore, we have a special group for school development, a working group, and there we even discuss what we will make, what we will do and from this usually also emerges what we’ll do at this school-intern in-service training day.

Ann's school is experienced in actively participating in school development, a special group agrees about possible events and in particular, one day per school year is dedicated to school-intern in-service training.

Contrarily, Edith concentrates much more on progress in learning whether individually or collegially, however, her view is rather concerned with learning gains and development:

Edith: The motifs for now are that it is important to improve one's skills, to foster learning gains, because otherwise one does not develop further, I think, or one advances too little.

Her initial motifs are not strongly tied to school development although this aspect emerges throughout the entire staff's engagement in in-service education. As stated elsewhere in the interview, and as already mentioned in the preceding sections, she reports about the processes that got started within her school.

To sum up, in the first position, in-service education is seen from a meta-level, whereby the teaching staff and the individual teacher are also in the explicit focus. In contrast, the second position is located on a micro level, although developments also have an effect on the others levels as well. That is, both levels are strongly connected, although the current focus and the corresponding view differ. However, the below-mentioned teacher statements that can also be assigned to the micro level are different from the attitude that was adopted by Edith since in these positions, clearly no broader view towards school development is included. That is, the aforementioned reciprocal connection, or relationship between the different levels is missing in the subsequent teacher views.

Kathryn, for instance, closely connects her motifs to attend an in-service training course to her teaching needs:

Kathryn: For me, the necessity to attend this in-service training course lies in that I noticed by myself, in my teaching, that the students have come from different 'Realschulen' and that the quality of these schools becomes noticeable.

She refers to her teaching, in particular to the students she is teaching, and continues to strongly argue that she needs help in order to deal with their heterogeneity:

Kathryn: Well, for me, the motivation actually comes from teaching, since I think that a student then, hmm, doesn't feel slowed down, but they very easily find it boring and how can I help those that do not have easy access to mathematics. [...] For me, the motivation solely is how do I handle the different acquirements of students.

Kathryn works at a special school that is restricted to secondary education. The students enter her school in grade 11 and come from very different school types. The problems she encounters in the classroom emerge because of these heterogeneous students.

Kathryn: Well, that is the motivation for me, but also my problem, what approaches do I have to deal with.

Her motivation to attend the in-service training course is to get informed about pedagogical and didactical themes, that would help her to improve her teaching.

Another different, yet related teacher position on the micro-level is the following one. By the commentaries given below, Peter explains why he engages in in-service education. Like the teacher before, he focuses very much on his students while being asked for his motifs to attend an in-service training course, but with different emphasis:

Peter: The students we have today cannot be compared to those we had in former times in regard of their behavior, their mathematical knowledge, acquisitions, and abilities. [...] Concretely, knowledge in basic arithmetic operations is lacking [...] Second issue perhaps: the ability to concentrate today is not as developed as what we would need for the lessons. [...] Thus, those are two points that spontaneously came to my mind, why students currently need to get a different attitude, also the teachers, compared to how it worked in former times.

The teacher provides a detailed statement why he feels forced to attend in-service education. Thereby, he explicates what has changed over the last decades with respect to the students. The position centers on the students, and reminds of accusing them because he feels forced to engage and participate in in-service education. The interviewer intervened and asked for Peter's concrete goals with a view to the training course and he stresses the following:

Peter: Actually, everything goes round in circles, these deficits are there and we can't deal with them appropriately, i.e., we have a time problem. That is, in the curricula it isn't explicitly addressed, but we must simply assume that acquisitions, for instance, for the rule of three are missing, and we have to account for that.

The teacher remains in the position of mainly focusing on his students. Since they have changed, he feels a necessity to change, too. However, the crucial point is that the initial movement does not emerge from his original needs, but is pushed from outside. Professional development is primarily conceived as trying to meet an obligation rather than really being on the move towards professional learning. In the above-mentioned commentaries, he sounds a bit resentful, a position that obviously impedes perceiving the individual process as being related to a greater context. His attitude is not open for development, a position that has been indicated above as at first rather *seeing the problem than the good idea*.

Another teacher, Jack, gives a quite analogous explanation for his motifs to apply for an in-service training course that deals with using the programmable calculator in classes:

Jack: Well, the first motif simply is that we have to introduce it [the programmable calculator], and we have no clue how to do so. That's why we have to deal with those things. [...] Thus, we have to tackle it, we are obligated to introduce that some day and we want to take up the challenge.

A bit similar to the motifs pointed out by Peter, this teacher also feels obliged to attend an in-service training course in order to deal with the changing variables.

In Germany, as pointed out in chapter three, a clear shift towards an output orientation in education has taken place. Obviously, due to this development, teachers, although they are not officially forced to attend an in-service training, feel like they have to since the necessity clearly evolves in terms of demands from outside. Jack further points out that he then feels left alone:

Jack: Strangely, one does not get instructions for those new things.

He explicates how he also felt not supported in a similar situation, i.e., when he tried to get used to the computer. He spent much time and effort on his own, and got additional help from his son, but there was nobody from school authority providing help for him.

Finally, the last position that is outlined is the one of Alan, who states the following:

Alan: Actually, the goals are set for us. Within two years, we have to bring the students to a level where they can pass a final exam, which has to be authorized by the 'Bezirksregierung'. And the goal is to get as many students there as possible.

Analogously to Peter and Jack, he feels forced from outside to invest in any professional learning.

As the presented discussion shows, some teachers' view on their professional learning and the corresponding motifs to engage in professional development are more on a meta level while others argue clearly on a micro level that is centered around their own teaching, their individual experiences and perception. Both levels can be connected through a reciprocal relationship, while the teacher's view on learning is just assigned to a different starting point but also considers the other direction.

Not for all teachers, such a view on professional learning as being a continuum ranging from individual advancement to institutional and systemic development could be assigned. Some of them clearly remain on the micro level, and are concerned with a perceived outside pressure to perform differently. These teachers appear as being mainly extrinsically motivated to attend in-service education, and some of the statements clearly pointed out how easily reluctances and obstacles can therefore emerge and can play a decisive role. Nevertheless, one should acknowledge that all teachers, even when following their own way, are in search for best approaches, which help them to help their students.

Support for teachers. Teachers need support in pursuing their professional development, whether in terms of simply showing appreciation, as the first of the listed teacher statements indicates, or by concrete institutional support, as is pointed out in the other commentaries. Concerning the former, Edith mentions an interesting point when explaining that she felt very privileged to get this *tandem* of a university teacher and a schoolteacher to her school:

Edith: And if we then, and I am now talking of *Mathematics Done Differently*, are fortunate that such terrific mathematicians come into the school, this here

is an experience that one could not have if one would drive elsewhere to attend an in-service course. [...] That we as teachers see that support from outside is provided, that we will be supported, is important, and one should not underrate something like this, in a positive sense.

One decisive parameter of the initiative *Mathematics Done Differently* is showing unreserved appreciation for the teachers. The above-mentioned statement points out how receiving support from outside is perceived positively. Obtaining the occasion to invite and work with mathematicians and mathematics educators in a direct contact is highly valued by the teacher. Moreover, Edith favors the opportunity to invite these trainers to the own school. That also breaks barriers between mathematics education, on the one hand, and mathematics teachers, on the other hand. Although some of the courses have already existed beforehand, the project made them available for all teachers in the whole of Germany.

Aspects of support for teachers encompass also simple financial help. Edith reports about how the teachers feel supported from outside, in particular, because they would not be able to procure money for that.

Edith: In-service education always goes with financial costs, and we as a school could not finance this kind of in-service training. That would absolutely not be possible, since the budget for in-service education is so small that we as a school can not afford to do so. Surely this is an important aspect, that the budget of schools for in-service educating is incredibly small, and that this goes beyond the possibilities of managing it in the school, of what we are able to afford.

Edith points out that her school would not have been able to provide the in-service training course since the school does not suppose of sufficient funds.

Another crucial issue in the field of professional development is support by school policy, either with respect to initially organizing an in-service training course, or follow-up meetings that focus on aspects of sustainability. Deborah stresses the significance of the support by school administration as follows:

Deborah: In consultation with the principal, in our school how we work depends a) on the character of my superior and b) on the issue of being a self-organized school. We work very independently in our positions as “Bildungsgangleiterin”.

She underlines that support by the headmaster or administration in general is very important to pursue school development independently. Accordingly, Pam reports about how she applied by the school administration for the in-service training course that was composed to contain four sessions:

Pam: In advance, I had asked my headteacher if she would allow a daily event. Well, and I said it costs nothing. Anyway, then I just said, it lasts four days and it costs nothing.

Most schools do not allow in-service training courses to last the whole day. The statement given by Pam shows that she anticipated problems to get this in-service

training approved. Therefore, she put in a good point when referring to the courses being free of charge provided by the project. In the following, she concretizes the obstacles for long-term events:

Pam: Well, daily events are not really welcomed in the state Berlin. Thus, there also is an instruction that not on any account should an in-service training course start before 2 p.m. Hence, as a rule, possibly after 3 p.m. And it is really an exceptional situation that administration of schools allowed that course, really. Well, this daily course, everybody is astonished that it worked.

Impressively, Pam points out that it was not taken for granted to get the permission for the course, particularly with respect to four days within the school year being necessary. Much of the research discussion related to professional development concentrates on abandoning short term and single events, but in the reality of professional development administrative restrictions are a matter of particular concern and run counter a long-term orientation.

Support by school policy encompasses fostering follow-up course work to enhance new or different teaching approaches. Agnes, for instance, stresses the importance of extensively dealing with the new input in the aftermath of a training course:

Agnes: Well, I think basic module for in-service education must be, well, successful to get all colleagues on board, to get them all to participate. Then, one has to develop a concept how the department can deal with, what the department can do with the insights provided by the in-service training course. How they can implement the school-intern curriculum, that they take homework from this in-service training, and meet again after six weeks, and that one then compares the homework. Well, thus a sustainable concept, regarding what needs to follow up.

Agnes emphasizes the fact that the in-service training course just presents one component. Much and collaborative work is needed within the department to implement incitements and ideas.

Accordingly, Ann broaches the following issues while reporting about how the staff will rework the input given by the in-service training course:

Ann: Definitely it [the issues imparted by the in-service training] will be taken up, well, and we will have a department meeting next Monday, where it will be reflected.

Ann's school is very seriously engaged in school development. In this context, she took over a leader role with respect to being responsible to administer funds for professional development:

Ann: Hence, it is simply like this: events are mostly offered to introduce the new core curricula, what they look like, what will be implemented and so on. Well, the school gets a budget for in-service education provided by the 'Bezirksregierung', and the school has to administer it on its own, that is, we have to watch out ourselves what trainers we invite, how much money we

have available. [...] That has to be maintained, and this lies even more in our responsibility than in former times.

She describes what developments have taken place, that in particular gave more responsibility to the individual school, even with respect to organizing in-service education. Given below, she points out that she informs her colleagues about specific events or advises them in related issues:

Ann: I am the one to organize those in-service training events, and the one who calls colleagues attention to it, like to point out that there are now more possibilities for in-service education and so on and so forth.[...] It is no additional money, in former times, hence, such issues always were submitted and accounted for by the 'Bezirksregierung'. That is, the 'Bezirksregierung' currently simply gives it to us, and has nothing to do with any longer, and therefore has much less work.

At first, Ann values that currently the single school gets funds to organize in-service education on its own, but she then deliberates about this trend and gives reason to think about it differently. That is, she also stresses that actually it was not the point that no money was available for the schools for in-service education, but that all events were administered centrally.

However, in the last statements she points out that fortunately establishing this fund has also initiated developments in the school:

Ann: Well, and insofar, if one now makes more out of it, it is maybe like that, because I walk around and refer to some in-service training courses, that we maybe do a bit more than in former times. But, in sum, at our school, it is like that, I do have the impression, that in the last years we have established pretty much and much things happened.

She finally concludes that decisive movements have taken place, also to further advance in school development.

SYNTHESIS AND CONCLUDING REMARKS

Both approaches of the empirical study, the quantitative and the qualitative one, contribute together to a comprehensive picture of how teachers conceive their professional development. At first, by means of a questionnaire, the following five dimensions, that structure the field of mathematics teacher professional development, were derived:

Table 15. Overview on the dimensions that result from the quantitative analysis

<i>Dimensions resulting from the quantitative analysis</i>
Importance of the Subject Department
Support by School Policy
Necessity of Professional Development
Implementation and Practicability
Sustained Collaboration

The dimensions were then analyzed in detail (cf. chapter six), a procedure that yielded some interesting aspects, of which some are briefly sketched in the following. Most teachers conceive their school as a collegial workplace, and feel supported by their school policy. However, a considerable amount of teachers does not state a supportive culture in the field of professional development. Furthermore, teachers widely acknowledge an individual and general need for in-service education, an issue that also played a decisive role in the teacher commentaries provided in the interviews.

Remarkably, much research in the field underlines the missing sustainability of in-service training, but the majority of teachers, i.e., almost two-thirds of them, consider the new issues imparted as feasible and practicable, and are thus much more positive in their estimation as generally thought. In turn, slightly more than one-third of the teachers stressed that no sustained professional exchange either with trainers or colleagues took place in the aftermath of an in-service training course.

Undoubtedly, teacher collaboration is a very decisive issue on the agenda of successful in-service training education, but the teacher estimations show that much development in this regard is needed. However, one should consider that this assessment, of course, refers to traditional forms of providing in-service education, where primarily single teachers from a school participated in centrally organized courses. Finally, with one exception, all dimensions were found to correlate significantly with each other. Connections are thus manifold, and they differ in their strength.

The qualitative findings correspond to the information collected by means of the questionnaire. That is, all dimensions were also included in the qualitative findings, although the labeling partly varied. However, the analysis of the qualitative data contributes to a better understanding of the specific attitudes and opinions of teachers. Particularly, the role of beliefs, affect, previous experiences and teachers' concrete needs are explored in detail and supplied a huge amount of interesting aspects.

So far, additional perspectives on decisive parameters for in-service education could be provided, as can be seen in the following table:

Table 16. Overview on the dimensions resulting from the qualitative analysis

<i>Dimensions resulting from the qualitative analysis</i>		
<i>Teacher learning</i>	<i>Teacher growth</i>	<i>Teacher needs</i>
Continous Learning	Previous Experiences	Need Identification and Prearrangement
Successful In-Service Training	Beliefs	Teacher Motifs
Relationship of Theory and Practice	Affective Variables	Support for Teachers
	Professional Collaboration	

The significance of the qualitative findings lies in exploring essential aspects of professional development in detail from a teacher's perspective. Thereby, the teacher statements provided by the interviews were at first assigned to the following three main dimensions: teacher learning, teacher growth, and teacher needs. These dimensions

were then further differentiated with respect to teachers' commentaries by which they informed about *their* views and experiences towards professional development.

However, as the detailed data analysis showed, the categories are of different value for teachers. In particular, the subcategories of the dimensions *teacher growth* and *teacher needs* revealed many interesting aspects that have not yet been explicitly reported on in the research literature. Correspondingly, the significance of beliefs and affective variables, the necessity of need identification and prearrangement, the role of teachers' motifs and the absolute need for support while pursuing their professional development should be highlighted.

NOTES

- ¹ For the sake of preserving teachers' and other persons' anonymity, the original transcripts cannot be found in the appendix, but are available from the author on request.
- ² The 'Bezirksregierungen' are special, regional organizations of the department of education, which provide in-service education in the state North Rhine-Westphalia.
- ³ <http://www.mathematikum-unterwegs.de/>
- ⁴ The term 'Bildungsbegleiterin' refers to a specific role of a teacher leader, the verbatim translation would be 'a person accompanying education'.