EMPIRICAL APPROACH AND METHODOLOGY

OVERVIEW

The previous chapters were concerned with presenting the theoretical framework and background, exploring the specific situation in Germany, and describing the initiative *Mathematics Done Differently*. This chapter deals with providing a synthesis of the issues explored so far. That is, the undertaken literature review results in listing the research questions that are guiding the empirical study.

Moreover, this chapter informs about how the aforementioned research questions have been approached empirically. As pointed out in chapter one, the conceptual frame of the empirical study considers various theoretical perspectives on mathematics teachers' professional development. Correspondingly, theoretical and methodological triangulation was chosen in order to include a wide range of views. The data collection thus draws on the different paradigms of quantitative and qualitative research. All methodological choices will be thoroughly discussed while addressing both of them explicitly. Thereby, the focus is on elaborating the basic principles and methodological justifications, the development and implementation of the research design, and finally the collection of data.

SYNTHESIS AND RESEARCH QUESTIONS

Conceptual diffuseness, multiple perspectives, and a lack of an overarching research-based theory characterize the field of professional development. However, there is some consensus on important variables that are crucial for effective professional development in general and in-service training in particular (cf. chapters one and two). Since much of the research conducted in mathematics education is concerned with elaborating on aspects of teacher knowledge, the focus of this work is to shed light on professional development from a broader perspective.

That is, the focus of the empirical approach is on the personal domain, the individual teacher as part of a professional world of practice. A key factor in ensuring effective professional development is matching professional learning opportunities to professional needs of teachers. Hence, teachers' related beliefs, subjective theories, experiences and learning needs are in the focus. Data that explicitly allows for looking into the subject from the corresponding teacher's point of view will be presented. Since Malara and Zan (2002) point out that "most studies are about teachers but not with or for teachers" (p. 554), the approach of this work is to stress the *with* and *for*.

All data is gathered in the context of the initiative *Mathematics Done Differently*, which is specifically dedicated to designing professional development opportunities

according to teachers' needs (cf. chapter four). In the empirical study, the first level of Lipowsky's (2004) four-stage system of examining and identifying successful aspects of in-service training programs is operationalized, i.e., teachers' opinions are explored. Thereby, the objective is to illuminate the following issues: professional learning and learning needs, professional and collegial exchange, professional identity, affective aspects and beliefs, as well as the relationship between theory and practice. What will be particularly elaborated on are factors identified by teachers as contributively to successful professional development.

As pointed out in the theory section, an encompassing *big* theory in teacher education is missing on the research agenda. The field is characterized by a huge variation of approaches, but there is at least consent on some key issues. In the empirical study, approaching teacher professional development thus draws on theoretical triangulation (cf. Cohen, Manion & Morrison, 2007). In particular, the following research paradigms have been stressed:
– Professional development is teacher learning.
– Professional development takes place in a field of tension between theory and practice.
– Growth processes not only occur in terms of knowledge but beliefs.
– Developmental processes initiated and supported by collaborative practice contribute to identity formation.
– Professional development explicitly considers teachers' needs and expectations.

The main assumption guiding the empirical approach is that teachers' view on professional development is structured and consequently unravelable. Clarifying the subject under investigation aligns with the aforementioned paradigms.

Corresponding research questions are listed below and are grouped into three different main dimensions, which are of course intertwined but are mainly addressed separately:
– *Teacher learning:* Professional development is regarded as a lifelong and continuous learning process. How do teachers perceive their learning and which variables do they consider relevant? Do teachers deem their professional development as a long-term career-related process? From a teachers' point of view, what makes professional development effective? What supporting or hindering factors can be identified? Which relationship between theory and practice is required in the field of professional development?
– *Teacher growth:* Influential for teacher growth processes are affective aspects and beliefs related to professional development, which play a decisive role in any learning process. What attitudes and beliefs do teachers hold towards professional development? What previous experiences influence the reception of current professional development events? What are the underlying views of the participants? How do they perceive any change processes? How is the role of professional collaborations valued?
– *Teacher needs:* A decisive approach in the field of professional development is to take teachers' needs and their expectations seriously. What are teachers long-term professional development needs? What is the teachers' motivation to actively engage in professional development or to participate in-service training courses?

How can those needs be differentiated with regard to aspects of content, context and community?

These research questions guide the empirical study that is presented in chapters six and seven.

METHODOLOGICAL CHOICES

The empirical study comprises the following proceeding: First, quantitative data was gathered in the run-up of the project *Mathematics Done Differently* concerning teachers' experiences, expectations and needs regarding professional development. Second, qualitative data was collected by providing interviews with teachers throughout the course of the project. Third, observations made while monitoring many of the in-service training courses complete the overall picture. However, the focus of the empirical study is on the first two aspects. The following subsections, which are dedicated to informing about the empirical choices, therefore just address those two.

Basic Principles and Methodological Justification

Various theoretical aspects on mathematics teacher professional development serve as a conceptual framework in this thesis. Theoretical triangulation allows for including this variety of viewpoints. The synthesis of different approaches provides broad insight and enables a widespread overview. The abovementioned divergent research paradigms were selected with regard to the addressed issues. Ultimately, teacher development is a specific aspect of human behavior, whose complexity demands "studying it from more than one standpoint and, in so doing, by making use of both quantitative and qualitative data" (Cohen, Manion & Morrison, 2007, p. 141).

Combining different methods of data collection thus allows for including different perspectives. According to this, more general quantitative data was gathered in order to get a first comprehensive overview. Furthermore, qualitative data, enabling a deeper analysis of the subject under discussion, was taken into account. Data collection in the study hence contributes to methodological triangulation (Cohen, Manion & Morrison, 2007). This strategy prevents the data from simply becoming an artifact of one specific method of collection. The two methodologies are used equally and in parallel and they both contribute to presenting a bigger picture of teacher professional development. In particular, the results section informs about the consistent findings and shows how these different approaches complement one another.

Quantitative approach.   The favorite approach to investigating knowledge and beliefs concerning a specific construct in psychological settings is a quantitative one. Correspondingly, one choice was to collect comprehensive data by means of a questionnaire. This questionnaire was also developed in order to get information about teachers' issues connected with professional development both in general and domain-specific in mathematics. The approach was chosen in the run-up to the project *Mathematics Done Differently* and the gathered data was essentially considered in the initial design phase (cf. chapter four).

Different dimensions normally structure attitudes towards a specific construct. The relevant question pursued in the quantitative analysis is to determine important dimensions for mathematics teacher professional development. The approach encompasses their perception and cognitive representation of beliefs and knowledge concerning issues of professional development. Factor analysis is employed to statistically discover the aforementioned dimensions in which participants categorize their experiences.

The choice of method inevitably determines the direction of research, and partly the perspectives included in the results. That is, the quantitative approach by using a questionnaire preliminary constitutes the scope within which teacher needs, expectations and perceptions on professional development manifest themselves. However, range of dimensionality and content of the dimensions are not determined. These two sets of parameters only emerge through the statistical analysis of the data even though theory-driven dimensions are already comprised in the questionnaire.

The obtained factors cannot be interpreted as presenting a final structure because the results are not simply determined by participants' choices, but also depend on the sample, the items and the basic factor model. Hence, number as well as content of the dimensions is subject to some context factors and choices; statements about the dimensionality can only be made hypothetically.

In the introduction of this work, while rephrasing the title of an article by Bauersfeld (1980), it was questioned whether there are *hidden* dimensions in the reality of professional development that are not covered by research in this area. The qualitative approach that will be outlined in the following is dedicated to giving the floor to the teachers in order to explore their personal view and individual interpretations on the phenomena under investigation.

Qualitative data.   Since human perspectives are more or less encoded when using quantitative data, additionally, qualitative data was collected. Interviews with teachers allow for giving broad insight into their perspective. It has been of particular concern to use the words of the teachers themselves to show what professional development looks like from their perspective. Cohen et al. (2007) describe the advantage of providing interviews as follows:

> Interviews enable participants – be they interviewers or interviewees – to discuss their interpretations of the world in which they live, and to express how they regard situations from their point of view. (p. 348)

For their quality, interviews rely on the nature of the interactions between the persons involved; this also includes the person of the interviewer (Partington, 2001). Kvale (1996) refers to the literal meaning of the term interview as actually being an *inter-view*, e.g., people do interchange their views on a specific topic, a socially situated interaction in which knowledge evolves by dialogue.

With regard to the aspects discussed above, the qualitative study contributes firstly to a deeper understanding of the quantitative findings, and secondly to gaining additional insight. That is, the questions used in the interviews are concerned with concretizing some of the issues reflected in the obtained dimensions, in particular

with regard to context, and also to explore what further aspects are relevant for teachers.

As a disadvantage in the qualitative paradigm, the researcher becomes an instrument of data collection, and results may vary greatly depending upon who conducts the research. This issue is particularly relevant when interviews are not entirely standardized. But in view of the wide range of information provided by teachers, as will be shown in the results chapter, this approach has proven to be a good choice, i.e., rich data could be collected. Nevertheless, this qualitative approach is time-consuming, in regard not only to collecting, but also to analyzing data.

Development and Implementation of the Research Design

The research design of the empirical study was developed in connection with the author's engagement in the initiative *Mathematics Done Differently*. Throughout this work, much information about relevant issues in the context of professional development, even from a teacher's perspective, was gained and contributed at the very least to the ultimate qualitative empirical approach. In chapter four, while presenting the initiative, the significance of a learning system that also includes the teacher educator learning was stressed.

Research questions were basically developed regarding the theoretical input but furthermore, daily experiences while dealing with teachers seeking their specific professional development, left their mark on the researcher's interest, too. In the following, important information on the choices that have been made concerning this matter are given in detail.

Development and implementation of the questionnaire. As already mentioned, the quantitative data was gathered before the actual project started. Addressed were teachers' retrospective as well as prospective views on their professional development. A huge questionnaire comprised of 272 items was employed to obtain information about the following topics (cf. section four; Jaeger & Bodensohn, 2006):

Demographic variables: Age, gender, education, and occupation.

Professional development in 2005: quantity, in mathematics, general content, domain-specific content, and own initiative.

Relevance of topics for professional development: subject matter themes, pedagogical content themes, interdisciplinary themes, pedagogical themes, and general themes.

Choice of topics: pedagogical content themes and general themes.

Attitudes towards and experiences with professional development: need for professional development, support by school, transfer and sustainability.

Expectations regarding future professional development: content and design, conditions, financial share, and trainers of the courses. (p. 9)

Of specific interest to this work is the part of the questionnaire that deals with attitudes towards and experiences with professional development. A preliminary and shorter version of the questionnaire was developed and tested in spring 2006 (Roesken & Toerner, 2006), and primarily draws on two different quantitative approaches (cf. Lipowsky, Thußbas, Klieme, Reusser & Pauli, 2003; Frey & Balzer, 2005). The segment relevant in this discussion dealt with 26 four-level Likert-items. In the following, the dimensions are labeled, and some examples for the items used are given:

– *Need for professional development:*
  – I see necessity for myself regarding professional development.
  – While exchanging with other colleagues during an in-service training, I became aware of my own deficits and needs.
– *Support by school:*
  – My school administration supports me in my endeavor to attend an in-service training course.
  – School administration honors attending in-service training courses by different measures.
– *Transfer and sustainability:*
  – I experienced that I gave up new ideas and suggestions after a short time and went back to the approved methods.
  – The implementation of issues learnt during in-service training has turned out to be difficult because my school only slowly prepares for new content.

The respondents were asked to rate each item on the following scale: 1 = agree strongly, 2 = agree somewhat, 3 = disagree somewhat, 4 = disagree strongly. It should be noticed that the questionnaire was administered in the German language. Since there is no adequate translation of the internationally used term of professional development, the notion in-service training course dominates the formulation of items.

Methodological aspects of the interviews. Interviews were conducted with participants of several in-service training courses provided by *Mathematics Done Differently*. One goal was to capture sensitive data covering teachers' attitudes and opinions towards their professional development by establishing a face-to-face encounter supplementary to the rather anonymous quantitative approach. This encompasses teachers' experiences with professional development in general as well as in the context of the initiative in specific. It should be noticed that the objective of the interviews was surely not to evaluate the provided courses, but to gather information on a meta-level.

All interviews were semi-standardized. Open-ended questions were used, but followed a preliminary theoretically grounded conceptualization. The broad and overall questions were the ones generally guiding the research. In addition, first impressions derived from the quantitative data analysis led to questions that were more precise and ranged from being descriptive to normative. An interview guide, indicating the topics to be covered and their sequence in the interview, was employed (cf. Kvale, 1996). That is, the guide contained a general outline of the

relevant topics as indicated by the research questions and more specifically, some interview questions:

– *Teacher learning:*
  – Regarding your professional development, do you have specific learning needs?
  – Is attending an in-service training part of a continuous process or rather a spontaneous decision?
  – What are your expectations regarding the in-service training course?
  – From your point of view, what makes professional development effective? Can you point out some supporting or hindering aspects?
  – How do you evaluate the tandem approach, e.g., that all courses are provided by a pair consisting of a university teacher and a schoolteacher?
  – What relationship between theory and practice do you deem as essential?
– *Teacher growth:*
  – What general goals do you want to achieve with regard to the in-service training?
  – How are your experiences with professional development so far?
  – From your point of view, what is important for your professional development?
  – How important is it that colleagues from your school accompany you to an in-service training course?
  – What does change in your classroom practice after attending an in-service training event?
– *Teacher needs:*
  – What are your long-term professional development needs?
  – What is your motivation to attend an in-service training course?
  – How important is support by your school administration or your colleagues?

However, the wording and the order of questioning were not standardized. But at least, the interview guide served as framework within which the teachers could respond in a way that represented their point of view accurately and thoroughly.

Obtaining sound qualitative data is a complex task and places high demands on the interviewer. While identifying problems in technique, Partington (2001) stresses the significance of the following issues in a research interview: empathy and rapport, listening and questioning, restatement, clarification and persistence. In the following, some clarifications are given with respect to these variables.

Questions format varied from direct to indirect. Mostly an indirect way, for instance, asking for the respondent's view on professional development in a rather general manner, was favored. Indirect approaches are more likely to obtain frank and open responses. Thereby, questions ranged from inviting factual answers to asking for opinions. Even though the interviewer is in charge of structuring and directing the questions, one advantage of the semi-structured interview is that the arrangement is essentially dependant on the interviewee. The primary technique applied during the interviews was trying to stimulate teachers to deepen their descriptions and explanations. That is, the vocabulary used by the interviewees was further taken up, and used as stimulus to probe for more in-depth responses. In most cases, the interviewees were sensitive to this invitation and elaborated on their statements.

This technique helps to avoid pre-determination by the interviewer as well as interpersonal dynamics. Besides, the definite course of the interview stays undetermined with regard to content. Further, the interviewer also remains flexible to a person's choices and the emerging themes. These issues were particularly relevant since the basic concern was to get information about teachers' thoughts, experiences and basic perceptions. As a result, interesting or even unexpected ideas and themes were raised by participants and were, in case of relevance, additionally explored.

Various themes occurred naturally and the results section reports on those. The statements given by teachers did not only cover descriptive, but also explicative information and enabled understanding issues of professional development more deeply. At a certain point, interventions turned out to be necessary in order to keep the interview functional.

COLLECTION OF DATA

Questionnaire

The questionnaire was administered as an Internet-based survey and was widely announced among teachers. In 2006, teachers had access to participate from the 3rd of November to the 3rd of December via the homepage of the Centre of Educational Research[1] (zepf), for more and detailed information see Jaeger & Bodensohn (2006). Participants came from allover Germany and many different school types. The filling out of the online questionnaire took 22 minutes on average. 1715 teachers participated in the study, which serves as an inventory, but is not a representative study since the Laender are not adequately represented in the data (cf. chapter four).

The age of participants ranged from 22 to 65 while the average age was 47 years. Further, 82% of teachers had studied mathematics or mathematics education while remarkably 18% did not. Teachers came from different school types of secondary education, and were engaged in primary education and some special schools as well. Finally, 72% of teachers were working full time and 28% part time. More detailed information about the demographic variables is given in Jaeger and Bodensohn (2006).

Interviews

The interviews were scheduled to last about 40 minutes. In reality, the interviews then varied from 20 to 60 minutes; the setting was dependent on the teachers' choices. Nine teachers participated in the interview study; three of them were male. Most of the teachers were interviewed in a room of their own school and during their working hours. Participants came from allover Germany and from different school types[2]: elementary school, Realschule, Gymnasium, comprehensive school and Berufskolleg. They were chosen out of approx. 2000 teachers who had participated in the initiative *Mathematics Done Differently* up to that point in time.

The age range was from 32 to 61, yielding an average of 50 years. Teachers were mostly experienced, five of them looked back on more than 20 years of teaching,

three of them on more than 10 years while one teacher was rather young and possessed only four years of experiences in the job. All teaches were assigned some special roles within the school community. Some of them were quite familiar with respect to being actively engaged in professional development, for instance, in the role of a teacher leader. In case that this information is relevant, a respective indication will be given in what follows.

Interviews were conducted in accordance with an interview guide by the author of this work; further, they were undertaken in the German language. Responses of the participants were recorded on tape and later carefully verbatim transcribed. In any case, a student assistant provided a first transcript that afterwards was carefully reviewed by the author and partly retyped. Those parts selected to be subject of an intensive analysis were then translated into English. Thereby, the aim was to translate literally as far as possible, but also in an accessible way. However, the data analysis also drew on rehearing the recorded interviews several times.

NOTES

[1] http://www.en.zepf.uni-landau.de

[2] For an overview on the German educational system see http://www.partners-in-education.com/pages/germany/prolog_germany.html