CHAPTER 2

MATHEMATICS TEACHER PROFESSIONAL DEVELOPMENT

Theoretical Models

Regarding the theoretical models, the goals of the chapter are to model teacher learning and professional development, to present major models of professional development, to elaborate on the specific model of in-service education and training, to discuss effects of in-service training, and to elaborate explicitly on teachers' needs and expectations. Finally, some implications for research on professional development will be given.

IDENTIFYING THE RELEVANT PROCESSES

While summing up issues of theory and practice in mathematics teaching development, Jaworski (2006) stresses that to theorise teaching is a problem with which most educators are struggling (p. 189). She further points out that although mathematics education has been assigned a key role in the development of theories, which were mainly promoted in other disciplines like for instance constructivism, "the position of mathematics teaching remains theoretically anomalous and underdeveloped" (p. 188). At least an overarching theory to characterize mathematics teaching as well as its development, or as Jaworski (2006, p. 188) puts it, "a big theory" for teacher learning is missing on the research agenda.

The corresponding, rather complex and demanding issue is to theorize professional development, above all when it is tackled on a meta-level, going beyond simply identifying the relevant variables. This approach is a crucial one, since most of the conducted research is restricted to merely theorizing but neglecting the significance of the processes (cf. Krainer, 2006). Since the former has been in the focus of this work so far, for instance, while dealing with the domains of knowledge and beliefs, in the following, different approaches to model how these parameters interact will be visited, hence, in terms of broader models.

MODELING TEACHER LEARNING AND PROFESSIONAL DEVELOPMENT

Although a big theory for teacher professional development is missing, there are different approaches relevant in the context that provide substantial theoretical models. Regarding the multiplicity, the following choices were based on if and how the aforementioned theoretical perspectives were seized on. That is to say, the following approaches are key with regard to the issues presented in the first part of the theory

section, since they stress procedural aspects in terms of interdependencies regarding the involved variables, moreover addressing the single teacher as well as the whole system.

At first, a general model on teaching will be outlined that draws on a teacher's knowledge, goals, and beliefs (1), secondly a more systemic approach valuing the interplay of aspects of community, context and content (2) will be presented, thirdly a model pointing to the same direction but being based on the dimensions of action, reflection, autonomy and networking (3) will be sketched and finally an interconnected model of professional growth (4) will be elaborated on:

Knowledge, Goals and Beliefs

Schoenfeld (1985, 1999) provides an interesting approach to the field of teacher education when deriving theoretical aspects concerning teacher professional development from aspects of learning and teaching mathematics in general. He enters the field by framing at first teaching as a type of problem solving with multiple goals relevant at the same time. His theory of *Teaching-In-Context*, that he also understands in a broader sense as *Teaching-In-Action*, models teaching primarily as function of a teachers' knowledge, goals and beliefs (Schoenfeld, 1998). In what follows, Schoenfeld (1999) also highlights the outcome of the approach:

> On the one hand, work addressing such teaching issues is deeply theoretical; it calls for delineating a teacher's goals, beliefs, knowledge, and decision-making, and modeling how all these interact. On the other hand, such work will have significant practical payoffs. It will provide tools for identifying practices and knowledge that support desired kinds of teaching, as well as tools for examining various forms of professional development and their impact. (p. 6)

Teachers are acting in a specific moment; these actions are goal-oriented and based on a teacher's knowledge, orientations as an abstraction of beliefs, values, preferences, and decision-making. Then, as an implication for professional development, he deduces that these parameters may not only serve as tools to identify practice, but in addition provide information about how several issues interact, finally with respect to capture how the dynamic can be influenced. What is interesting in the model provided by Schoenfeld is that the parameters he considers as crucial and decisive are also referred to in many publications dealing with aspects of professional growth. However, the focus is on the individual teacher, and although contextual factors are valued, the taken perspective is primarily a cognitive one.

Community, Context and Content

Llinares and Krainer (2006) provide a different approach while pointing out that considering teacher learning as a crucial aspect of professional development involves discussing the issue on an individual, a social and an organizational level:

> This perspective stresses the fact that the analysis of teachers' professional development needs to take into account a wide range of variables which include

> the teachers, their relations with other teachers, and the context in which their operate, and of course the content. (p. 445)

To sum up, relevant variables for teacher learning are the ones of community, context and content, but particularly crucial is their interconnection. Krainer (2006, p. 86) explicates the concepts as follows:

> *Contents* that are relevant for all who are involved (e.g. interesting activities for the students, challenging experiments, observations and reflections for teachers, constructive initiatives and discussions at school);
>
> *Communities* (including small teams, communities of practice and loosely-coupled networks) where people collaborate with each other in order to learn autonomously but also to support others' and the whole system's content-related learning;
>
> *Contexts* (within a professional development program, at teachers' schools, in their school district, etc.) have conducive general conditions (resources, structures, commitment, etc.)

Since the research focus so far has often been on content, and communities have nowadays found their way onto the research agenda, what is often neglected is the relevance of the context. The former two aspects, for instance, are addressed jointly by Lachance and Confrey (2003), who report about a successful professional development opportunity while interconnecting content and community. However, the latter has only received minor interest. That is, a decisive parameter is the organizational support by administration or the educational system as a whole, not at least regarding variables like "enough time, space and other resources" (Krainer, 2006, p. 86).

The concepts are sometimes referred to as the three C's of marketing, a naturally interesting approach to teacher in-service education, which understands providing help for practicing teachers to be dependent on the law of supply and demand. This issue is explicitly paid attention to in the project design of the professional development initiative that will be presented later.

Action, Reflection, Autonomy and Networking

Krainer (1998, 2002) further introduces a four dimensional-model of teachers' professional practice while dealing with action, reflection, autonomy, and networking, which are described as follows:

> *Action.* The attitude towards, and competence in, experimental, constructive and goal-directed work;
>
> *Reflection.* The attitude towards, and competence in, (self-)critical and one' own actions systematically reflecting work;

> *Autonomy.* The attitude towards, and competence in, self-initiated, self-organized and self-determined work;
>
> *Networking.* The attitude towards, and competence in, communicative and co-operative work with increasingly public relevance (Krainer, 2002, p. 282)

While reflecting the typical situation of a teacher at school alongside these dimensions, Krainer (2002) describes it as "mostly dominated by action and autonomy, there is a lack of reflection and networking in the sense of a critical dialogue about one's teaching with colleagues, mathematics educators, etc." (p. 282). As explanation, Krainer (2002) refers to the traditional pre- and in-service education, focusing primarily on the individual teacher.

The dimensions are dependent on each other since "an increased competence in reflection raises the quality of action, and the knowledge of views of others enlarges the view of one's own situation. Summing up, more reflection and networking contribute to a higher quality of autonomous action" (Krainer, 2002, p. 283). Hence, the dimensions considerably correlate with each other and balancing the needs of an individual within this field of tension is a great challenge for teacher educators and teachers.

The model further serves to capture similarities and differences of diverse professional development programs, independent from the country in which they were launched (Krainer, 2002). That is, the focal point of initiatives can be discussed against this background. Moreover, the dimensions are crucial when considering teacher education on a theoretical level, since they bring together different perspectives, particularly valuing the influence of attitudes and beliefs. The interdependency between action and reflection, for instance, is also a central issue in action research (cf. Altrichter et al., 2008), the conception of teachers as learners, whether autonomous or collaborative is in the focus of constructivism and any relation between those views is the central topic of a systemic theory (Krainer, 2002).

Interconnected Model of Professional Growth

The last model that will be outlined is particularly aiming at teacher professional growth while elaborating on different domains of developmental processes. Clarke and Hollingsworth (2002) describe the model as offering "a powerful framework to support the analyses of those studying teacher change (or growth) and the planning of those responsible for teacher professional development" (p. 947). The model that will be discussed in detail was developed through several iterations (Clarke, Carlin & Peter, 1992; Clarke & Peter, 1993; Peter, 1995, Clarke & Hollingsworth, 2002).

As Clarke and Hollingsworth (2002) report, the empirical foundation of the model draws on three different Australian studies: the ARTISM study (Active and Reflective Teaching in Secondary Mathematics), the EMIC study (Exploring Mathematics in Classroom) and the negotiation of meaning project. What is striking is the explicit focus on understanding the processes of professional growth and the supportive conditions. At first, Clarke and Hollingsworth call to mind the "implicit purpose

of many teacher in-service programs: specifically the causal chain in which such programs are based" (p. 949):

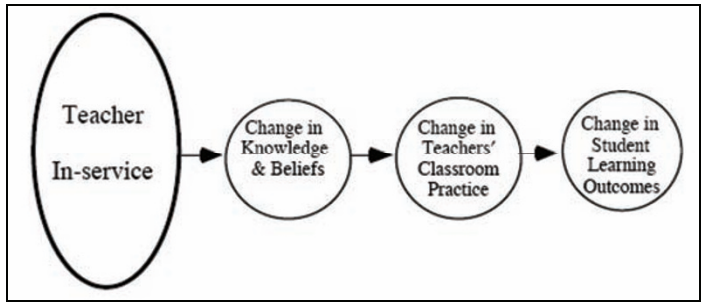

Figure 1. An implicit model of the purpose of teacher professional development (Clarke & Hollingsworth, 2002, p. 949).

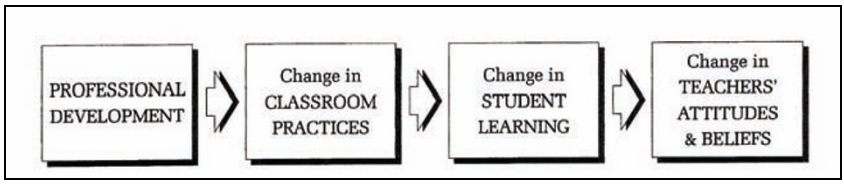

Figure 2. Guskey's (2000, p. 139) model of the process of teacher change.

The "change in attitudes comes first" approach, so Guskey (2000, p. 139), which is modeled in figure 1, drives most of the common professional development programs and draws on the classical work by Kurt Lewin who stated a likewise relationship for therapeutic settings. An alternative model is given by Guskey (2000), who emphasizes that "significant change in teachers' attitude and beliefs occurs primarily *after* they gain evidence of improvements in student learning" (p. 139), as is indicated in figure 2.

Still the process of teacher change is defined by means of a naïve linear model and some authors rightly criticize that a highly complex process is oversimplified (Clarke & Peter, 1993; Peter, 1996). In this regard, Peter (1996) reminds of the fact that Guskey's model is mainly derived from in-service training practice in the 70s and early 80s.

However, the model at least refers to one striking point, that is, the sequential order in the model indicates that change in a teacher's beliefs and attitudes is a long-term goal, depending on how changes in a teacher's classroom practice interfere with changes in student learning outcomes. That is, significant development is likely to occur, "once teachers have "field-tested" change proposals in classrooms and experienced first hand changes in student learning outcomes" (Clarke & Hollingsworth, 2002, p. 949).

Cobb, Wood and Yackel (1990), who explain that changes in beliefs can occur at any point of the developmental process, provide a consequently different approach. They draw on the well-known work by Leon Festinger and explain that teachers have to undergo feelings of cognitive dissonance. While engaged in the classroom, conflicting beliefs and thoughts need to occur in order to produce any change in behavior.

Clarke and colleagues have modified the initial linear model by Guskey fundamentally while assuming a cycle of professional development, as can be seen in figure 3:

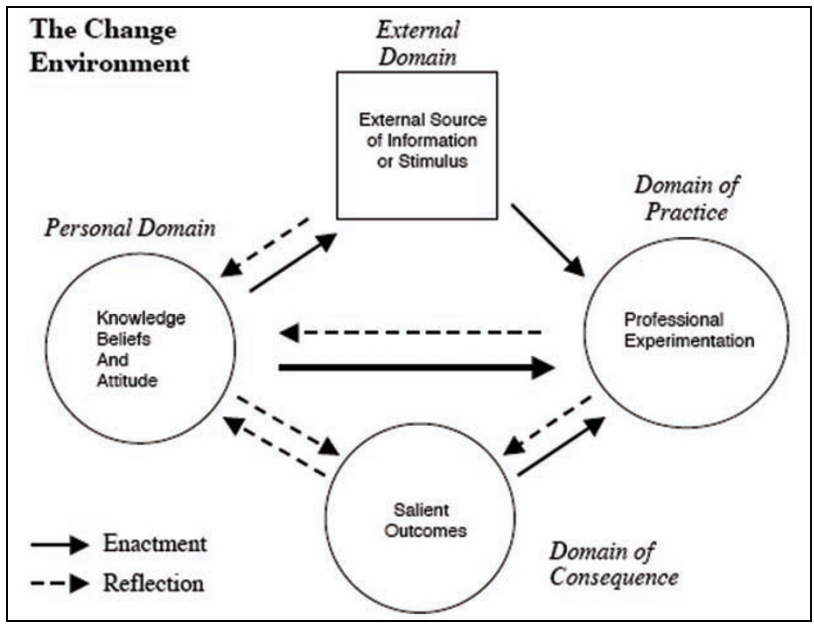

Figure 3. The Interconnected Model of professional growth (Clarke & Hollingsworth, 2002, p. 951).

The *Interconnected Model* explains teacher professional growth in terms of analytic domains that are connected through mediating processes. The domains, provided by Clarke and Hollingsworth (2002, p. 950), are the following ones:

- *The personal domain*: teacher knowledge, beliefs and attitudes
- *The domain of practice*: professional experimentation
- *The domain of consequence*: salient outcomes
- *The external domain*: sources of information, stimulus or support

Hence, the model encompasses two different types of domains while distinguishing between external and rather internal domains, the latter representing a teacher's personal world:

> In combination, the domain of practice, the personal domain and the domain of consequence constitute the individual teacher's professional world of practice, encompassing the teacher's professional actions, the inferred consequences of

> those actions, and the knowledge and beliefs that prompted and responded to those actions. (Clarke & Hollingsworth, 2002, p. 951)

In the personal domain, teachers' knowledge, beliefs and attitudes, underlying any classroom practice, are considered as essential while the domain of practice is concerned with the enactment of knowledge and beliefs, explicitly considering the teaching practice as being partly experimental (Peter, 1995, 1996) but also conceiving it as "encompassing all forms of professional experimentation" (Clarke and Hollingsworth, 2002, p. 950).

The values then attached to the corresponding outcomes, so Peter (1995), "constitute the mediating domain by which classroom experimentation is translated into changed teacher knowledge and beliefs" (p. 322). Clarke and Hollingsworth (2002) further explicate, "change in the domain of consequence is firmly tied to the teacher's existing value system and to the inferences the teacher draws from the practices of the classroom" (p. 953). Furthermore, they emphasize that values do have an individual dimension, i.e., that they differ among teachers, who also estimate different issues as salient.

Referring to values is an interesting approach since teachers appear to have a very strong value system, which makes them easily resistant to any purpose of change processes. Moreover, values also exist on the administration side that might lead to conflicting positions.

The external domain encompasses any external source of information or stimulus and is not restricted to in-service sessions but includes other sources of information like publications or conversation with colleagues as well (Clarke & Hollingsworth, 2002). An important role is attached to those mediating processes that are "classified as being either enaction or reflection" as means to "translate growth in one domain into another" (Peter, 1995, p. 322). Clarke and Hollingsworth (2002) explain the labeling as follows:

> The term "enaction" was chosen to distinguish the translation of a beliefs or a pedagogical model into action from simply "acting", on the grounds that acting occurs in the domain of practice, and each action represents the enactment of something a teacher knows, believes or has experienced. (p. 951)

Obviously, the authors' conception is close to Schoenfeld's approach of understanding teaching as a function of a teacher's knowledge, goals and beliefs.

The model allows for describing different aspects of change processes, serving as factors that influence a teacher's growth. The change process can begin and end at any point in the model but an ideal course would include all domains (Peter, 1996). As mentioned earlier, the model has been revised a number of times. Since most of the change processes could not adequately be described in earlier versions, for instance, because the intentionally provided in-service education was not the only stimulus for changes in the classroom or because the reciprocal interaction of the factors was firstly neglected (Peter, 1996), further modifications have been worked out. Finally, as Clarke and Hollingsworth (2002) note, "this model recognizes the complexity of professional growth through the identification of multiple growth pathways between the domains" (p. 950).

Though a teacher's learning process is modeled in detail by including different domains, it can also be described in rather individual terms, e.g., with respect to a single teacher's growth. Accordingly, Clarke and Hollingsworth (2002) provide an individualized version of the model, explicitly stressing the focus on a particular teacher, as can be seen in figure 4:

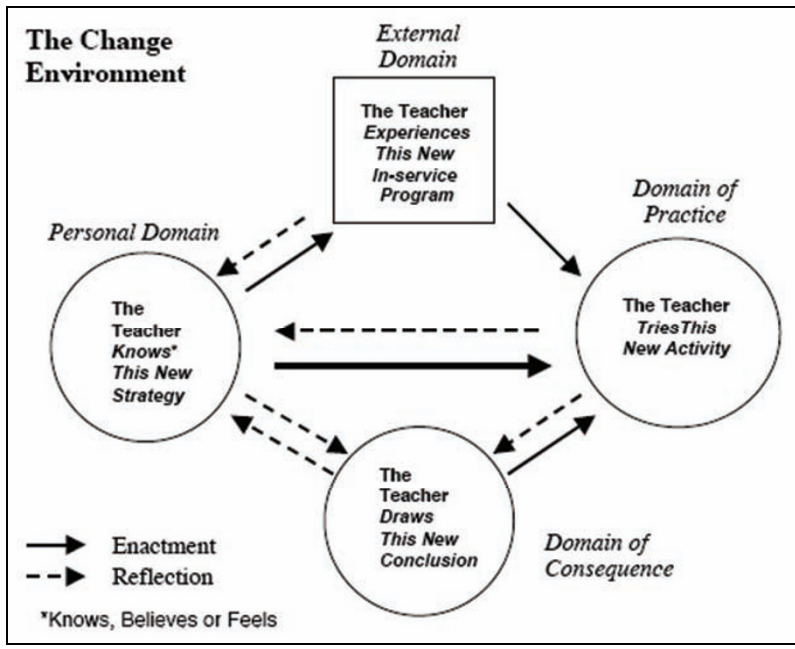

Figure 4. Operationalization of the domains regarding a single teacher (Clarke & Hollingsworth, 2002, p. 957).

All domains are now personalized, a teacher obtains new information or strategies during an in-service program, tries the new activities in the classroom, connects them to the salient outcomes which then "will inevitably reflect the teacher's existing conception of the goals of instruction, and of acceptable classroom practice; that is, the teacher's knowledge and beliefs" (Clarke & Hollingsworth, 2002, p. 957).

The authors are aware of the demand that their "modeling of teacher growth must conform to some coherent theory of learning" (Clarke & Hollingsworth, 2002, p. 955). With respect to the criticism expressed by Jaworski (2006), as reported earlier in this section, they mainly regard a cognitive or situative perspective on learning as crucial but they advise against the following:

> The Interconnected Model can be interpreted as consistent with either the cognitive or the situative perspective, dependent upon whether we take teacher growth as being the development of knowledge or of practice. This is not a

> dichotomous choice. Indeed, any dichotomization of knowledge and practice as competing objects of learning should be seen as problematic. (Clarke & Hollingsworth, 2002, p. 955)

An analogous point of criticism has been raised earlier, Ball (2000b) reflected upon the distinction between knowledge and action as a not helpful fragmentation in teacher education. In that sense, the value of the model lies not only in its interconnectedness but interrelatedness since it pays attention to both development of knowledge *and* practice in terms of possible growth networks, takes into account key change domains and highlights the mediating processes relevant for effective professional development.

MAJOR PRACTICAL MODELS OF PROFESSIONAL DEVELOPMENT

The increasing discussion on professional development has not only led to various theoretical and methodological approaches but also to new models and designs. Guskey (2000) differentiates seven major models of professional development, which are presented in table 1:

Table 1. Major practical models of professional development (Guskey, 2000, p. 22).

Majors models of professional development
Training
Observation/assessment
Involvement in a development/improvement process
Study Groups
Inquiry/action research
Individually guided activities
Mentoring

As Guskey (2000) further points out, "these various models differ in their assumptions, expectations, and beliefs about professional growth" (p. 28). They serve different purposes since some aim at changes on a more general and systematic level whether others explicitly provide support on the individual level.

However, the most common conception of professional development is certainly related to providing training for serving teachers, which is the prevailing model in many countries (Guskey, 2000). Even though over the last 20 years, the vision of teachers as lifelong learners has permeated research in this area, in-service education and training appear "to be the most efficient and cost-effective way to reach the huge population of teachers" (Day & Sachs, 2004, p. 8). These courses have a wide range of topics, goals and methods but limited duration. The methods involved can

range from group work, use of video, learning from practice to presenter-given input. Until so far, and regarding the focus of this work, in-service education will be deeply elaborated on in the following, always keeping in mind that no method is innovative or traditional by itself (Cochran-Smith & Lytle, 1999).

The other models of professional development will not be presented in detail but sometimes referred to since they stress relevant aspects for a general debate on teacher growth; for a general conspectus on study groups, inquiry and action research the reader is referred to the work of Altrichter et al. (2008), Borko (2004), Jaworksi (2006), and Lave and Wenger (1991). As more relevant is considered that these models are not discrete entities. One legitimate view on in-service training arguably might be to view this specific type of activity as partly comprising the other ones. That is, in-service training can include facets of inquiry and action research or study groups. Garet, Porter, Desimore, Birman and Yoon (2001) point to the same direction when concluding that "to improve professional development, it is more important to focus on the duration, collective participation, and the core features (i.e., content, active learning, and coherence) than type" (p. 936).

IN-SERVICE EDUCATION AND TRAINING

For good reason, the focus so far has been on teacher professional development, the broader and more elaborated concept, embracing that of in-service education and training. While providing principles concerning effective professional development, Loucks-Horsley et al. (2003) emphasize that "beliefs about professional development have changed during the past 30 years" (p. 47). Particularly, they stress that "in the early 1970s, professional development was called inservice training" (p. 47). However, the authors do not further explicate what kind of beliefs about professional development are decisive and of relevance for teachers, teacher educators and administration. Particularly, teachers' beliefs about and attitudes towards professional development are a non-negligible parameter, as will be pointed out in the following sections.

Meanwhile, the concepts of professional development and in-service education are clearly distinguishable and much research has been conducted focusing on each of them, although with different strength and relevance concerning the specific subject education. As mentioned earlier, the model still definitely associated most with professional development is in-service teacher training (Guskey, 2000), since it ultimately presents the most common form of providing help for practicing teachers.

There has been much progress in the field, and viewing in-service education as being job-embedded and a part of professional development has permeated the agenda. Nevertheless, the following statement given by Guskey (2000) stresses that the hitherto conception of in-service education as brief and rarely sustained, deficit oriented, and radically under-resourced unfortunately is still relevant:

> Many teachers and school administrators regard professional development as special events that are restricted to 3 or 4 days during the school year. Seldom have they had input into the planning of these events, and only rarely are the ideas that are offered applicable to their situation. (p. 14)

However, while acknowledging a growing recognition of conceptualizing in-service education and training and professional development in different ways, Hargreaves (1994) gives an interesting metaphor for each of the concepts:

> The INSET [In-Service Education and Training] model during periods of reform treats teachers as needing occasional injections to pep them up, calm them down, or ease their pain. The professional development model requires a different metaphor: Unless teachers are offered through professional development a regular and balanced diet, they will not be effective practitioners. (p. 430)

In the past, in-service training was mainly conceived as bringing outside knowledge to the single teacher; no particular relevance was given either to collegial work or the system the teacher was working in (Day, 1999). In this regard, Day (1999) recalls that the concept of professional development "does not eschew INSET [In-service Education and Training], in the form of courses, but locates it in a wider learning context, as contributing to the repertoire of learning modes now used to promote growth of individuals and institutions, and taking place both on- and offside" (p. 131). In particular, in European countries a historically rooted reluctance to speak of professional development in terms of a systemic and life-long conception can be recognized (Day, 1999).

Further, Day (1999) reminds of the fact that a traditional concept of in-service training as taking place rather isolated from the learning life in school still hinders staff development in single schools. Practicing teachers do have learning experiences on a daily basis and the crucial point, also with regard to what makes professional development successful, is to connect any offer to a teacher's daily and lifelong professional learning, in order to strengthen processes that are already on the way (Tenorth, 2007).

However, Day gives a straightforward definition of in-service education, the much more precise concept than the global one of professional development, when defining it as a "planned event, series of events or extended program of accredited or non-accredited learning" (p. 131). Although views on professional development differ notably from one another, they can be classified into two groups that were earlier labeled as deficit compensation and empowering teachers. Again, Day (1999) makes a very good point when regarding the underlying different philosophies as follows:

> If it is accepted that teachers, schools and policy-makers outside schools have legitimate interests in improvement and redirection in contractual, moral and professional accountability contexts, then notions of 'defect' and 'growth' approaches present a false dichotomy. (p. 134)

He moreover stresses that "INSET [In-Service Education and Training] should not focus predominantly on one at the expense of the other" (p. 134), which can easily happen. Nevertheless, since so far, at least in European countries, the emphasis has been on regulating from outside, for example via curricula, a crucial shift that has to take place is the one in favor of a more a bottom-up approach by giving change into the hands of teachers or simply viewing them as involved instead of concerned people (Krainer, 2002). To sum up, beyond any dichotomy, the effects of in-service

teacher education address the whole system. Hence, professional development goes alongside with school and educational system development.

EFFECTS OF IN-SERVICE EDUCATION AND TRAINING

However, under the headline *Teachers' Professional Lives*, Schoenfeld (1999) drastically concludes, that "for the most part, they don't have them – that is, teachers in the United States don't have professional lives, in any sense worth speaking of" (p. 22). He criticizes that most teachers do not have opportunities for sustained and well-conceived professional development. Likewise, Day (2000) concludes that "for many teachers, the last 20 years have been years of survival, rather than development" (p. 101).

More drastically, Hargreaves and Goodson (1996) stress that "teachers deserve and demand professional lives but some of the new directions and developments may mean that this historic aspiration is being seriously threatened" (p. 3).

However, there are recent developments and trends that have provided much progress in the field. In the following, some promoting and hindering factors for teacher professional development will be discussed. The lists are rather specific, as they ultimately reflect issues relevant in the context of this work.

Identifying Effects on Different Levels

Although there is a considerable body of research related to in-service education, what is lacking is a systematic empirical approach to the effectiveness of professional development regarding both improvements in teaching and in student outcomes (Terhart, 2002; Guskey, 2000; Sowder, 2007; Garet et al., 2001). Single in-service programs are accompanied by evaluation studies but their results are mostly too specific to provide general insight. Garet et al. (2001) summarize the situation as follows:

> The research literature contains a mix of large- and small-case studies, including intensive case studies of classroom teaching, evaluations of specific approaches to improving teaching and learning, and surveys of teachers about their pre-service preparation and in-service professional development experiences. In addition, there is a large literature describing "best practices" in professional development, drawing on expert experiences. (p. 917)

Lipowsky (2004) provides an overview on research explicitly dealing with examining and identifying successful aspects of in-service training programs. His state-of-the-art is guided by the following questions, *What overall effects can be anticipated from in-service education? What characteristics influence the effects positively? How can these effects be gathered?* His summary of the literature review is orientated on a four-stage system that has already been established in some evaluation studies (Lipowsky, 2004, p. 3):

1. Teachers' opinions and impressions
2. Changes in teachers' professional knowledge

3. Changes in teachers' actions
4. Effect on students' performance

In the *first category*, teachers themselves are asked how they value the benefit of the specific in-service training, if they are satisfied with the chosen program and how they perceive the profit regarding their competence. As most important parameter with regard to transferring issues imparted at an in-service training into practice, teachers identify the relatedness to their classroom practice. Not surprisingly, the teachers also acknowledge the content both in terms of subject matter and pedagogical content knowledge and emphasize the importance of active learning. The next essential factor is collaborating with colleagues in terms of a prolonged exchange during as well as after the event.

Lipowsky (2004) further points to the evaluation of a specific in-service training program in Germany, the SINUS-project, which will be described in more detail in the following section. Besides emphasizing the relevance of collaborative work, the results gained in the context of that project hint at the importance of professional exchange in terms of sustained mentoring and effective guidance by externals. Obviously, community aspects essentially influence whether lasting effects will take place both addressing the collegial and the teacher educator level.

The *second category* explicitly deals with changes in a teacher's professional knowledge whereby the notion applied by Lipowsky (2004) follows Bromme's (1997) definition of professional knowledge, encompassing subject matter and pedagogical content knowledge, curricular knowledge, routines, reflective practices and beliefs. Lipowsky (2004) explicates that some studies have provided evidence for a causal relation between teacher knowledge and student outcomes, therefore in-service training should explicitly aim at changes in a teacher's cognition.

He moreover pays attention particularly to changes in beliefs and reports about studies indicating that any change in beliefs could occur even while reflectively dealing with them. In this regard, the supportive role of cognitive conflict or at least the necessity of challenging beliefs to make them accessible was pointed out. For instance, changes in beliefs towards a constructivist position were initiated while the teachers came to know different perspectives or got insight into students' ways of learning. However, there is a clear lack of empirical research dealing with the conditions necessary to make these changes being reflected in classroom practice.

Regarding the *third category*, Lipowsky (2004) provides information about studies dealing with the effect of in-service training events on teachers' actions in the classroom. While there is little empirical evidence on the general level, he states a well-researched area of microteaching, personal coaching or cognitive oriented training models. Microteaching is organized practice teaching, focusing on single actions in the sense of modular teaching, moreover favoring collegial exchange. Although its effect on changes in behavior is indisputable, the transfer from the artificial situation to the complex classroom one is questionable, i.e., it is doubtful if these changes will establish themselves in a teacher's repertoire.

Moreover, Lipowsky (2004) points out that with respect to specific models like inquiry-based learning changes in teachers' actions could be observed while, an

interesting point, their beliefs nonetheless remained the same. The situation was rather reverse for pre-service teachers who modified their beliefs but not their actions. The data was collected in the context of a long-term professional development program combing phases of theoretical and practical learning (cf. Luft, 2001).

In the *fourth and last category*, the effects of in-service training on students' outcome are questioned. Ultimately, all reform efforts are aiming at enhancing students' performance but only a few studies explicitly deal with a causal relation between those two. Lipowsky refers to Kennedy (1998), who provides a meta-analysis on 93 studies dealing with effects of professional development programs. Only in twelve studies, a positive effect on students' outcomes could be stated. In this respect, in-service courses addressing a change in a teacher's behavior were less successful than the ones focusing on providing specific knowledge.

Lipowsky (2004) concludes that in-service education is successful when the design is long-term, input and practice phases alternate, opportunities to test in the classroom are provided and adequate feedback is given to the teachers. No sustainable effect is attributed to short-term programs that do not offer opportunity to adequately contemplate the presented issues. What can be highlighted is the decisive role of intensive communication and collaborative work among teachers of the same school. The interactive work of colleagues teaching the same subject allows for discussing, testing and modifying new ideas.

Furthermore, Lipowsky (2004) stresses that successful in-service education and training do supply some specifications regarding content and goals but leave flexibility to consider self-determined and independent learning, as indicated in some studies. Regarding content, the focus should be on pedagogical content knowledge, concentrating on specific themes, allowing for deep reflection, for instance, on students' ways of thinking and problem solving.

What Lipowsky (2004) overtly underlines is to be aware of a teacher's beliefs and values, to make them transparent and accessible in order to understand how these effect any perception of classroom action. In this regard, a promising approach is to uncover discrepancies between one's own beliefs and corresponding actions, furthermore when these are reflected against the practices of other teachers. For this purpose, the use of video serves as a fruitful way to make the aforementioned processes evident.

Finally, these four categories also differ in how they can be empirically approached. Studies addressing level 2 (changes in teachers' professional knowledge) and level 4 (effect on students' performance) require an empirical and methodological expertise while level 1 (teachers' opinions and estimations) and level 3 (changes in teachers' actions) can be tackled on a qualitative basis. For example, asking teachers for their opinions during interviews can gather data on level 1 while a rather innovative approach to assess anticipated changes in teacher's actions as mentioned can be to involve students in the evaluating process.

Despite the fact that some aspects of effectively designing in-service education could be identified, many research questions, so Lipowsky (2004), remain unanswered. For instance, no results deal with the influence of personal parameters like a teacher's cooperativeness, his or her impressions of how the specific needs were reflected in the course offer and an overall feeling of satisfaction.

Another interesting contribution is given by Garet et al. (2001) who primarily deal with defining high-quality professional development while identifying characteristics relating to positive outcomes of teachers and students. The authors point out that although there is clearly progress in the field, "few studies have explicitly compared the effects of different characteristics of professional development" (Garet et al., 2001, p. 918). The data they gathered was related to a specific federal professional development program and was collected in order to shed light on the following assumed interdependency:

> We designed this study to enable us to examine the relationship between features of professional development that have been identified in the literature and self-reported change in teachers' knowledge and skills and classroom teaching practices. (Garet et al., 2001, p. 918)

Garet et al. (2001) draw their empirical approach on research concerning high-quality professional development. As a result, the analysis focuses on *structural features* and *core features*, whereby the former refers to "characteristics of the structure or design of professional development activities" and the latter to "dimensions of the substance or core of the professional development experience" (p. 919). More concretely, they identify the following structural features (Garet et al., 2001, p. 919/920):

a) the form of the activity: (i.e., whether it is a reform type, such as a study group or network, in contrast to a traditional workshop or conference)

b) the duration of the activity; including the total number of contact hours that participants spend in the activity, as well as the span of time over which the activity takes place

c) the degree to which the activity emphasizes the collective participation of groups of teachers from the same school, department or grade level, as opposed to the participation of individual teachers from many schools

Additionally, Garet et al. (2001) discover three core features of professional development activities. The connection between those two types of features can be described as follows, "it is primarily through these core features that the following structural features significantly affect teacher learning" (p. 919):

a) the degree to which the activity has a content focus (that is, the degree to which the activity is focused on improving and deepening teachers' content knowledge in mathematics and science)

b) the extent to which the activity offers opportunities for active learning, such as opportunities for teachers to become actively engaged in the meaningful analysis of teaching and learning (for example, by reviewing student work or obtaining feedback on their teaching)

c) the degree to which the activity promotes coherence in teachers' professional development, by incorporating experiences that are consistent with teachers'

> goals and aligned with state standards and assessments, and by encouraging continuing professional communication among teachers.

To sum up, the authors gain a two-layer model for describing positive effects on teachers' growth. First, they identify core features relevant for the single teacher's learning, and second, they describe decisive structural features, which are both analyzed further regarding a possible interaction.

Identifying Promoting Factors

In the preceding section, different levels were distinguished while gathering aspects of effective professional development in general and in-service training in specific. That is, these effects were discussed with regard to the outcomes as structuring features. Now, the parameters leading to effective professional development will be elaborated on in more detail. Since effects can be reflected as being positive and negative, this section is concerned with promoting factors while the subsequent one deals with hindering factors.

In the following, the list of promoting factors also reflects current trends, and is surely not a final or complete one. Moreover, the factors are seized because they are relevant regarding both the particular professional development program that will be presented later as well as the results of the empirical study, which is in the focus of this work. In particular, what will be dealt with are the following aspects: (1) in-service education only makes sense pragmatically, (2) in-service education affects a learning system, (3) in-service education requires collaboration among teachers, and (4) in-service education connects research and practice.

In-service education only makes sense pragmatically. Some years ago, Cooney and Krainer (1996), a bit ironically, formulated the following two thesis as subsections in their contribution to the International Handbook of Mathematics Education (Bishop et al., 1996): "Thesis 1: We expect too much from in-service programs" (p. 1167) and "Thesis 2: We expect too little from in-service programs" (p. 1168). While discussing thesis one, the authors explicate that due to the increasing educational demands "the expected outcomes of in-service programs may become unrealistic" (Cooney & Krainer, 1996, p.1167). They particularly remind of the long way issues provided at an in-service training take to become implemented in the classroom:

> From another perspective, we have a tendency to inflate our expectations when inservice is based on research which certifies that a particular teaching strategy or particular curricular approach positively affects students' achievement or attitudes toward mathematics. The question remains, however, as to how the teacher translates that knowledge into teaching strategies for her students. (Cooney & Krainer, 1996, p. 1167)

But it is not only that we expect too much from in-service training but from the single teacher as well, so Cooney and Krainer (1996), and refer to consequences like burn out as reaction on increasing demands and complexity that teachers feel not able to meet.

Interestingly, they formulate the opposite position as thesis two, when claming that we expect too little from in-service programs. The authors explain that a central point is to integrate mathematics and pedagogy in any professional discourse. In this regard, a crucial approach is "to make it possible for teachers to experience new methods themselves and to develop similar activities for their students" (Cooney & Krainer, 1996, p. 1168). But, as Cooney and Krainer (1996) explicate, "most inservice programs fail to challenge teachers' beliefs about what or how they should teach" (p. 1168). The authors consequently hint at the following:

> When in-service programs fail to consider the circumstances and beliefs of teachers, they ensure that their effect will be essentially random, significantly dimishing any potential impact. Such an approach underestimates the potential of inservice programs to affect change and, in a sense, dishonors the potential teachers have for realizing reform. (Cooney & Krainer, 1996, p. 1168)

Once more, the emphasis is on honoring the potential of teachers since they are the experts for their specific learning. Krainer (1996) moreover explicates that rather traditional in-service approaches, which are based on bringing outside knowledge to the teachers, not at least fail due to the increasing demands on schools and teaching. In order to deal with the complexity, more attention should be given to the internal knowledge already existing, that is, teachers' competencies and strengths. Finally, Krainer (1996) concludes that these two theses, though being contrary, so share understanding in-service education as being subject to change.

The issues mentioned by Cooney and Krainer (1996) shed some light on what is meant by the claim that in-service training does only make sense pragmatically. Certainly, the message that is transported is multifaceted, although the statement might sound rather disillusioning at first. Tenorth (2007), who also stresses that expectations on in-service programs are too high, reminds of viewing in-service training as taking place daily, being part of a lifelong and long-term process, or as Lave (1996) puts it, considers teachers as learners in practice.

Additionally, Tenorth (2006, 2007) underlines that teacher learning is rather *unlearning* than *new learning*, never occurring isolated but in an educational setting or context. That is why in-service education only makes sense pragmatically, i.e., as partly initiating change even in terms of unlearning or relearning moreover addressing and involving a learning system. In the last section of this chapter, consequently, the explicit focus is on teacher needs and expectations regarding in-service education and training rather than simply viewing them as consumers of a program.

In-service education affects a learning system. Closely intertwined with the aforementioned idea, is viewing in-service education as affecting a system. This aspect is only partly covered in the aforementioned categorization provided by Lipowsky (2004) since the identified levels of effects of professional development just consider teachers and students. Any global effects addressing the educational system that can be an outcome of an in-service education program which is, for instance, well documented in the context of the IMST-project in Austria (see chapter 3) is not brought up.

However, Krainer (2002) actually refers to the four dimensions of action, reflection, autonomy and networking to emphasize that it is the interaction of the people within the educational system that finally results in a learning system. In this regard, particularly reflection and networking addressing all relevant persons, is rather undeveloped. Professionals not only continue to grow through their professional lives, but their learning, so Krainer (2008b), is moreover situated in a broader context since different levels are involved:

Micro level: Individuals, teams

Meso level: Networks, schools

Macro level: Districts, nations

Krainer underlines the importance of each level and emphasizes the significance of a vertical connection. Further, he points out that research in teacher education has primarily been concerned with the micro level, neglecting the importance of the meso and macro level. But teacher education is more than teacher development on an individual level, teacher education is school improvement since all participants in the system learn (Krainer, 2002; Tenorth, 2007).

An issue that has so far not been discussed in this work is the following one by Palmer (2007), who states that "our large, complex institutions are increasingly unresponsive to external pressure, even on those rare occasions when an informed and organized public demands change". However, impulses that develop bottom-up, first being initiated by teacher development and progress and second being imbedded in the school context, continue to be of relevance for the educational system as well. That is, a crucial approach is to focus on the single school, particularly for quality management and improvement (Daschner, 2004), thereby acknowledging that progress develops little by little emerging from inside rather than at a quick pace initiated from outside.

The understanding of in-service education and training as addressing a learning system naturally leads to the question, *Who is also learning?* Some answers will be given in chapter 3 when discussing the influence and effects of the IMST-project in Austria.

Another body of research centers on the learning of teacher educators, and considers them as developing professionals, too (cf. Llinares & Krainer, 2006; Sowder, 2007). Zaslavsky and Leikin (2004), for instance, report about the growth of mathematics teacher educators while engaged in a professional development context. In their work, they provide an interesting modification of Jaworski's (1992, 1994) teaching triad for students' learning. Since the teaching triad comprises the management of learning, sensitivity to students, and the mathematical challenge, Zaslavsky and Leikin (2004) adapted the corresponding triad for teacher educators as follows:

> Accordingly, we consider the teaching triad of a mathematics teacher educator to consist of the challenging content for mathematics teachers (i.e., Jaworski's teaching triad), sensitivity to mathematics teachers and management of mathematics teachers' learning (see Figure 1). (p. 7)

One decisive parameter of the adapted triad is the sensitivity to teachers, which might have been rather underestimated in the past and is in the explicit focus of this work.

In-service education requires collaboration among teachers. Obviously, there has been a clear shift from the ethos of teacher isolation (Lortie, 1975) to collegial collaboration, or as Krainer (2003) remarks, an "increasing awareness of the social dimension in mathematics teacher education" (p. 93). Interestingly, in the 1980ies, it was Bauersfeld (1980) who emphazised the significance of the social dimension in the classroom. Furthermore, this shift has been accompanied by different theoretical orientations, so Krainer (2003), as indicated by "the emergence and usage of new theories that go beyond cognitive views on learning" (p. 93).

The notion of collaborative work has permeated the literature, whether in terms of teacher inquiry groups, communities of practice or networks of critical friends, and is closely intertwined with reflective practice (Krainer, 2003; Jaworski, 2006). Schoen (1983) coined the notion of reflective practice both in terms of reflection on-action and reflection in-action. Some authors extend the conceptualization to reflection about action, to strengthen that reflection means "thinking that is not just ivory-towered contemplation, but that is linked directly to practice" (Hargreaves & Goodson, 1996, p. 12).

Ultimately, the question of how practice can become reflective has resulted in fostering collaborations, providing opportunities for a shared understanding of issues relevant for teaching, further contributing to the growth of teachers' knowledge regarding their own practice. With respect to the growing body of research, Hargreaves and Goodson (1996) conclude:

> But what matters throughout this literature are the emphases that all teachers reflect in some way, that teachers can articulate and share their reflections more explicitly, that reflection is at the heart of what it means to be professional, and that teacher education, supervision and development should be constructed in ways that make such explicit reflection more feasible and more thorough. (p. 12)

Particularly, the contributions made by Lave and Wenger (1991) and Wenger (1998) on a social theory of learning, stress the significance of the four processes of learning, meaning, community, and identity (cf. Lieberman & Miller, 2005). Learning in practice is viewed "as social and collective - coming about through social participation in communities of practice where people feel a sense of belonging and a need to make a contribution" (Lieberman & Miller, 2005, p. 155).

Moreover, referring to Wenger's work and in particular elaborating on the success of communities of practice, Krainer (2003) poses various questions:

> How does this relate to those organizations that seem to be primarily responsible for knowledge and learning – to schools and universities? Are they loosing their monopoly for educational affairs? To what extent can an approach like "Community of practice" be applied to learning at schools and university?

> What can we learn from "learning enterprises"? What implications for research in teacher education has an approach that builds on "community of practice"? (p. 96)

These thoughts apparently show that collaborative work is not only a key factor regarding teacher learning but in addition makes a systemic approach a subject of discussion in teacher education as well.

Lachance and Confrey (2003) provide some additional answers to the question why teacher communities in mathematics education should be promoted. They report on research indicating that "successful schools had teachers who had continual and substantive interactions" (p. 109). Further, they stress that "there is substantial research in the broader area of school reform that suggests that peer collaboration and support is a crucial prerequisite for teachers to be successful in restructuring their classrooms and their schools (p. 109). However, many initiatives have in common that they focus too much on the individual (Krainer, 2001) rather than on communities of teachers.

In-service education connects research and practice. A very decisive relationship is the one between research and practice, an issue that has earlier been touched while elaborating on the significance of teacher knowledge. In particular, the work of Cochran-Smith and Lytle (1999), who distinguish knowledge-*for*-practice, knowledge-*in*-practice and knowledge-*of*-practice in order to refer to different relations between those two, was presented. While the focus in that section was primarily on the knowledge aspect, in the following further possible connections are discussed.

For instance, Shulman (1997) so aptly emphasizes the role of research and its significance for practice when stating the following:

> Research begins in wonder and curiosity but ends in teaching. The process of research is incomplete until the researcher can communicate his or her understandings clearly, persuasively, and effectively. (p. 6).

Correspondingly, Krainer (1996) deems a connection between research and in-service education as central perspective, i.e., "conceptualizing inservice as a context for integrating theory and practice" (Cooney & Krainer, 1996, p. 1155). Under the headline, *The fusion of teacher education and research*, Krainer (2003) stresses:

> Working with teams, communities or networks of teachers and investigating their professional growth are activities where teacher education as a field of practice and a field of research merge (see e.g., Cooney, 1994). (p. 98)

A very specific merging is reflected in one of the constitutive parameters of the professional development program that will be presented in detail in chapter 4. That is, in-service training offers are made by tandems of a teacher educator and a teacher. Thus, from their very inception, courses are sure to combine research and practice in a fruitful way.

Talking about research and practice implies reflecting on the corresponding role of theories. In this regard, Jaworski (2006) emphasizes that "theories help us to analyze,

or explain, but they do not provide recipes for action; rarely do they provide direct guidance for practice" (p. 188). Likewise Sprinthall et al. (1996) conclude that "there is no linear equation from theory to practice nor the other way from practice to theory" (p. 667) and further pose the question, "is theory embedded in practice and is practice visible in theory?" (p. 667).

The quotations focus on the gap between research and practice whereas Shulman (2000) maintains a rather conciliatory position while reflecting the different roles that a researcher and a teacher are involved in as follows:

> The problem is that our experiences as researchers and teachers are vastly different. Research does not end with our heaving a sigh of relief as we make a discovery or make a connection and say "I now understand it." We aren't done with the research until we have displayed it, summarized it, submitted it for peer review, and, once its quality has been attested to, shared it with as much of our community as will pay attention to. That's what we do as researchers. As teachers, we're almost like psychotherapists. We have these extraordinary encounters with groups of students – encounters build around our design, interactions, assessments of how the students did, and reflections of how it worked and how we would want to do it differently the next time. We engage in a full active investigation every time we teach a course, and then we bury it in our files, never to see the light of day again until the next time we teach that course and, if we're lucky, we remember in which file we buried it. (p. 7/8)

By the aforementioned descriptions, Shulman (2000) makes explicitly clear that differences between research and practice cannot simply be viewed abstractly but have to be regarded in terms of different roles, goals and purposes of the persons being involved. Cochran-Smith and Lytle (2001) point to another interesting aspect of research and practice as conflicting or concurring areas as they point out the following:

> Unfortunately, practice is often "juxtaposed with the terms theory and research to suggest both relationships and disconnections - as in the common phrases putting theory into practice and translating research for practice, and in the complaints that something is too theoretical, not practical enough […]. (p. 54)

However, what has already been stressed earlier is that one crucial role of research definitely is to provide "outsider knowledge as a source of new ideas" (Wideen, Mayer-Smith & Moon, 1996, p. 195) and "outsider knowledge as a catalyst and support for collaboration" (Wideen et al., 1996, p. 194). To explicate the essence of a possible collaboration, Wideen et al. (1996) draw on the work of Hawkins (1967) who "asserted that we cannot gain competence and knowledge except through communications with others. Without a Thou, there is no I evolving. Without an It there is no content for the context". (p. 47).

Shulman (2000) contributes to these thoughts by reminding of the fact that "the fundamental morality of the scientific and scholarly community is that we acknowledge the role of others. In fact, the word "acknowledgment", with the word knowledge in its center, implies we can't have knowledge without others" (p. 30).

The process of research does not end by gathering data but furthermore comprises to present results, give conclusions and discuss implications, that is, "the work of the scholar is incomplete until it is shared with others" (Shulman, 2000, p. 12).

Borko (2004) adds another interesting option for how this shared knowledge might contribute to general improvement. While calling for connecting research and practice on the level of researchers and professional developers, she considers it crucial to reflect on "multiple design/research cycles to refine the program and study its impact on the development of professional community and the learning of the individual teachers" (p. 12). However, another relevant issue is inexplicably connected to such a viewpoint, that is, to consider and understand the researcher as a learner, too.

Bringing research and practice together is obviously an essential point, always keeping in mind that of course the agendas of teachers and researchers might be different. But what Cooney correspondingly (1994) stresses is, that "we are wise to think of the teacher as an inquiring mind rather than as the object of an inquiring mind" (p. 627). That is why the particular focus in this work is on considering teacher needs and expectations.

Identifying Hindering Factors

Again, the aim of this section is not to provide a complete list but rather some information about factors that hinder successful in-service education beyond simply reversing the aforementioned positive factors. The contribution is organized around the following topics: (1) influence of the previous teaching style, (2) decisive role of knowledge and beliefs, (3) non-effective issues and (4) systemic constraints. One should bear in mind that the headlines do not simply count as a list of factors, rather they comprise several aspects.

Influence of the previous teaching style. Cohen (1990) gives an impressive example for the constraints of professional development by his well-known case study of a teacher named Mrs. Oublier. The portrayal, as Sowder (2007) puts it, serves as "a generic description of a class of teachers who have misinterpreted the principles underlying the professional development they received" (p. 160).

Mrs. Oublier was very open for implementing new curriculum material and activities, that is, "she eagerly embraced change, rather than resisting it. She found new ideas and materials that worked in her classroom, rather than resisting innovation" (Cohen, 1990, p. 311). But surprisingly, the change initiated by the obtained professional development just remained at the surface (cf. Pehkonen & Toerner, 1999). Accordingly, Cohen (1990) concludes that Mrs. Oublier's "teaching does reflect the new framework in many ways. For instance, she had adopted innovative instructional materials and activities, all designed to help students make sense of mathematics. But Mrs. O. seemed to treat new mathematical topics as though they were part of traditional school mathematics" (p. 311). Cohen (1990) describes her teaching style as mélange of "something old and something new" (p. 312) and underlines that "some observers would agree that she has made a revolution, but others would see only traditional instruction" (p. 312).

What is striking is that although the teacher was open for new approaches, well-established beliefs, knowledge, routines and scripts were not simply replaced but new experiences added or assimilated. The crucial point, so Sowder (2007), was that "Mrs. Oublier had little opportunity for sustained guidance and support. She had much to unlearn, but no one to help her do this unlearning. The lessons here for the need for sustained professional development and mentoring are significant" (p. 160).

Pehkonen and Toerner (1999) report on a similar observation and stress the influence of the established teaching style as follows:

> Teachers can adapt a new curriculum, for example, by interpreting their teaching in a new way, and absorbing some of the ideas of the new teaching material into their old style of teaching. (p. 260)

Again, it is the old style of teaching based on established knowledge and beliefs that runs counter implementing, even appreciated, new aspects of teaching, a subject that is approached in the following.

Decisive role of knowledge and beliefs. Interestingly, a comparable case study referring to partly different aspects can be found in the literature. Toerner, Rolka, Roesken and Schoenfeld (2006) analyze the teaching practice of an experienced teacher after having participated in an in-service training course on using open-ended task in mathematics teaching. Since it was not the focus of the study to examine the effectiveness of the professional development event, it turned out that the teacher's beliefs built a hindrance to successfully implementing new ideas.

The teacher started a lesson about introducing linear functions by using several open-ended tasks which the students worked on in small groups by using the computer. After apparently 20 minutes, the teacher gathered the results and the teaching style changed rapidly since the group work did not satisfy the teacher's lesson goals.

Toerner et. al (2006) could show how in this situation old beliefs established over a period conflicted with new beliefs adopted recently, an issue that will be elaborated on later. While the teacher favored a student-centered approach by letting students deal with open-ended tasks in the beginning, she gave up in favor of a teacher-centered style during the course of the lesson. Particularly, her mathematics-related beliefs came into the foreground, which is commented by Toerner et al. (2006) as follows:

> The underlying approach of the teacher caught in such a situation could be loosely described as follows: "When things really go wrong, who can afford to be interested in the pedagogy? One must only rely on the structure provided by the mathematical content." Pedagogy then loses in the game 'pedagogy versus content' (Wilson & Cooney, 2002). (p. 10)

In order to understand the turn around in the teaching trajectory and the emerging discontinuities involved rationally, the authors additionally interviewed the teacher after the lesson (cf. Toerner, Rolka, Roesken and Sriraman, 2010). The teacher then reflected the developments during the lesson in retrospect; the open interview style incited her to justify goals and beliefs, partly without being explicitly asked to do so.

Remarkably, on the one hand, beliefs initiated by the issues imparted at the in-service training on open-ended tasks, and on the other hand, old beliefs in terms of deep teaching convictions came into conflict. That is, the teacher started the lesson with the belief that mathematics lessons have to be designed openly. She completely fulfilled this requirement in her lesson planning and realized this approach consequently in the first half of the lesson up to the aforementioned turning point. Then, reacting to the unexpected course of the lesson, she revised the use of open-ended tasks, an approach that was founded on rather recently experienced beliefs, in favor of the following one: "open questions have to be prepared" (p. 412). She then explicated that "open questions have to be drilled. You cannot simply throw an open question at the students and then say: Okay, start!" (p. 413).

Complementary to the fundamentally positive approach of designing lessons as open and discovery oriented, she fell back on her traditional teaching style, requesting, for instance, her students to give a mathematical definition. In the interview, she explained her behavior as follows, "the central term to be mediated in the context of linear functions is the concept of slope, which prepares students for the concept of derivative" (p. 415). Toerner et al. (2010) further explain that it is the following goal, "the term slope must be mentioned in this lesson" (p. 415) that caused the extraordinary turning point. Hence, the authors draw the conclusion, that, "all pedagogical content goals and beliefs lost their rather positive value and stepped aside to make room for subject matter goals and beliefs" (p. 416). Finally, the authors consider the systematic subject matter content as *safety net* for class situations developing as not planned.

Interestingly, a teacher who participated in a discussion on the lesson commented the situation as follows: "When the house is on fire, who will then worry about pedagogy? Then you can rely only on the systematic nature of the content" (Toerner et al., 2010, p. 416). Toerner et al. (2010) conclude that one reason for the turning point in the lesson lies in that the teacher had not hitherto developed a solid repertoire in successfully employing the new teaching approach. The observations are in line with the ones drawn by Cohen (1990). Knowledge and beliefs, which are reflected in goals and actions, are decisive and may substantially impede implementing new teaching approaches. New ideas cannot be put into practice ad hoc, adopting and modifying teaching takes time und guidance, maybe in form of substantial mentoring as part of a professional development program or collegial support within the school.

Non-effective issues. Beyond these two case studies shedding some light on hindering factors, Sowder (2007) refers to the work of Hargreaves (1995) who provides general information about reasons for professional development being not effective:

> Teachers are likely to reject knowledge and skill requirements when (a) the requirements are imposed or encountered in the context of multiple, contradictory, and overwhelming innovations; (b) teachers (except for those selected to design teams) are excluded from the development; (c) professional development is packaged in off-site courses or one-shot workshops that are alien to the purposes and contexts of teachers' work; or (d) teachers experience them

> alone and are afraid of being criticized by colleagues or of being seen as elevating themselves on pedestals above them. (p. 171).

That is, Hargreaves (1995) found non-effective professional development not primarily lacking an appropriate offer of knowledge but criticizes that "it does not acknowledge or address the personal identities and moral purposes of teachers, nor the cultures and contexts in which they work" (p. 14). The importance of explicitly considering teachers' needs and expectations is the focus of the subsequent section and is reflected in the project design of the initiative that will be presented in chapter 4.

Systemic constraints. Since a first approach was to reflect hindering factors that are mostly dependant on the teacher, in terms of knowledge, goals, beliefs, attitudes but also communication and ongoing support, there are also systemic constraints that impede teachers from even being able to participate in professional development. Smith and Gillespie (2007, p. 212, 213) refer to the work of Wilson and Corbett (2001) who identified the following hindering factors in their research: Time constraints, financial constraints, distance, information gaps, lack of face-to-face interaction, mismatch of goals.

That is, hindering factors are also time and financial constraints, which make it mostly impossible for teachers to participate in in-service training. Moreover, opportunities are often not locally offered but centrally located and therefore place additional demands on teachers. Information gaps and lack of face-to-face interaction particularly play a role when in-service training is not offered decentralized.

The more adequate approach would be to address all subject teachers from one school or the local region, in order to understand in-service education as a rather job-embedded model. Finally, a mismatch of goals is mentioned, that is, "the goals of the professional development and the individual practitioners' professional interests" (Smith & Gillespie, 2007, p. 213) might not meet in an appropriate way. The next section deals with these professional interests in terms of needs and expectations.

TEACHERS' NEEDS AND EXPECTATIONS

Shulman (1986) reminds of the fact that "teaching and learning is not a one way street", neither is teacher learning and teaching in front of a class. Learning needs of teachers are of dynamic nature, they change over time and are consequently not easily accessible, even for teachers themselves. For instance, problems might occur in the aftermath of an in-service training course, i.e., the process of transferring knowledge into practice may result in different or additional needs that have not been on the agenda so far.

Mostly, teachers' needs for professional development are considered from a very specific perspective. That is, so Ball and Cohen (1999), "teachers are thought to need updating rather than opportunities for serious and sustained learning of curriculum, students, and teaching" (p. 4). Even more sharply formulated, Day (1999) stresses:

> Attempts both at local and national levels to provide INSET [In-service Education and Training] support for the CPD [Continuing Professional Development]

> needs of teachers and schools are rarely conceptualized beyond the rhetoric of statements such as, 'They should result in improvement'. (p. 132)

Comparable statements like *teachers should* as well as *administration should* have been mentioned in the introduction of this work, strict positions or hardened fronts that do not contribute to viewing professional development in a substantial way.

Effective in-service education depends on the axiom of being of one's own choice, that is, such events being oriented on the specific needs of teachers is absolutely necessary (Day, 1999; Llinares & Krainer, 2006, Sowder, 2007). And this is what makes in-service education rather difficult, to meet the unique needs of teachers which are usually not well-known by teacher educators. At most times, trendy topics like, for instance, standards or cooperative learning, have easily dominated the offers, they, so to speak, upstage important topics of teachers.

In this regard, Day and Sachs (2004) recall that "the kinds of CPD [continuing professional development] which predominate at any given time often reflect views of teachers' needs by those outside the classroom" (p. 9). Hence, it is frequently assumed that teachers need to be provided with something, like specific knowledge or skills, in terms of what they need to know and do (Sowder, 2007). In contrast, a more adequate view on in-service education would be that "it supports policies that enable good practice rather than prescribe it; recognize the knowledge, skills, and abilities of teachers; and provide incentives to increase their knowledge" (Lieberman & Miller, 2005, p. 153). Particularly reflecting the situation in mathematics education, Sowder (2007) argues, "even with increased recognition that teacher professional development must be a priority, the professional development offered in mathematics often does not meet teachers' needs" (p. 159). Likewise, Simon (2007) considers professional development for mathematics teachers as mostly being unresponsive to teachers' needs and interests.

However, Hargreaves (1994) adds an interesting point to the discussion while reminding of viewing in-service education in broader terms as professional development. In particular, he requests teachers to "begin to think less in terms of INSET [In-Service Education and Training] and more in terms of staff development and the need for whole-school policy to drive it" (p. 430). The change in perspective includes viewing in-service training needs not simply in terms of individual needs but concerning the subject department of the school. Hence, stressing a bottom-up approach does not mean to base it rather fragmentarily on a single teacher, but it explicitly addresses the collaboration among them. In this regard, the role and significance of the headmaster should further not be underestimated.

Hargreaves (1994) underlines that in the same way, as professional development is a lifelong process, teachers have lifelong professional learning needs. A crucial point, consequently, is considering teachers' learning needs by enabling them to participate in planning for their professional development (Wilson & Berne, 1999). Schoenfeld (2006) reminds of the fact that "some of the most interesting approaches to professional development are those that take the notion of teacher learning seriously" (p. 485). Krainer points to the same direction when arguing that traditional in-service programs lack considering teachers as learners, a viewpoint that has been elaborated earlier. Logan and Sachs (as cited in Day, 1999, p. 135) identify

three aspects while characterizing more closely what teacher learning is about and what issues need to be addressed by in-service training:

> Re-orienting in which teachers develop their capacities to make 'significant revisions' to current practices as a result of the introduction of new teaching methods, different working conditions, changed management procedures or expectations, or as a result of a change of role;
>
> Initiating in which teachers are inducted into new roles (social initiation) or incorporate new ideas and practices learnt through reorienting programs into classrooms and school life (technical initiation),
>
> Refining in which teachers' current practices are strengthened and extended.

That is, Logon and Sachs (as cited in Day, 1999) provide some kind of clarification what teacher learning means and what processes are involved and hence, what issues are necessary to be touched upon besides merely focusing on content. Remarkably, they not only elaborate on commonly shared aspects like re-orienting and initiating but furthermore refining as learning that serves to connect to teachers' current practices.

Nonetheless, in-service training courses are mostly externally provided and from this perspective primarily a temporary intervention but, and that is the crucial point, are placed into teachers' learning lives (Day, 1999). The consequences occurring when teachers' needs are not paid adequate attention are described by Day (1999) as follows:

> Teachers' professional development will be restricted rather than extended and fragmentary rather than coherent whilst the breadth of their learning needs continues to be ignored; and professional learning will come to be associated not with capacity building for the use of insightful judgment exercised in complex situations, but with one-shot events specifically targeted at immediate technically defined implementation needs as determined by others. (p. 141)

What is moreover stressed is that "need identification, it follows must be a matter for negotiation between the interested parties, rather than prescription by one at the expense of the other" (Day, 2000, p. 109). Bolam (as cited in Day, 1999, p. 136) provides an interesting need matrix while linking system and individual needs with respect to group performance, individual performance, career development, advanced professional education, and personal education. Nevertheless, the matrix lacks providing a more elaborated relationship between those two. However, at least what is transported is that the relationship between system and individual needs is not static but dependant on what aspect of professional development is stressed.

Issues like ownership, participation and equity are of important relevance, even more so since they ground on a teacher's own responsibility and promote account-ability (Day, 1997), maybe resulting in rather far-reaching effects like establishing leaderships of teachers (cf. Lieberman & Miller, 2005). Day (1999) provides an overview on teachers' preferences regarding professional development, i.e., he

lists successful activities that met teachers' expectations for the following needs (p. 147, 148):

> *Targeting needs.* They were focused upon needs specific to the particular age range taught, i.e. relevant.
>
> *Content needs.* They increased knowledge/awareness, reinforcing and re-assuring current thinking but encouraging participants to see issues from different perspectives.
>
> *Utilization needs.* They provided direct curriculum development benefits and application to classroom practice.
>
> *Process needs*. Successful courses presented a balance of activities which were well-structured, involved working with colleagues and sharing experience.
>
> *Leadership/Modelling needs*. Successful courses were led by tutors who were well-prepared, enthusiastic, caring and aware of group dynamics.
>
> *Time and energy needs*.

Day (1999) distinguishes between short and extensive in-service training and identifies the latter as contributing significantly more to long-term growth needs. Teacher needs that are related to "longer, more reflective and analytical in depth learning opportunities" (p. 149) are the following ones:

> *'Vision' needs.* Participants had been able to relate their experience of practice to theory, to reconsider critically their assumptions, predispositions, and values (the 'why' as well as the 'how' and 'what' of teaching), and the contexts in which they were taught.
>
> *Skill development needs.* They were able to develop new skills over time.
>
> *Intellectual needs*. They were able to engage in systematic reading which, 'otherwise I wouldn't do'.
>
> *Personal needs to build self-esteem*, so important in these days when we're continuously being battered from all sides as regards our skills as professionals. (Day, 1999, p. 149)

However, while the work on teachers' needs provides some answers, the following issue stressed by Krainer (2002) that the freedom of defining one's own research questions is, among other aspects, a decisive factor for teachers' growth, should not be underestimated. Hence, the questions trivially remaining are the following ones, *What do teachers want to have in their in-service training? What do they want to learn?* In order to understand teachers' needs from an inside perspective, explicit attention ought to be given to their views, beliefs, values, expectations, experiences, goals as well as hopes regarding their professional development.

What is striking, too, is that so far little attention has been given to the relevance and "importance played by teachers' life histories, situated lives (within the culture of the school) and personal circumstances and motivations" (Day, 1997, p. 40).

Especially the field of affect is only partly touched in the context of professional development or in-service education, and as the data presentation in chapters seven and eight will show, ultimately plays a crucial role for the effectiveness of any offer.

SUMMARY AND IMPLICATIONS

The first two chapter were concerned with elaborating the international theoretical discussion on mathematics teachers' professional development. Different theoretical perspectives were presented that led to identifying the relevant variables. Further, numerous theoretical models were discussed in order to elicit the relevant processes. So far, in-service education and training are a valuable contribution to professional development of teachers. Since the focus is on teachers' lifelong and continuous learning, in-service training offers are supposed to be of long-term orientation, job-embedded and aligned with a teacher's actual job. The conceptualization is wide-ranging and assigns a crucial role to the relation of knowledge, beliefs and practice.

Developing professional knowledge is primarily considered as an interactive process responding to teachers' growth needs. Professional development is not simply an individual endeavor but is most powerful in terms of collaboration, particularly among subject teachers of the same school. Identity formation is thus seen as ways of belonging to a broader constellation, hence, a specific community of practice, which moreover contributes to a teachers' identity.

In view of that, teachers are regarded as mostly responsible for their professional growth. Related to their personal goals and associated reflective practice, it is stressed that only authentic teachers are able to take care of their personal and professional development. A decisive approach, hence, is to integrate teachers in planning with regard to their needs, and to implement their choices.

However, professional development also contributes to teacher as well as school development. That is to say, a "growing synthesis between a more sophisticated conception of professional development and a strong commitment to institutional development" (Hargreaves, 1994, p. 424), can be stated. The corresponding challenge is the balancing of individual and organizational needs. Likewise, Hargreaves and Goodson (1996) sum up as follows:

> For at the end of the day, teacher professionalism is what teachers and others experience it as being, not what policy makers and others assert it should become. (p. 22)

Correspondingly, all the recommendations reflected in the aforementioned thoughts, trying to improve teacher education and schooling, should avoid, as mentioned earlier, *either/or* approaches and focus on *both/and* ones.

In chapter 4, a specific professional development initiative that particularly takes into account these fundamental issues is outlined.