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Distal and Proximal Indicators of Teacher Effectiveness

As Predictors of Students' Mathematics Competence in Germany (Grade 5 – 7)

Saba Hanif

University of Bamberg Press

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To my parents

who valued and believed in me

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Chapter 1
Introduction

"Interventions at the structural, home, policy, or school level is like searching for your wallet which you lost in the bushes, under the lamppost because that is where there is light. The answer lies elsewhere – it lies in the person who gently closes the classroom door and performs the teaching act –the person who puts into place the end effects of so many policies, who interprets these policies, and who is alone with students during their 15,000 hours of schooling."
(John Hattie, 2003, p.3)

The focus of research on educational effectiveness has turned from school effectiveness towards the effectiveness of the teachers as research in the recent past has shown that teachers are the most important determinant of student learning. However, there is still a lack of consensus as to whether teacher variables or teaching variables are more important. A strong body of knowledge has shown the importance of teacher variables in student learning. Seidel and Shavelson (2007) claimed in their recent meta-analyses, however, that teacher variables are in fact distal indicators of effectiveness whereas teaching factors are the proximal indicators of teacher effectiveness. Therefore, Seidel and Shavelson assumed in their study that proximal factors are stronger predictors of student learning in comparison to distal factors. Distal and proximal factors are defined in terms of their proximity to the teaching-learning process. Seidel and Shavelson mentioned that correlational research which is the most dominant design used in teacher effectiveness research has often examined teacher effectiveness through distal indicators and very little research has used proximal indicators in educational effectiveness research. This might be the reason behind the weak effects of teacher and their teaching on student learning as shown by previous correlational studies in comparison to quasi-experimental and experimental studies. Although, Seidel and Shavelson found proximal indicators as more effective than distal indicators in their meta-analyses study, there is important evidence showing teacher factors are an indicator of student learning, for instance meta-meta-analyses of Hattie (2009), and this evidence cannot be ignored. Moreover, findings from a single meta-analysis study are not enough to diminish the significance of teacher factors. More research is needed in correlational studies to explore this issue. Although, it may be true that proximal indicators are more important than distal indicators, the question is, do distal indicators have an effect on student outcomes? Are proximal indicators independent of distal indicators of learning? I believe not as teacher beliefs can affect teachers' practices (Stipek et al., 2001) and teachers' professional knowledge can affect the nature and quality of classroom activities a teacher plans for the learning process. TALIS (2009) found that teacher belief, practices and attitudes affect the classroom learning environment and student learning. Although, it is beyond the scope of the current study to investigate how teachers' factors shape teachers' instruction, but the effect of teachers factors on student mathematics competence have been investigated directly assuming that teacher factors affect classroom instruction and hence student outcomes. The current study aims to measure the effectiveness of both distal and proximal indicators of teacher effectiveness in order to see which factors strongly predict student competence.

Recently there has been a growing interest in examining teaching and learning in domain-specific contexts. Seidel and Shavelson (2007) found that studies in domain-specific contexts showed a greater effect on student learning than domain-general studies. Baumert et al. (2013) affirmed that teaching and learning are domain-specific and Hattie (2009) also provided the evidence that different teaching approaches show different effects on student learning in different domains. However, more evidence is needed on domain-specific learning. Therefore the current study has mainly examined the proximal indicators of teacher effectiveness in a domain-specific context.

In order to get better insights about the role of the teacher, it is important to measure the effect of teachers and their teaching on students' learning in natural settings. This is not possible with experimental or quasi-experimental studies in which the results could not be generalized to larger populations or in cross-sectional studies in which the effects might be from a previous teacher. It is important that the teacher has taught students for a meaningful period of time, hence the design of the current study is longitudinal in nature with representative data from Germany. As the data is from different types of lower secondary schools in Germany, it offers the opportunity to analyze and compare the role of mathematics teachers and their teaching in students' mathematics competence development among schools.

The first objective of the study is to examine if proximal indicators are more significant predictors of teacher effectiveness than the distal indicators. Distal indicators are rather general factors, for instance teacher beliefs, *professional training*, and *job satisfaction*. Proximal indicators are the domain-specific factors which are measured proximal to the process of learning for instance *cooperative learning, cognitive activation, student engagement* and *cognitively challenging tasks*.

The second main objective of the study is to find the combination of teacher factors or teaching (instructional factors) or the combination of both teacher and instructional factors that make a teacher effective.

The third and the last objective of the study is to compare the teacher effectiveness among different school types and to see the role of teachers in each school type in their students' mathematics competence development. Because the teachers in different school types in Germany are trained differently and, as Baumert et al. (2013) argued, teachers of different school types differ in their characteristics, it's important to examine if they also differ in their effectiveness.

1.1. Outline of the Study

The study is divided into five chapters. In chapter 2, the theoretical framework of the study is discussed in detail. At first, the history of teacher effectiveness, definitions of teacher effectiveness and models of teacher effectiveness are discussed briefly. Secondly, the idea of distal and proximal indicators of teacher effectiveness is explained, along with the description of each distal (teacher factors) and proximal (teaching factors) factor that are included in the current study and then mathematics competence is described. Thirdly, the analytical framework of the study is detailed and research gap in the previous literature is identified. Finally, the relevance of the study and research questions is discussed.

In chapter three, the methodological approaches and procedures used in the study are described. At first, the National Educational Panel (NEPS) is introduced along with the reasons for using NEPS data for the current study. Secondly, the data collection, sample and instruments of the study are explained in detail along with the results from the confirmatory factor analysis. Finally the data analysis techniques that are used to analyze each research question are described. In chapter four, the results of the study are explained in detail for each research question and hypothesis. In chapter five, the findings of the study are discussed. The main results of the study are summarized, and then the results from each research question are discussed. The limitations of the study are described and implications and recommendations are provided.

Chapter 2

Theoretical Background

The chapter covers the theoretical foundations and state of the empirical research on teacher effectiveness. The chapter briefly describes teacher effectiveness, its history, theoretical models, empirical state of research, factors teacher effectiveness factors, analytical framework of the study, research gap and research questions of the current study. The history of teacher effectiveness explains how the concept of teacher effectiveness has developed overtime. Following this, the various ways in which different educational researchers have defined teacher effectiveness and the criteria for defining teacher effectiveness are discussed. Theoretical models describing the basis of different aspects and elements of effectiveness and the empirical evidence regarding each model is provided. Teacher factors and instructional factors of teacher effectiveness are discussed as distal and proximal indicators of teacher effectiveness. The concept and the state of empirical research are described in relation to each construct and the expectations of the current research are discussed in relation to each construct. Finally the research questions are discussed in detail and the analytical framework of the current study is provided.

2.1. Brief History of Teacher Effectiveness

Mouly (1963) states that “teachers are humans and nobody expects them to be perfect. But society has the right to expect certain effectiveness in promoting the purposes and objectives for which teachers and schools exist” (p.16).

Measuring teacher effectiveness is not a new subject; teachers used to be evaluated even in the days of one-room school, the evaluation used to be done locally through some locally developed standards at school, for the purpose of job extension or increase in teacher salary (Markley, 2004).

With the industrial revolution, along with the other changes in societies, evaluation systems at schools also began to change. The industrial revolution brought the awareness that students are an asset of the nation and the future of the nation lies in the hands of children and consequently in the hands of teachers. Therefore, teachers' personal characteristics were studied as a predictor of student outcomes. Research on teacher effectiveness began in the early 1920s with a number of studies referring to superior and inferior teachers with respect to their teaching quality and by the middle of the century such studies resulted in the formation of the American Educational Research Association (AERA) in 1952 (Doyle, 1977). The motivating factor behind this advancement was the Sputnik crisis and the cold war between the USA and the USSR. It drew attention to the issue that American children's education was lacking and resulted in improvements in teacher training and assessment (Markley, 2004). This led to the formation of theoretical models of teacher effectiveness (the models will be discussed later) in order to measure the components of teacher effectiveness. Later the idea of teacher effectiveness was broadened to school or educational effectiveness with the assumption that school level factors (e.g. school leadership, learning environment) do effect teacher behavior and hence student outcomes. Research then began in the area of educational effectiveness as school effectiveness and teacher effectiveness began to be considered as a part of educational effectiveness. The starting point for the educational effectiveness study was with the studies conducted by Coleman et al. in 1966 and Jencks et al. in 1972 in the United States of America (Creemers, n.a). These sociological studies attempted to reveal the relation between society and schools and found that inequality in educational opportunities is the major problem (Scheerens, 2000). Later the subject of school effectiveness was studied in the field of education and the key finding from the decades of research on school and educational effectiveness is: the classroom level or teacher and teaching quality is the most important predictor of pupil outcomes (RAND, 2013; Muijs & Reynolds, 2001; Kyriakides, Campbell, & Gagatsis, 2000; Scheerens & Bosker, 1997; Brophy & Good, 1986; Kyriakides & Creemers, n.a.).

But throughout its history, research on teacher evaluation has faced problems regarding theory, methodology and productivity. Most of the research on measuring teacher effectiveness (or educational effectiveness) is a-theoretical in nature and has focused on finding the statistical relationship between teacher factors and students' outcomes without any concern about theory generation and testing (Creemers, 2002) and this problem exists till today. However, there is a consensus that teachers are the most important factor in the development of student learning and competence. Wenglinsky (2000) reported that what happens in the classroom is critical for students and Sander (1999) affirmed that the teacher is the single biggest contributor to student performance. The importance of teacher and teaching summed up nicely by Elmore (2009) as "to improve student learning, you do not change the structure. You change the instructional practices of teachers. The schools that seem to do best are those that have a clear idea of what kind of instructional practice they wish to produce, and then design a structure to go with it".

2.2. Defining Teacher Effectiveness

Despite agreement that effective teaching is the most important factor that contributes to student achievement, there is still no widely accepted definition of teacher effectiveness. Furthermore, there is the lack of agreement about what constitutes effective teaching which has resulted in a broad range of definitions of teacher effectiveness.

Defining teacher effectiveness is intricate because the definition, the elements of teacher effectiveness and the techniques of measuring it are strongly interconnected with each other and, hence, should be in line with each other. Therefore, the definition of teacher effectiveness reflects the components of teacher effectiveness along with the measurement methods used to investigate it. For instance, Campbell et al. (2004) defined teacher effectiveness as "the impact that classroom factors such as teaching methods, teacher expectations, classroom organization and use of classroom resources, have on students' performance" (p.78). From this definition, it is clear that teacher effectiveness is the effect of the procedures used by the teacher in classroom and the effects on student learning or competence development. It is also obvious from the definition that the method used to measure teacher effectiveness would probably be classroom observation. On the other hand, Doyle (2008) stated that "teacher effectiveness is the amount of student learning that occurs" (p.2). From this definition we can interpret that teacher effectiveness is not directly related to the elements involved in teaching/ classroom and only concerned about student achievement and the effectiveness of the teacher is about the level of growth in student learning.

Swank, Taylor, Brady, and Frieberg (1989) defined teacher effectiveness is terms of specific teacher actions in classroom. They stated teacher effectiveness is asking more academic questions during instruction, shrinking the lecture time and ineffective practices, like negative feedback and low-level questions. Teacher should ask cognitively challenging questions, should avoid direct instruction and activities in which students cannot participate actively. They believed that teacher effectiveness in this way can be easily evaluated because all these factors can be easily observed during teacher instruction. Million (1987) stated effectiveness is centered on the lesson design and methods of delivery. According to Smith (1995) teaching is about arranging the experiences in an effective way. Vogt (1984) stated that effective teaching is "the ability to provide instruction to different students of different abilities while incorporating instructional objectives and assessing the effective learning mode of the students". Clark (1993) wrote that "effective teaching involves someone who can increase student knowledge" (p. 10). Collins (1990) established the criteria for an effective teacher, based on five characteristics; the effective teacher is committed to student learning, knows the subject matter well, is responsible for managing students, can think analytically about their own practice, and is a member of the learning community.

Although, the above mentioned definitions have stated differently but most of them have two things in common; teacher instruction and student learning which shows that both aspects are integral part of teacher effectiveness. Teacher effectiveness cannot be determined without knowing its effect on student outcomes. The current study will adhere to this tradition and defined teacher effectiveness as "the effect of teacher and instructional factors on students' mathematics competence from grade 5 to 7. In current study, factors that would show positive effect on student mathematics competences could be considered as effective. In Walberg's words "what's good for the goose is good for the gander" (1984).

2.3. Models of Teacher Effectiveness

In the beginning of 1990s a strong interest came up in the theoretical models on the educational effectiveness in reaction to the factors and characteristics of effective teachers. A number of empirical studies have examined the theoretical models of teacher (or educational) effectiveness and provided empirical findings regarding those models. The current study has briefly discussed those models and provided the empirical findings, for more details see Doyle (1986), Borich (1996), Scheerens (2004), Creemers (2002), Seidel and Shavelson (2007), Bolhu-is (2003).

2.3.1. Presage-product model

The presage-product model is the oldest model to measure teacher effectiveness. The model was based on the assumption that background characteristics and psychological characteristics of teachers make them more or less effective and these characteristics include teachers' age, intelligence, gender, motivation, professional training, and personality (like attitudes, authoritarianism and flexibility: Woolfolk 1985). In order to investigate it, personality characteristics of teachers have been measured using a variety of psychological tests (Campbell, Kyriakides, Muijis & Robinson, 2004). Schofield and Start (1980) stated that most of the research in teacher effectiveness until the late 1950s was done based on the presage-product model and gathered personality, experience, attitudes, education, socio-economic background as components of teacher effectiveness, however, the empirical evidence between presage variables and student outcomes was not convincing and therefore, the approach was extensively criticized. Research found that generally there is no relationship between teachers' characteristics and student performance (Borich, 1996).

The reviews done by Medley and Mitzel (1963) and Gage (1965) on the studies of teacher effectiveness showed that there is no consistency between the effects of teachers' personal characteristics on students' outcomes (presage-product model). The lack of consistency in the results between teacher characteristics and student outcomes and the emergence of behaviorist school of thought in student learning turned the focus of teacher effectiveness research from personal characteristics of teachers to their behavior in the classroom and therefore, teachers' classroom behavior (process) and student outcomes (product) was measured.

2.3.2. Process-product model

When the psychological factors of teachers failed to explain the relation between teachers' effectiveness and student competencies, researchers started looking into the role of teachers' behavior on their effectiveness. The model was influenced from the theories of behaviorist psychologist, mainly Ivan Pavlov and B.F. Skinner.

The process-product paradigm was based on the assumption that the product (student learning) is the outcome of the process (classroom instruction). As the whole process of classroom instruction is controlled by teachers, teachers' behavior has an important role in student learning. Studies based on this model were mostly conducted in 1960s involving the measurement of student competencies at the beginning and end of the study, with standardized tests. Albert Bandura later added motivation, thought, belief and expectations, in addition to behavioural factors, which also influenced the transition from the behaviorist school of thought to that of cognitive psychology.

Process-product studies have deepened the understanding of the teaching-learning process. Findings from research on process-product showed that specific teachers' behaviors are consistently correlated with student achievement (Brophy and Good, 1986). Lowyck reported (as cited by Scheerens, 2004) the following teacher factors as predictors of students' outcomes in process-product studies; clarity (clear presentation adapted to suit the cognitive level of students), flexibility (varying teacher behaviors, teaching aids and activities), enthusiasm, (in behavior), task related/ business like behavior, criticism, indirect activity (taking up ideas, accepting students' feelings and stimulating self-activity), providing the students with opportunity to learn criterion material, making use of stimulating comments and varying the level of both cognitive questions and cognitive interaction. However, these specific behaviors were not enough to explain effective teaching, therefore, the question was how much the factors of teacher effectiveness need to be extended (Campbell et al., 2004).

2.3.3. Dynamic Model of educational effectiveness

The dynamic model of educational effectiveness was presented by Kyriakides and Creemers in the 1990s. The dynamic model of educational effectiveness is a top to down model from state or regional policies to what occurs in classroom. The model involves all factors from school that can influence students' outcomes. This model details all the factors of teaching quality which are given in table 2.1.

The model does not promote any single approach to teaching but rather explainshow the whole process of teaching should be conducted in the classroom. The model is grounded on the assumption that factors of teaching are interconnected and are not distinct from eachother (Campbell et al., 2003; Creemers, 2007; Johnson, 1997) so teaching quality cannot be achieved by concentrating on an isolated teaching approach rather by using the effective skills together from different teaching approaches (Gilberts & Lignugaris-Kraft, 1997). However, the model was criticized also for the same reason i.e. it is only concerned with the increase in student performance, neglecting the fact that those teaching skills are not in line with each other and belonged to different teaching approaches (Creemers & Kyriakides, 2008). Nonetheless the model was supported by findings from some recent studies. For instance Antoniou, Kyriakides and Creemers (2011) conducted an experimental study in order to investigate the effectiveness of dynamic integrated approach (DIA) to teacher professional development and student performance. The study was conducted by creating two

Table 2.1: *Showing teacher level factors of dynamic model is educational effectiveness*

Factors	**Main Elements**
(1) Orientation	(a) Providing the objectives for which a specific task/ lesson/series of lessons take(s) place; and (b) challenging students to identify the reasons for which an activity takes place in the lesson.
(2) Structuring	(a) Beginning with overviews and/or review of objectives; (b) outlining the content to be covered and signaling transitions between lesson parts; and (c) calling attention and reviewing main ideas.
(3) Questioning	(a) Raising different types of questions (i.e., process and products) at appropriate difficulty level; (b) inviting students to develop strategies; and (c) promoting the idea of modeling.

(4) Teaching modeling	(a) Encouraging students to use problem solving strategies presented by the teachers or other classmates; (b) inviting students to develop strategies; and (c) promoting the idea of modeling.
(5) Application	(a) Using seatwork or small group tasks in order to provide needed practice and application opportunities; and (b) using application tasks as starting points for the next step of teaching and learning.
(6) Classroom as a learning environment	(a) Establishing on task behavior through the interactions they promote (i.e., teacher-student and student-student interactions); and (b) Dealing with classroom disorder and student competition through establishing rules, persuading students to respect them and using the rules.
Management of time	(a)Organizing the classroom environment; and (b) maximizing engagement rates.
Assessment	(a)Using appropriate techniques to collect data on student knowledge and skills; (b) analyzing data in order to identify student needs and report the results to students and parents; and (c) evaluating their own practices
Source: Creemers and Kyriakides. Enhancing quality in education: A dynamic model of educational effectiveness for research and practice.	

intervention groups, one for DIA and the other for holistic approach (HA). HA aimed at teacher's reflection of his own behavior regarding his teaching beliefs, practices and experiences in order to improve his effectiveness (Golby & Viant, 2007).The study found that teacher performing high on the factors of quality teaching in the dynamic model are more effective than teachers who performed low. The study also compared the effectiveness of (DIA) and holistic approach (HA) and found that the dynamic approach is found to be more effective than the holistic approach in terms of student achievement; however, the findings are not conclusive.

2.3.4. Comprehensive model of educational effectiveness

Creemer's Comprehensive model of educational effectiveness presented in 1994 is actually the Caroll's model of school learning. The Caroll's model stated that 'the degree of mastery is a function of the ratio of the amount of time students actually spend on learning tasks to the total amount of time they need (Kyriakides, Campbell & Gagatis, 2010). Caroll (1963) argued that time actually spent on learning is defined as equal to the sum of three variables: opportunity, perseverance (to learn) and aptitude. In his model both opportunity and time are defined at the level of classroom and school. Creemers model is based on the following four assumptions: maximizing class time, successful grouping and organization, exhibiting best teacher practices, adapting practice to particulars of classroom (Creemers, 1994). The model is based on the anticipation that among school factors, classroom is the most important. Therefore, the quality of teaching in the classroom is important for student learning for instance effective teachers would take less time in classroom management, arranging the materials and would spend more time on learning tasks and activities, thus students would have more time to learn. However, Creemers did not present students as passive learners, if time and opportunity are in hands of teachers, eventually students would decide how much time they will spend on the learning activities and how better they would avail the learning opportunity. The model is based on the assumption that educational effectiveness has a hierarchical structure of levels; context level, school level, classroom level and student level.

According to this model, classroom factors contribute to lower level of effectiveness and the school and the context factors contributes to the higher level of effectiveness. The low level is defined not in the terms of low importance rather in the terms of hierarchy considering the structure of school, classroom is the lowest level and national context is the highest level that develops educational policies. Lower level of effectiveness is conditional to higher level of effectiveness however; both levels together contribute to student outcomes. The contribution to effectiveness at the lower levels comes from teacher and the students and the contribution at the higher levels includes educational policies, curriculum, school leadership, and school climate. The levels in the model effect student performance for instance time on task and opportunities used by students depends on the time and opportunity and quality of instruction offered by the teacher (Creemers, n.d.). The model has four principles necessary to achieve educational effectiveness. The first principle is *consistency* which means the consistency of effective features within and between levels; c*ohesion* implies that all the teachers in school should be effective; *constancy* principle implies that teaching should be effective during all schools years of student and the last principle *control* implies outcomes and school environment should be evaluated (Creemers, 1994). It's not easy to apply this model in real life because of the conditions for the application (like all school teachers should be effective) and most of the studies failed to provide the proof about the validity of the model.

2.3.5. Danielson model of effective teaching

Danielson (1996) created a model of effective teaching based on behaviorist theories in which she mentioned four domains of effective teaching which have showed to improve students' learning by empirical studies and theoretical research. These domains include planning and preparation, classroom environment, instruction and professional responsibilities. The sub-factors that contribute to each domain are given in the table 2.2. The model was criticized for being dealing students as passive learners.

THEORATICAL BACKGROUND

Although, teacher effectiveness models have provided some basic and important knowledge about the factors of teacher effectiveness, they lack enough empirical evidence to support their argument and the findings are inconclusive about the factors of teacher effectiveness. Moreover, the models were dominated by the theory of behaviorism i.e. teacher as a dominant figure of the learning process and the student as the less active figure in comparison to other schools of thought of learning. If we look into the learning theories other than behaviorism for instance Ausubel's theory of meaningful learning, cooperative

Table 2.2: *Danielson model of effective teaching*	
Domain 1: Planning and Preparation 1a Demonstrating Knowledge of Content and Pedagogy 1b Demonstrating Knowledge of Students 1c Setting Instructional Outcomes 1d Demonstrating Knowledge of Resources 1e Designing Coherent Instruction 1f Designing Student Assessments	Domain 2: Classroom Environment 2a Creating an Environment of Respect and Rapport 2b Establishing a Culture for Learning 2c Managing Classroom Procedures 2d Managing Student Behavior 2e Organizing Physical Space
Domain 4: Professional Responsibilities 4a Reflecting on Teaching 4b Maintaining Accurate Records 4c Communicating with Families 4d Participating in a Professional Community 4e Growing and Developing Professionally 4f Showing Professionalism	Domain 3: Instruction 3a Communicating With Students 3b Using Questioning and Discussion Techniques
Source: Danielson (1996) Danielson model of effective teaching.	

learning theory, and Vygotsky socio-cognitive theory of learning, learners actively participate in the process of learning. In the 21st century, the aim of education is to make the student an independent thinker, therefore, the student should be more responsible for their learning especially at secondary level where students are able to regulate their learning. Therefore, these models of teacher effectiveness are less beneficial. Furthermore, they have neglected the domain-specific aspect of learning and provided similar methods for all types of learning domains. Current studies in the field of educational research aim to measure teachers' effectiveness in a domain-specific context for instance the Teaching and Learning International Survey (TALIS). Another current topic in the field explores teachers' usage of constructivist learning activities in comparison to behaviorism, for instance professional competence of teachers, Cognitive Activating Instruction and Development of Students' Mathematics Literacy (COACTIV). Therefore, the recent models of teacher effectiveness are also inclined towards the domain-specific aspect of learning and constructivist learning activities. Bolhuis' model of instructional effectiveness is one of those and is discussed in this chapter in detail under the heading instructional factors along with the extension of the model done by Seidel and Shavelson in (2007) for their meta-analysis study.

2.4. Distal and Proximal Indicators of Teacher Effectiveness

Current models of teacher effectiveness measure teacher effectiveness proximal to the process of teaching and learning rather than distal factors such as teacher factors. The idea of proximal indicators to the teaching-learning process is introduced by Seidel and Shavelson (2007) in their meta-analysis in which they found that proximal indicators are better indicators of measuring teacher effectiveness. Proximity is a matter of degree. The proximal indicators of measuring teacher effectiveness discussed by Seidel and Shavelson (2007) are experimental methods and quasi experimental because both methods are quite close to the process of instruction. However, both methods are expensive ways of data collection and therefore, data is usually collected in small samples that lack in generalizability. The study has found that teacher effectiveness research is dominated by correlational studies in which distal indicators are used to measure teacher effectiveness which they suggest is not the best way of measuring teacher effectiveness. Therefore, in correlational research there is a need to measure the instructional process and in correlational studies with large samples instruction is usually measured proximally by asking teachers or their students about the instructional process. Therefore, the current study is correlational in nature but has taken into account the idea of proximally measuring the teaching-learning process through an instructional questionnaire that directly asked teachers about their practices in the classroom. Although, proximal indicators may be the better way of measuring teacher effectiveness, does it mean teacher factors are no longer important? Teacher factors are important as they have the power to shape teachers' instruction. Empirical studies have shown that teacher factors (distal indicators) influence instructional practices (Stipek, Givvin, Salmon & Macgyvers, 2001) and also student outcomes (Seidel & Shavelson, 2007). However, according to Seidel and Shavelson (2007) teacher factors are a less reliable way of measuring teacher effectiveness, but they are still important. Although the power of distal indicators of teacher effectiveness shouldn't be underestimated, proximal indicators may be the better way of measuring teacher effectiveness. Therefore, the current study aims to measure teacher effectiveness not only through instructional factors (proximal indicators) but also through teacher factors (distal indicators).

2.5. Teacher Factors

Baumert and Kunter (2013) affirmed that teachers play the most important role in the education system. Hattie stated that "the current mantra is that teachers make the difference" (2009, p.34). Therefore, abundant efforts are made in order to make teachers competent and effective. In Germany, teachers are trained in both subject-matter knowledge and pedagogical knowledge to ensure they are able to cope with the challenges they will face in the classroom and help children learn to their potential. Moreover, teachers are trained in relation to the school type in which they will teach. However, the research shows that although teacher training is systematic and well planned teachers are not effective in a similar way and it might be because there are certain habits, beliefs and pedagogical ideals of teachers that influence their teaching. Some previous studies have reported that teachers' practices are influenced by their general beliefs. For instance Baumert et al. (2010) have conducted a longitudinal study and have shown that teachers' beliefs and knowledge are related to students' outcomes and this relation was mediated by instructional practices. This shows that there are some factors that influence teacher instruction e.g. teachers beliefs, approaches, pedagogical ideals, job satisfaction etc. Although, the findings are not conclusive, the previous research has shown that these factors have an effect on students' outcomes. Therefore, the current study aims to measure the effect of teacher factors on student outcomes in order to get a better understanding and empirical evidence about the effect of teacher factors. Each teacher factor is discussed here in detail.

2.5.1. Teacher belief

The belief is something that is hidden and inferential. It can only be inferred or indirectly observed from the teacher's responses or practices. Although hidden, beliefs play an important role in the teacher's decision making process about the instruction. Nespor (1987) concluded that beliefs are more important than knowledge in determining individuals' behavior and way of organizing the tasks.

Teacher's own belief is thought to function as a filter influencing decisions and actions made before, during and after instruction (Philipou and Christou, 1997). *Teacher's philosophy and beliefs* were found to have an impact on students' achievement, teachers' attitudes about the effectiveness of various teaching methods, innovations, curricula, textbooks and software material (Ernest 1999, Philippou and Christou 1997, Roulet 2000). Class organization, the choice of learning activities, the question posed by teachers and homework that teachers assign to students are likely to be influenced by *teacher's beliefs* (Stipek et al., 2001). In a study conducted by Campbell, Kyriakides, Mujis, Robinson (2004) teachers characterized by *connectionist beliefs* were found effective in comparison to teachers with *direct transmission beliefs* and discovery based learning orientations. According to Askew et al. (1997) connectionist teachers believe that being numerate involves being both efficient and effective, being able to choose an appropriate problem-solving or calculation method and being able to make links between different parts of the curriculum and not only the learning of facts. Thompson (1992) has stated that relationship between beliefs and practice is a two way relationship in which practical experience shape beliefs. The process-product model also supports the idea that *teacher beliefs* are determinants of teacher effectiveness. Although, there are studies that support the argument that *beliefs* shapes teachers' instruction in the classroom (TALIS, 2009), there are studies that shows no relationship between *teachers' beliefs* and practices. Wilcox-Herzog (2002) conducted a study on early childhood trained *teachers beliefs* about developmentally appropriate practices (DAP). The data about teacher belief was collected through a self-report questionnaire and teachers' instruction was measured through videotapes. The study found no relationship between *teachers' beliefs* and practices. The past studies have explored *teachers' beliefs* about different dimensions for instance about DAP, learning strategies (Kistner, et al., 2015) etc. and the findings from those studies cannot be generalized to *teachers' beliefs* to other dimensions. The findings from the studies which explored direct instruction and constructivism are also inconclusive. Moreover, in the current era, teaching and learning are domain-specific; TALIS (2009) stated that little research has been done about *teachers' beliefs* in relation to the subject being taught and TALIS itself has measured the domain-general aspects of teachers' belief.

Therefore, it would be worth exploring the relationship between *teachers' belief* and practices in a domain-specific context. The current study has measured the four dimensions of teachers' beliefs: belief about deep learning, aim of education, constructivism and direct instruction.

If a teacher believes that learning should be deep, they would plan and provide the learning opportunities for students that would take them from ideas to understanding and beyond, surface learning, on the other hand, is when a teacher believes that students should simply learn the facts and figures. Biggs & Collis (1982) have done a study about deep learning and reported that various teachers claimed that the aim of their teaching is to improve *deep learning*. *Surface learning* is not unimportant of course as it provides a base for *deep learning*, but in the 21st century where the aim is to make a child an independent learner and thinker, they should be trained to construct meaning and meaningful experiences in the light of the knowledge attained from the teacher. This can only be possible if a teacher believes that learning should be in-depth. Hattie (2009) stated that learning would be successful if students became their own teachers and to achieve this teachers need to make students participate in the learning process actively, let them know different ways to solve the problems, to provide opportunities to apply the learned knowledge and to monitor their learning. Pajares (1992) stated that beliefs have a key role in teachers' perceptions and decision making, which directly affect their teaching practices. A positive belief about deep learning would make teachers plan in-depth learning. Planning of deep learning activities is essential for *cognitive activation* and construction of knowledge in students. Bransford et al. (2000) stated that learning needs development of meaning and in-depth understanding of learning content. *Teachers' positive beliefs about deep learning* shows teachers' high expectations from their students and previous research has shown that teachers' high expectations have a positive influence on student outcomes.

THEORATICAL BACKGROUND

A teacher having a *constructivist belief* would provide an opportunity to learner to construct and reconstruct the idea and the aim is not to understand the idea rather the learners' construction of ideas. Scheerens (2004) stated that "students are to be confronted with "contextual real world environments. Or rich artificial environments simulated by means of interactive media" (p. 31)

As the name suggests *transmissive beliefs* implies the transmission of facts directly to the students. This approach conceives the learner as a passive recipient. On the other hand, *constructivist beliefs* are based on the theory of involving the learner actively in the learning process. For the constructivist school of thought, learning is a journey from ideas to comprehension and to construction of knowledge and onwards. A constructivist teacher claims that their role is that of a facilitator that provides learning opportunities to the individual students to attain knowledge and build (construct) understanding through their own activities and through arguments, reflecting on the issue and sharing the ideas with other learners with a minimum interference and correction from the teacher (Cambourne, 2003). A teacher with *transmissive beliefs* would focus on basic skills, pre-specified objectives, small steps, feedback and reinforcement, on the other hand a *constructivist* teacher focuses on intrinsic motivation, challenging problems, discovery learning and context-based knowledge (Scheerens, 1995). TALIS (2009) mentioned that

"close monitoring, adequate pacing and classroom management as well as clarity of presentation, well-structured lessons and informative and encouraging feedback – known as key aspects of direct instruction – have generally been shown to have a positive impact on student achievement."(p. 89)

Now most of the educational researchers and educational policies want to see the learner as an active participant in the learning process and therefore support the *constructivist approach*. Scheerens and Bosker, (1997) however concluded that most effective teaching involves highly structured learning, direct teaching that is followed by testing and providing proper feedback. Hattie, (2009) also found from his synthesis of 800 different meta-analyses that direct instruction is not an inferior teaching approach rather he said "*direct instruction* has a bad name for the wrong reasons" (p. 205). He reported that *direct instruction* involves the following eight steps: learning intentions (objectives), success criteria, build commitment and engagement, how teacher should present the lesson, guided practice, closure, independent practice. Though all these steps are planned and led by the teacher but it does not mean that the learner is a passive receiver. However, the results of his study also showed that direct instruction is less successful for mathematics instruction than constructivism. TALIS (2009) found that teachers in all the participant countries the average endorsement of *constructivist beliefs* is higher than direct instruction. Moreover, TALIS (2009) stated that educational researchers also support constructivism.

2.5.2. Professional training

A Teacher's professional training shapes their instructional practices because, along with other factors, instructional practices depend on the skills a teacher takes to the classroom and these skills come from their *professional training*. Professional competence is considered to be an important indicator in teacher's instructional practices (Campbell et al., 2004). The scope and impact of *professional training* is broad, from shaping teachers' instructional beliefs, knowledge and skills to their organizational behavior, for instance cooperation among colleagues (TALIS, 2009). Danielson (1996) states that *professional training* and development involves participating in a professional community, growing and developing professionally through participation in the professional development meetings. Kunter and Baumert (2013) stated that teacher professional skills include preparation of lessons, organization of classroom environment, and evaluation of student learning outcomes.

Many researchers wrote on the importance of *professional training* and development. According to Kennedy et al. (2008) *professional* *training* of teachers is a key in equipping future teachers with the essential professional competence. *Professional training* not only helps teachers to grow professionally but also results in the better quality of schools (TALIS, 2009; Covino & Iwanicki, 1996). TALIS (2008) found that 88% of the teachers who attended *professional training* last year reported that *professional training* had a positive impact on their teaching. Sparks (2004) investigated the differences between fully certified teachers and teachers with probationary and emergency licenses and found that fully certified teachers have slightly more effect on student outcomes in mathematics, science and reading. However, Glazerman, Mayer and Decker (2006) also compared the emergency licenses teachers with trained teachers and found no differences.

Previous research has investigated the effect of teachers' professional competence both quantitatively and qualitatively. Qualitative studies have shown that teachers' professional competence has a positive effect on student's outcomes and the range of strategies teachers used in the classroom depends on teachers' in-depth conceptual knowledge of the subject being taught (Baumert & Kunter, 2013). However, qualitative studies have investigated the effects of teacher professional competence by using proximal indicators i.e. by doing case studies. Quantitative studies have investigated the construct often by distal indicators of teacher training for instance certification status or completion of courses (Cochran-Smith & Zeichner, 2005). Distal indicators are type of training, certification and professional development and proximal indicators are the actual assessment of the teacher's content knowledge and pedagogical knowledge. Recently the trend has changed too in quantitative studies and proximal indicators are used to measure teachers' professional competence (content knowledge and pedagogical knowledge; Krauss et al., 2008b). Although, proximal indicators are a better way of measuring teachers' professional competence but generally, in previous research, distal measurement of teacher effectiveness generally showed a positive effect on student achievement if the teachers are trained to teach the particular subject and results are more positive in mathematics (Baumert & Kunter, 2013).

In Germany, professional training or teacher training is mandatory. Even though, teachers get the same training (at least in the same school type) they vary in their professional competence. These differences can be on the basis of teachers' grades prior to entering professional training (Baumert et al., 2013) or, more often, based on teachers' cognitive, psychosocial, and biographical characteristics (Kunter, Kleickmann, Klusmann, & Richter, 2013). Baumert and Kunter (2013) reported that attending more courses during the university phase of *professional training* has a positive effect on student outcomes. Teacher education in Germany is divided into two phases: the first phase focuses on content knowledge with a secondary focus on pedagogical knowledge and the second phase consists of a structured and monitored two year induction program in schools. When teachers get hired as permanent teachers they have no or little stress to attend any further professional development courses. Teachers have criticized the current teacher education program because they found the two-phases of training disjointed and the pedagogical training in phase one is useless in preparing them for the practical challenges they face in the classroom (Cortina & Thames, 2013) and the most important area of professional activity for teachers is classroom instruction (Mareike, Kunter & Voss, 2013).

The COACTIV study, conducted in Germany, explored how professional competence develops and also proximally measured teacher's professional competence. In Germany, *professional training* mainly involves development of content knowledge and pedagogical knowledge. The study has assumed that teacher domain-specific knowledge is an important predictor of good instructional quality in terms of both *cognitive activation* and individual learning support (Kunter & Baumert, 2013) and found that teachers differ substantially in their level of domain-specific knowledge. This difference depends largely on the track for which the teachers are trained for i.e. academic track teachers scored significantly higher than teachers trained for other school types even when cognitive characteristics were controlled at the time of entry to teacher training (Kunter & Baumert, 2013).

2.5.3. Job satisfaction

Unless a person is satisfied with their job, it is difficult for them to carry on their duties efficiently and effectively. Satisfaction from one's job affects the quality and quantity of the output. Chandramma (2013) stated that one can only work enthusiastically, if they are satisfied with their job. Teachers who are well settled in their life and profession are more effective in their teaching (Prakasha, Jamavaya, & Malesha, 2011). Ololube (2006) conducted a survey on teacher related factors of *job satisfaction* and found that *job satisfaction* factors have a great impact on teacher outcomes. Ross (1998) found that *job satisfaction* is associated to teacher instruction and students' achievement. TALIS (2009) found that most of the variance in *job satisfaction* is explained at teacher level and less at the school and country level. The study found that teachers' *job satisfaction* depends on how well teachers get along with their colleagues and their relations to other teachers and students. Teachers' perception about the classroom environment, school climate and their self-efficacy and competence are strong determinants of job satisfaction and therefore, *job satisfaction* is more a teacher level variable and not a school level variable. The study found that job satisfaction is unrelated to teacher beliefs and classroom practices however; *job satisfaction* is related to professional collaboration among colleagues i.e. teachers who are satisfied with their job collaborate more often with their colleagues which might indicate that job satisfaction is indirectly related to students' success. TALIS results from 2013 showed that *job satisfaction* is much more affected by classroom behavior than class size. Furthermore, the study found that overall teachers are satisfied with their job and would like to be teachers again but two out of three teachers in all participant countries believe that their profession is not valued by society, and therefore, they lack identification with their job.

2.5.4. Planning

Planning involves the structuring of the content and preparation of the activities to deliver the content. Comprehensive Model of Teacher Effectiveness mentioned structuring and planning the content to be taught in the classroom as important factors of teacher effectiveness. Good teachers dedicate more time to *planning*, therefore, they can increase the learning time during instruction. TALIS (2013) reported that on average teachers spend seven hours a week for preparing lessons from a total of thirty-eight hours of work. During planning effective teachers set appropriately challenging goals and then structure learning situations, so the students can reach those goals. Doyle (1986) stated good preparation for the lesson is the key factors of effective teaching. In Danielson's (1996) four domain model of effective teaching, planning and preparation are mentioned as important indicators of effective teaching. *Planning* and preparation include demonstrating the knowledge of content and pedagogy, demonstrating knowledge of students, setting instructional outcomes, demonstrating knowledge of resources, designing coherent instruction and designing student assessments.

A first British study done in 1988, which explicitly linked school and teacher effectiveness, found the following factors related to teacher effectiveness: planning, structured sessions, intellectually challenging teaching, and a positive climate. *Planning* not only involved structuring the lessons but structuring the lessons according to students' needs. The students' needs vary in a classroom, therefore teachers should care about individual student needs while *planning*. It is challenging for teachers to be equally effective for all students as students are diverse in their abilities, level of motivation, needs etc. Therefore, effective teachers plan the activities that are beneficial and appropriately challenging for all learners or plan different activities for the students with different needs. Krauss et al. (2013) stated that to plan instruction according to individual student needs, teachers must have knowledge of student cognitive abilities in that particular subject and the teacher should be able to recognize, analyze and categorize the students' errors from the type of mistakes students' make. Results from the National Center on Teacher Effectiveness study showed that teaching is effective when teachers manage their classroom towards productive learning by presenting content accurately and in meaning-oriented way, and by addressing students' needs (Blazar, Litke, Barmore, & Gogolen, n.a). Baumert and Kunter (2013) mentioned *planning* as an important facet of pedagogical knowledge for teacher training. In the context of the current study, *planning* involves the planning of lessons, *individual needs of students*, and *creating interest in learning*.

2.5.5. Cooperation among teachers

Scheerens (1990) presented an integrated model of school effectiveness in which cooperative planning is an important factor. A cooperative environment among teachers is a sign of a friendly environment and less competition among colleagues. According to Creemers (n.d.) school level factors are assumed to influence teachers' instructions in the classroom. If teachers work as a team to achieve their goals it can help novice teachers and could result in better student learning. When teachers start teaching they face such challenges in the classroom for which they are not trained. *Cooperation among teachers* can help them to tackle those challenges. *Cooperation among teachers* involves different aspects including general collaboration, planning the instructional material together, sharing the useful materials , assistance to new teachers or observing the colleagues (to learn and to provide feedback).

The Louisiana School effectiveness Study (Teddlie & Stringfield, 1993) was a program based on series of studies that investigated the factors of school effectiveness both quantitatively and qualitatively. The program investigated the school effectiveness at principal, faculty and students level. At faculty level, the effective schools include characteristics such as a friendly environment, faculty cohesiveness, no major conflicts among faculty, integration of support staff into faculty, cooperative efforts to enhance teaching, uniform teaching behaviors and assistance to new faculty members. On the other hand, ineffective schools have characteristics like the faculty is cold, lack of cohesiveness among faculty, open disputes, low faculty stability, large variances in teaching behaviors and little assistance to new faculty members. Furthermore, Levine and Lezotte (1990) reviewed the studies done on effective schools and reported the school environment to be an effective indicator of school effectiveness. The sub-factors of the school environment include orderly environment, faculty commitment, problem solving orientation, faculty cohesion, consensus, communication and collegiality, faculty input decision-making and a schoolwide emphasis on recognizing positive performance.

TALIS (2013) study found that teachers who participate in *collaborative learning* are more satisfied with their jobs and feel more confident about their abilities. In the current era it is not enough for teachers to teach in the classroom in isolation, they need to cooperate with each other because working together with teachers could indirectly affect students' outcomes (TALIS, 2009). TALIS (2008) results confirmed the significance of cooperation among teachers. However, the study reported that too many teachers work unaccompanied. TALIS also found that teachers having stronger beliefs about teaching methods showed more cooperative behavior with other teachers and felt they were more effective. TALIS (2009) distinguished two sub-factors of cooperation among teachers; *exchange and coordination for teaching* (e.g. exchange of instructional material) and professional collaboration (*e.g.* observing other teachers' classes and giving feedback). The current study has followed the same sub-factors of cooperation among teachers because the items to measure cooperation were adopted from TALIS by NEPS. TALIS (2009) suggested that teacher effectiveness could be improved by extending teacher cooperation as cooperation among teachers' would improve the school climate that would indirectly improve student outcomes.

2.5.6. Stress in planning and classroom

Stress in planning and classroom is an exploratory factor included in the current study in order to measure does stress during teaching activities affects students' learning outcomes. No study was found in past research that has investigated this factor before. Past studies have investigated teacher stress both in relation to job satisfaction and teacher effectiveness but only focused on personal (e.g. self-esteem) organizational (e.g. work load) and social (e.g. relationship among colleagues) aspects that cause stress for instance Borg, Riding and Falzon (1991) and Abel and Sewell (1999) looked into the following 4 aspects of teacher stress; pupil misbehavior, time/ resource difficulties, professional recognition and poor relationship with other teachers. Kyriacou and Sutcliffe (1977) reviewed research on teacher stress and reported organizational aspects as source of teacher stress and later in 1978 Kyriacou and Sutcliffe proposed a model of teacher stress that also only covered professional and personal aspects of stress. Trendall (1989) examined the different aspects of teacher stress and their effect on teacher effectiveness and found that stress has a negative effect on teacher effectiveness. Therefore, the current study has aimed at exploring the effect of *stress in planning and classroom* on teacher effectiveness and student mathematics competence.

2.6. Instructional Factors

The paradigm shift from teacher quality to instructional quality resulted in a focus on teacher instructional practices in the classroom. Moreover, this focus on instructional practices is rather specific i.e. teaching with respect to the nature of the subject to be taught assuming that learning is domain-specific and it should be according to the nature of the subject. For instance, Hattie (2009) reported that constructivist teaching is effective in mathematics teaching and direct instruction for reading. This is called domain-specific instruction. In Baumert and Kunter's (2013) words "teaching and learning are domain specific."

THEORATICAL BACKGROUND

On the basis of the importance of instruction in recent models of teacher effectiveness NEPS has measured teachers' instructions in relation to the subject being taught (domain specific instruction). In addition to domain-specific learning, the development of self-regulation is of grave importance in the 21st century. Learners should be able to set their own goals and direct themselves to achieve those goals and school learning should help students to make them self-directed learners. NEPS has followed Bolhuis' (2003) model of instructional quality in order to measure the instructional practices of teachers. The model was developed by Bolhuis and was further expanded by Seidel and Shavelson (2007) for their meta-analyses study, for more details about the model see Bolhuis (2003) and Seidel and Shavelson (2007). Frahm et al. (2011, p. 228) reported that "Bolhuis' model views learning as a self-regulated, lifelong and multidimensional process". The process of learning is a multidimensional process which offers learning in a flow in which the teacher arranges learning in a social context and students participate in groups in the learning process actively, they interact, they argue, they discuss and move towards achieving their goal. They share and discuss their experiences and thoughts with the class and teacher and learn from their experiences and here the teacher has the chance to monitor and guide students and change the direction of their thoughts, if needed. This implicitly develops among students the idea that learning is more a process of constructing knowledge which is subject to change rather than objective truth. It implies that prior knowledge may need fundamental change (Vosniadou, 1994). Further, the teacher activates students' cognition by providing opportunities that critically analyze the domain or subject-matter being taught. In this way the process of learning not only develops critical thinking among students but also the responsibility of being an independent learner. It is further followed by assigning students *cognitively challenging tasks* that foster their thinking skills. This balance between social and individual learning opportunities strives for the development of social skills and self-regulation, which are the aims of education in the current era. The model basically implies

Vygotsky's theory of social development, *cooperative learning*, critical learning and conceptual change theory.

Bolhuis' model of instructional quality is a rather new model and very few studies have adopted it in their studies. One study that has adopted this model is the meta-analyses study done by Seidel and Shavelson (2007). In this model Bolhuis defined five components of instruction that are interrelated. These are goal setting, orientation, executing learning activities, evaluating and regulating/ monitoring/ deciding. The first four components are arranged in a cycle and the fifth component is the central component that integrates the other four components (Seidel & Shavelson, 2007). Seidel and Shavelson have further added the components of knowledge domain (subject being taught), amount of time for learning, organizational frame for learning and classroom social climate. NEPS has employed the extended version of this model. The current study, however, has not used all the components of the model and has only focused on the executing learning activities component. This is because from the instructional aspect of teaching, the current study only aimed to measure the proximal learning process. The distal effects are measured by the teacher factor questionnaire. Both the Bolhuis (2003) and Seidel and Shavelson (2007) studies have assumed that executing learning activities is the more proximal to the knowledge building process. Seidel and Shavelson (2007) also assumed that this component would produce the maximum effects. Therefore, the present study expects more from the execution of learning activities and so included them in the study. Seidel and Shavelson defined executing learning activities as

"The execution of learning activities is characterized by teaching acts that support social interactions between students and provide direct experiences for students, facilitates the basis process of information (e.g. high language level, thinking aloud methods), or provide domain-specific opportunities for processing content information (such as mathematic problem solving, science inquiry)."

This study has taken into account the five different dimensions of learning in the classroom. These are *cooperative learning, student engagement, cognitive activation, cognitively challenging tasks,* and *differentiation*. The details about each construct are given below.

2.6.1. Cooperative learning

Different studies have used different terms for this construct, for instance; group learning (Baumgartner, 2001), social context of learning (Seidel and Shavelson, 2007), social learning (Bolhuis, 2003), student-centered learning and *cooperative learning* (Abrami, 1995; Bolhuis, 2003; Slavin, 1995). Although given different names, the focus is always on the student-centered and social aspect of learning.

Cooperative learning prevents the mere transfer of verbal knowledge from teacher to learner and facilitates the learner learning from their social environment. In the process of *cooperative learning,* prior knowledge is activated and learners actively engage in the process of learning and that facilitates the construction of knowledge, critical thinking and discussion. *Cooperative learning* discourages the idea that learning is only doing the assigned work and memorizing; it helps learners to be responsible for their own learning and gives them the feeling of accomplishing the tasks by themselves. *Cooperative learning* is a student-centered approach in which the teacher neatly plans and administers the learning by keeping themselves in the background. According to Slavin (1996) *cooperative learning* does not replace teachers' instruction but rather replaces individual activities (e.g. individual seatwork or drills) with group activities in which group members make sure that each and every individual in the group understands the content well. The effectiveness of *cooperative learning* depends on the teacher's ability to carry out the process and take it towards the achievement of the goal. Teachers should give instructions about the task at hand, ways of cooperation, and should assure the environment of positive interdependence among the group members (Slavin, 1995). They should be in the background but should be there whenever needed. The teacher should set such tasks and should set those tasks in a way that they would be challenging but attainable for students, should provide the environment and learning equipment that facilitate students learning and thinking. In other words, the tasks should be in the learners' zone of proximal development. Bolhuis, (2003) has summarized the process of *cooperative learning* in the following way

"by cooperative learning: 1) students have an opportunity to acquire social skills that are of great importance in life; 2) student self-esteem is promoted; 3) learning of students is enhanced by assuring all students active involvement; 4) student serve as a source of information and help for each other; they learn from each other by explaining and modeling solution as well as by forcing reflection and discussion in the case of disagreement, causing cognitive conflict; 5) student independence and self-regulation in learning are fostered; 6) student experience the social construction and the social origin of knowledge. Of course these points are realized only if the *cooperative learning* is organized to do so." (p.331)

Cooperative learning showed a positive effect on student learning in past research (for details see Slavin, 1996), particularly in experimental settings. However, Slavin (1996) also mentioned that the application and success of *cooperative learning* depends mainly on teachers' competence to use the method effectively. Some conditions for the effective use of this method include group activities but with individual accountability. Therefore, the success of this method depends mainly on the teachers' competence to use this method, the conditions a teacher applies and how well a teacher motivates the students. Seidel and Shavelson (2007) have found in their meta-analyses that in correlational studies social context of learning has an effect size of .05 on the cognitive domain and observational studies have an effect of .15 (the effect size was calculated by computing Fisher's Z).

2.6.2. Student engagement

Student engagement is defined as the students' psychological and physical investment in learning. It generally refers to *student engagement* in the learning process in the classroom. Bodovski and Farkas (2007) conducted a study by using longitudinal data at elementary level in order to see the effect of instruction time and *student engagement* on student achievement. The study has divided student into four groups on the basis of their previous mathematics achievement. Both instructional time and *student engagement* was measured as perceived by the teacher for each individual student. The study found that the group of lowest performing students gained the most from the engagement in the classroom and engagement in learning of students with low competence can result in a dramatic growth in achievement in succeeding grades. From the low achievement group, the students who engaged in the learning gained the most and the students who did not engage in learning gained the least. The study reported that the lowest engagement of those students was partly due to the teacher's inability to engage them in the learning. Moreover, the study found that *student engagement* has the most significant effects for the students from the lowest performing group even when their engagement was low in comparison to students the of high performing groups. This shows that *student engagement* can help in reducing inequality in education. Teachers should put more effort in engaging low performing students in the process of learning. According to Borman and Overman (2004) *student engagement* predict academic resilience among less privileged students.

Yair (2000) examined the *student engagement* and alienation from instruction among students of elementary and secondary schools in USA. The study found that Hispanic and African American children are least engaged in the instructional process, however, when the instructional process became challenging, relevant and academically demanding and made students' use their skills, Hispanic student became more engaged and, on some occasions, the Hispanic students led other groups in engagement in instruction.

Hence, we can say that *student engagement* depends largely on teacher instruction (Yair, 2000), it can bring high achievement gains to student learning particularly among low performing students (Yair, 2000; Bodovski & Farkas, 2007), it can help students from low socio-economic status and minority groups to reduce inequality in education (Borman and Overman, 2004; Yair, 2000; Bodovski & Farkas, 2007)

Teacher's instruction is a strong predictor of *student engagement*. Yair (2007) reported that *student engagement* depend on instructional methods, for instance working in groups showed a *student engagement* rate of 73%, individual and group presentations showed a rate of 66.7%, discussion showed a rate of 63.1% and teacher lecture showed the lowest engagement rate of 54.4%. Therefore, in the current study, *student engagement* is measured by the student presentation to the class and discussion among the class assuming that both instructional methods offer high chances of *student engagement* (given that group learning is measured by the construct cooperative learning) in order to see its effect on students' achievement.

2.6.3. Cognitive activation

Cognitive activation is related to Ausubel's, (1961) idea of cognitive organization and the constructivist school of thought that knowledge is created and not transferred. *Cognitive activation* is the process of activating students' prior knowledge, making students think on the basis of their prior knowledge and helping them integrate newly learned knowledge to what they already know and making learning meaningful to them. Instruction that activates students' prior knowledge and fosters their thinking is a main goal of teaching. Scheerens (2004) has stated that in secondary education, quality instruction focused on "higher cognitive processes like insight, flexibly adopting knowledge and problem solving". Teaching should maximize the opportunity of engaging students in activities that foster higher order learning (Bransford et al., 2000; Donovan & Bransford, 2005; Grenno et al., 1996). Doyle, (1986) has emphasized the formation of cognitively challenging learning situations in the classroom. This is because the spectrum of knowledge at secondary education is broader than primary education and students should be trained to think deeply, analytically and critically. *Cognitive activation* makes the learning meaningful and lifelong by connecting it to the prior knowledge of students that facilitate opening new horizons of thinking and *cognitive activation* is a step forward towards making students independent thinkers. In teacher effectiveness research, this component is investigated as domain specific information processing, cognitive activation or higher order learning. Teachers can foster cognitive activation by asking challenging questions according to their prior knowledge.

Scheerens (2004) has reported on the basis of a review of recent instructional research that more attention is given to the constructivist approach and higher order learning (Anderson, 1991; Anderson, 2004; Brophy, 2001; Baumert et al., 2001; Muijis & Reynolds, 2001; OECD, 2003). Brophy, (2011) stated 12 principles of effective teaching. Among those "thoughtful discourse" is an important principle that involves engaging students in structured discussion around powerful ideas. Baumert et al. (2013) has reported *cognitive activation* to be a significant predictor of students' outcomes. Seidel and Shavelson (2007) in their meta-analyses based on studies from the past decade reported that in quasi-experimental studies, domain-specific information processing is a strong predictor of students' cognitive outcomes with the effect size of .25.

2.6.4. Cognitively challenging tasks

Wang and Walberg (2001) mentioned practice and application activities as an important principle of effective teaching among his 12 principles. Doyle (1986) stated that, in the process of effective direct instruction, students should be provided with enough time and tasks to practice what has been learned. However, in the present study, the instructional activities are more inclined towards constructivist learning due to the recent models instructional quality (Bolhuis 2003; Seidel and Shavelson 2007) such that the tasks should not only be an opportunity to practice what is learned, rather they should be an opportunity for more challenging tasks. Scheerens (1990) in his integrated model of school effectiveness mentioned time on task (including homework) and high expectations of pupils' progress as important components of classroom level factors. High expectations of pupils' progress could involve *cognitively challenging tasks* that require students to provide solutions to the problems that are challenging for them and make them think and do not involve only the practice of already learned concepts. Doyle (1986) also emphasized that the tasks should be various and intellectually challenging for students. Scheerens (2004), in his comparison between the traditional instructional models and constructivist instructional models, mentioned cognitively challenging tasks to be an important part of the learning process.

Learning is process oriented and involves the production of knowledge and the transmission of skills and the application of learned skills. Floden (2001) mentioned, from a cognitive perspective, that teaching is the creation of learning environments that maximize cognitive activities necessary for building knowledge and reasoning capacity. *Co-operative learning, student engagement*, and *cognitive activation* are not enough to achieve that goal. Volet (1995) stated that the transfer of in-depth knowledge requires students to practice learned skills in different contexts, with a wide range of tasks, different teachers and by activating critical reflection. Time on tasks and the *cognitively challenging tasks* help student internalise the newly learned ideas. Moreover, assigning the *cognitively challenging tasks* to students as homework facilitates students becoming independent thinkers. However, in this case *cognitively challenging task*s is more a theoretical concept and there is not enough evidence about the effectiveness of cognitively challenging tasks in the empirical research.

2.6.5. Differentiation

Despite teachers carefully preparing lesson plans, learning in the classroom can be much less predictable. Teaching involves a lot of challenges and one of those challenges is teaching students with different abilities. This requires teachers to offer adaptive teaching or *differentiation*. Previous research on *differentiation* showed mixed results. Seidel and Shavelson (2007) in the meta-analyses of process-product paradigm studies have found the effect size of .04 of *differentiation* or adaptive instruction on student outcomes. Kulik and Kulik (1982) have meta-analyzed the studies on ability grouping at secondary level and reported that both within and between class ability grouping shows weak but positive effects in the subjects of mathematics and reading i.e. .30 for students with high abilities and .20 for the students with low abilities. Slavin (1996) has meta-analyzed the research studies on within class ability grouping. This involves the grouping of students on the basis of their ability within classroom and learning from the same teacher and the same curriculum. Between class is the grouping of students with different abilities into different classes. Slavin reported that within class ability grouping has positive effects on mathematics and reading.

Glass (n.d.) has reviewed the studies and meta-analyses done on *differentiation* and reported that *differentiation* offers few advantages and many risks. The advantages are for the students with high abilities as learning in homogenous groups offer accelerated learning and the risks, for the students with low abilities, include stigmatizing the students, low level instruction and curriculum, low expectation of teachers, no chance of learning from their peers and marginalization. However, ability grouping has an advantage of saving time as high ability students do not need to wait while their teachers give basic explanations to low ability students and slow students are not required to learn material which they are not able to understand.

The classification of students into homogenous ability groups is as old as universal compulsory education in the United States (Glass, n.d.). Students go to different schools or classes on the basis of their ability or previous performance. In Germany, this system was introduced by the United States of America after World War II in West Germany in order to cope with the economic challenges the country was facing at that time and later was immediately adopted by East Germany after the reunification of the country (Cortina & Thames, 2013). However, due to the decentralized education institutions the system varies slightly across the federal states of Germany, for instance, generally students are selected for different school types in grade 4 but in two states (Berlin and Brandenburg) this selection occurs in grade 6. However, there are other types of schools called comprehensive schools and schools with several tracks. In those schools, students are allowed to be on different academic levels across subjects while staying in the same home classroom. Therefore, German schools are very diverse in nature offering both between class grouping (different school tracks/ different classrooms in the same school) and within class grouping (in the same classroom). In such a diverse educational system, the effects of *differentiation* on students' outcomes should be different across school types because some schools are comprised of students of relatively similar abilities and in some school students vary in abilities. Previous research has shown that the effects vary between within and between class ability grouping. Moreover, teachers vary too across schools on the basis of their teacher education i.e. teachers of academic track are trained with the focus on content knowledge and teachers of lower school tracks are trained with the focus on pedagogical knowledge.

2.7. Mathematics Competence

To compete in the 21st century mathematics skills are integral, therefore, everywhere in the world teaching mathematics to children is of great concern. The importance of mathematics is reflected in the number of national and international studies measuring mathematics competence and from the fact that European Parliament and the Council of the European Union have identified mathematics competence and literacy as one of the key competences necessary for personal fulfillment and active citizenship in society. Furthermore, *Council conclusions on preparing young people for the 21st century: an agenda for European cooperation on schools*, in 2008 made the acquisition of literacy and numeracy the main priority for European cooperation in education.

Teaching and learning mathematics is a great challenge for teachers and students. In the last few years, it has been found that children are facing difficulties in achieving mathematics literacy. According to PISA findings, a large number of countries are lagging behind in mathematical competence development. Results from the PISA study (2009) showed that in the 27 European countries an average of 22.2% of students were low achievers in mathematics. Low achievers have a very limited knowledge of mathematics to apply in real life situations. This leads to an interest in exploring the problems faced by children in learning mathematics, shortcomings of the instructional methods, teachers' professional training and how student mathematics competence develops. One of the main reasons for this number of low achievers is the quality of mathematics teaching.

Germany is one of the countries that was not successful in teaching mathematics effectively and German children scored below average in PISA. The first results of the PISA study were shocking for Germany and resulted in a number of studies to explore the reasons why Germany is not teaching students effectively. One of the main studies conducted in Germany is the National Educational Panel Study (NEPS) that aims to measure learning as a lifelong process. The National Educational Panel Study (NEPS) aims at investigating the development of competences across the whole life span, therefore, it is collecting data on competence development.

The concept of measuring student mathematics competence in NEPS is not based on the idea of student mathematical achievement or student mastery on the content being taught; rather it is based on the ability of students to apply the learned knowledge in real life. NEPS has adopted this idea from the PISA study that defined it as an individual's ability to recognize, formulate and tackle mathematical problems in the context of real life which they term mathematical literacy. NEPS has defined mathematics competence similarly. In order to define mathematics competence in terms of practical knowledge is necessary to assess to what extent students are able to apply the learned knowledge in problems outside the context of the mathematics classroom. The concept of mathematical competence also reflects the teachers' skill to prepare students to apply the learned skills in real life situations and not only as the source of getting grades.

2.8. Operational Definitions

Operational definition of all the constructs used in the study at hand are provided here

2.8.1. Teacher belief

Teacher belief implies teachers' disposition about different aspects of teaching and learning like deep learning, constructivist instruction and direct instruction.

2.8.1.1. Belief about deep learning

It implies teacher's belief that learning should be deep.

2.8.1.2. Belief about constructivist instruction

It implies student as an active participant in the process of learning and a teacher's role is to facilitate the learning process.

2.8.1.3. Belief about direct instruction

The definition is adapted from TALIS (2009) definition and is stated as a teacher's role is to communicate knowledge in a clear and structured way, to explain correct solutions, to give student clear and resolvable problems.

2.8.2. Planning

Planning implies planning of lessons while considering the interest and needs of students.

2.8.2.1. Lesson planning

It implies planning of learning material, teaching and learning methods and assessment.

2.8.2.2. Planning about creating interest in learning

It implies creating students' interest in learning and making learning pleasurable.

2.8.2.3. Planning about Personal/ individual needs of students

It implies teacher's consideration of needs of students while planning lessons and assessing students.

2.8.3. Job satisfaction

It implies satisfaction of teachers with their job.

2.8.3.1. Missing identification with job

It implies a teacher's lack of interest in their job and difficulty to cope with the challenges of their job.

2.8.3.2. Stress at job

It implies the factors that stressed-out teachers about their job.

2.8.3.3. Extrinsic motivation for job

It implies the factors of extrinsic motivation for job.

2.8.4. Stress in planning and classroom

It implies the factors that teachers get stress-out teachers while lesson planning and in classroom.

2.8.5. Cooperation among teachers

It implies teachers' cooperation in teaching activities.

2.8.5.1. Professional collaboration

This definition is adapted from TALIS (2009) definition of the construct. It implies planning and preparation of learning material and lessons together and participation in team discussions.

2.8.5.2. Exchange and coordination for teaching

Like professional collaboration this definition is also adapted from TALIS (2009) and states that exchanging of instructional material or discussing learning problems of individual students among colleagues.

2.8.6. Professional training

It implies the pre-service and in-service teacher training.

2.8.7. Cooperative learning

The definition is adopted from Slavin (1996) definition and is stated as "*cooperative learning* refers to a variety of teaching methods in which students work in small groups to help one another learn academic content." (p.18)

2.8.8. Student engagement

As defined by Newmann (1992) *student engagement* is defined as "the student's psychological investment in and effort directed toward learning, understanding or mastering the knowledge, skills or crafts that academic work is intended to promote." (p.12)

2.8.9. Cognitive activation

The definition is adopted from Kunter et al. (2007), "are the elements of instruction, meaning all learning situations with the potential to trigger students' conceptual involvement with the learning task."

2.8.10. Cognitively challenging tasks

It implies tasks that activate student thinking and foster higher order learning.

2.8.11. Differentiation

Differentiation is defined in the current study as defined by Tomlinson (2001), "*differentiation* is the recognition, articulation, and commitment to plan for students' differing needs."

2.8.12. Mathematics competence

As cited by NEPS mathematics competence in NEPS and therefore, in current study is based on the idea of mathematics literacy in PISA study and is defined as "an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen." (OECD, 2003, 24)

2.9. Analytical Framework

The underlying idea of the study is that the teacher factors and teachers' instructional practices both have an effect on students' learning. The teacher factors could have both a direct and indirect effect on students' learning and instructional factors could have a direct effect on students' learning. The analytical model of the current study has been developed on the basis of the evidence provided from the theoretical models and previous research. While there are other important factors of teacher effectiveness mentioned in the previous research e.g. classroom management, pedagogical knowledge, teacher-student relationship, classroom environment etc. these have not been included in the study as these factors could not be examined using NEPS data. The analytical model given in the figure 1 shows the teacher factors and instructional factors that were analyzed in this study in order to measure the relationship between teachers' effectiveness and students' mathematics competence. Teacher factors are the distal indicators of teacher effectiveness and instructional factors are the proximal indicators of teacher effectiveness as teacher factors are distal to the teaching-learning process and instructional indicators are proximal to the teaching-learning process. The definition of distal and proximal indicators is adopted from Seidel and Shavelson (2007). The expectations of the current study from each distal and proximal indicator are as follows.

The first teacher factor in the model is *teacher belief*. On the basis of the theoretical background and empirical evidence provided about *teacher beliefs*, it is expected that teacher belief could affect teacher' practices and hence student learning. The study has investigated the following aspects of teacher beliefs; *deep learning, transmissive instruction* and *constructivist instruction*. The second teacher factor is teacher *professional competence*. As explained earlier, the teachers significantly differ in their professional skills mainly because of the different types of teacher training in Germany; the current study has explored if the students in certain school tracks disadvantaged in relation to students from other school tracks due to their teachers' different types of training. Although, it is better to measure teacher *professional competence* by proximal indicators, the current study has measured it distally because NEPS study has measured it only in this way. NEPS has followed the TALIS method of measuring teacher's professional competence i.e. professional training attended by teachers and their participation in the activities of professional development. NEPS has followed the same pattern. Moreover, the COACTIV study has recently investigated professional competence of teachers through proximal indicators and provided detailed findings. Therefore, the current study examined the effect of teacher's professional competence on students' mathematics competence through distal indicators. The third teacher factor being investigated is teachers' *planning* which includes *lesson planning,* considering *individual needs of students* while planning and *creating interest in learning*. On the basis of the theoretical background it is expected that teachers' planning has a positive effect on student learning. The fourth teacher factor is *cooperation among teachers*. The current study has followed the TALIS study pattern and has investigated two aspects *of teacher cooperation; exchange and coordination for teaching* and *professional collaboration*. The current study investigates how often mathematics teachers cooperate with each other and what are the effects of their cooperation on student mathematics competence. The fifth teacher factor is *job satisfaction*. The current study has investigated three dimensions of *job satisfaction; missing identification with job, job stress,* and *extrinsic motivation* as the determinants of *job satisfaction. Missing identification with job* addresses factors like how happy and unhappy teachers are with their job and how successfully they are coping with the challenges involved at workplace. *Job stress* tests the factors that stress teachers for instance missing appreciation, lack in opportunities and competition among colleagues. *Extrinsic motivation* explored the factors that keep teachers motivated for their job. On the basis of previous research, it can be expected that teachers' level of satisfaction with their job might affect their practices and hence their students' learning. The sixth and final teacher factor is *stress in planning and classroom*. The current study expected to have a negative effect of *stress in planning and classroom* on student mathematics competence.

Teacher instructional factors include five factors that are related to teachers' instruction in the classroom. Learning in general and mathematics learning in particular, require active student participation in the process of learning. Therefore, all the instructional factors revolved around active student participation. The first is *cooperative learning* which is measured through the usage of social groups in learning, peer-tutoring, project-based learning, partner work and discussions. *Cooperative learning* showed positive effect on student learning in previous research, however, the previous research has shown that the success of *cooperative learning* depends on the competence of teachers to apply this method successfully. It is expected that there will be a positive effect of *cooperative learning* on student mathematics competence. The second instructional factor is *student engagement* in learning. This construct is measured through discussion among teachers and students and students presenting to the classroom. It is assumed that the more the teachers use these two instructional methods, the higher the student achievement. The third instructional factor is *cognitive activation*. The construct is rather new and as such more research is needed, however, it has thus far shown a positive effect on student learning particularly in mathematics instruction. The fourth instructional factor is *cognitively challenging tasks*. Although very little past research is found on this construct, and weak but positive effect were found on student outcomes. The current study also expected a positive effect of *cognitively challenging tasks* on student. The last instructional factor is *differentiation*. It is measured by teachers' usage of adaptive instruction on the basis of students' abilities. Previous research has shown mixed results regarding the effectiveness of *differentiation*.

In the present study, the data about teacher factors was collected on a teacher self-report questionnaire and data about teacher instruction in the classroom was collected on instructional questionnaire. Both questionnaires were self-report questionnaires. The data from students was collected on standardized mathematics competence tests.

2.10. The Research Gap

The results from the first two PISA studies showed that German students are at-risk regarding their competencies (Baumert et al., 2001; Blum et al., 2004). A number of studies have investigated teacher effectiveness and student learning in different learning domains in Germany following the PISA shock. Some of those studies are discussed here briefly in terms of their operationalization and findings regarding teacher effectiveness. However, as learning is domain-specific, only those studies are discussed that were conducted in relation to mathematics learning.

The project for the analysis of learning and achievement in mathematics (PALMA) was a longitudinal study that analyzed the development of students in mathematics from grade 5 to 10. The study has assessed students' mathematics competencies annually. The study mainly focused on analyzing student individual characteristics in mathematics, classroom instruction in mathematics and variables of classroom and family context. The sample was representative of Bavaria and was drawn from three school types; Grammar school, intermediate-track school and lower-track school. The quality of instruction was measured through student questionnaires and interviews focusing on the cognitive quality of instruction, the teacher's motivation and classroom management Teacher questionnaires were used to measure job satisfaction variables like burn out, emotions and aspects of their professional career. The study found that in general students' mathematics competence

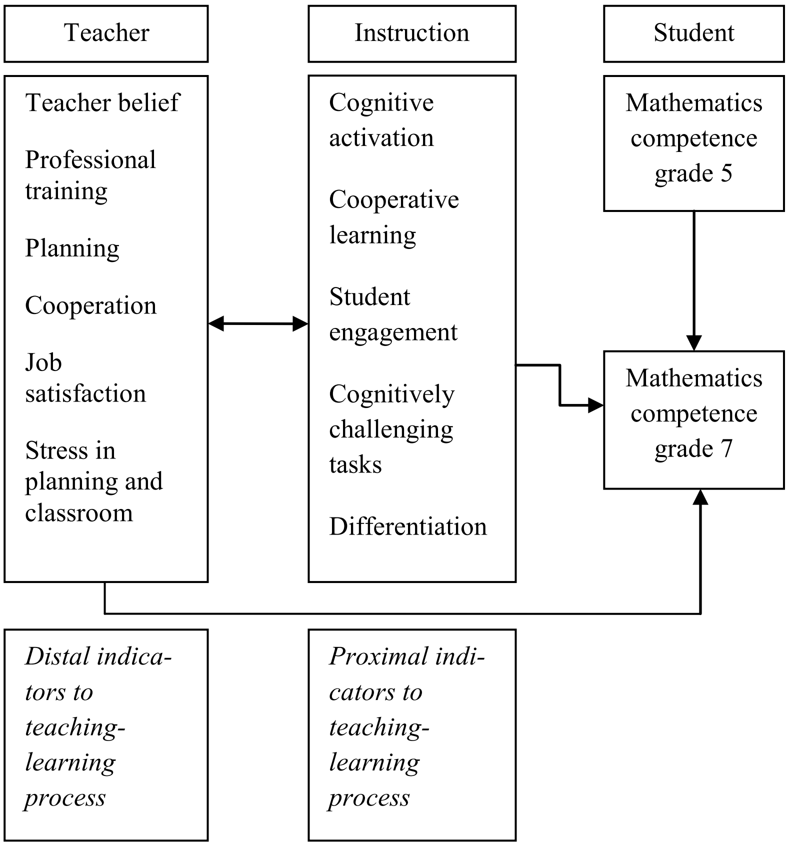

Figure 1: Analytical framework of the study

increased over the years but the number of students who are at-risk regarding mathematics literacy also increased from 15% to 19% from grade 5 to 7 and the classroom context might be the reason for this increase in the at-risk group. Moreover, the study found that German students' deficiency in mathematics competence is not only among 15 year olds (as shown by the PISA 2000, 2003) but also at the beginning of secondary school. Further, the study reported that interviews with students showed that mathematics instruction is not sufficiently supporting the development of mathematics competence and differences between the quality of instruction were not only found between schools but also within schools. According to the findings of that study, teachers' instruction is most likely the reason for this deficiency in mathematics learning. Moreover, the study reported a drop in students' positive emotions in mathematics, self-efficacy and self-regulation and the reason may be the decline in cognitive activation and individual support provided by the teacher.

The COACTIV study is a longitudinal study that is embedded in PISA 2003 that has assessed the same students who participated in PISA 2003 and their teachers a year later. The study aimed at providing evidence about teachers' knowledge, belief and psychological functioning. It found that these are prerequisites for mathematics instruction and student learning and found systematic differences among all these factors. These factors depend on the type of school a teacher teaches in and is trained for. Grammar school teachers reported high knowledge, *cognitive activation* in the instructional process and were less likely to endorse *transmissive beliefs*. *Cognitive activation* and *classroom management* have positive effects on students' mathematics learning. Moreover, the study found that strong mathematics instruction aiming at insightful learning is rarely offered in German schools.

Structure as a quality feature in mathematics instruction (2007) is a study conducted in collaboration between two educational research institutes in Germany and Switzerland. The sample was composed of 20 Swiss and 20 German secondary schools of the grammar and intermediate school types. The study looked into two factors of instruction; structured organization of the learning environment (classroom management) and structured presentation of leaning content (cognitive activation). To collect data, three mathematics lessons were videotaped on the topic “An introduction to the Pythagorean theorem”. Students’ knowledge of the Pythagorean theorem was assessed immediately before and after the lessons and students were also asked about their motivation, emotions and cognitive activities during the lessons. Videos were analyzed to assess organizational and content related aspects of structured instruction. The study found that students from well-disciplined classrooms and classrooms that involved cognitive activating instruction followed the lesson well. These findings are in line with the findings from the previous research that both classroom management and cognitive activation are an integral part of successful instruction.

“Professional competence of teachers: effects on instructional quality and student development” was part of the COACTIV study project. The sample of the study was representative of Germany including 194 secondary school teachers. The study determined teacher pedagogical knowledge from their in-depth pedagogical knowledge, positive beliefs about constructivism, intrinsic disposition towards their work and their self-regulation. The study assumed that teachers’ belief and domain-specific knowledge would have positive effects on student achievement and teachers’ enthusiasm and self-regulation abilities would have positive effects on students’ motivation. The study found that high pedagogical knowledge was linked to cognitive activation and better learning support for students. As expected, cognitive activation resulted in better student achievement and teachers’ enthusiasm was associated with students’ motivation. However, teachers who showed *constructivist beliefs* reported that they faced issues in *classroom management*. These results are in contrast with the results from the PALMA study in which teachers who reported high *cognitive activation* they reported low on ineffective *classroom management*.

Although the above mentioned studies were longitudinal, quasi-experimental and well-designed, the sample was either not representative of the whole of Germany or the studies have drawn the sample from only a few school types. The current study is different in that the sample is representative of all of Germany, drawn from all school types within

Germany and it's also a longitudinal study extended over the period of two years that measured student mathematics competence both at the beginning and at the end of the two years. The study took place in a natural setting and the classes are taken into study intact. Moreover, the current study is different from other studies in a number of ways. For instance, the PALMA study has looked deeply into mathematics competence development through interviewing students which is beyond the scope of the current study but the current study has looked more deeply into teacher effectiveness. The current study has covered a large number of teacher and instructional factors. PALMA, for instance, looked into the burnout and emotions regarding *job satisfaction*, while the current study has investigated *missing identification with job, stress* at job and extrinsic *motivation for the job* and its effect on students' mathematics competence. The COACTIV study looked into a few aspects of instruction whereas the current study has looked into numerous instructional factors including *cognitive activation, cooperative learning, student engagement, cognitively challenging* tasks and *differentiation*.

The PALMA study has shown that teachers' instruction varies between and within schools and the study reported that it might be because of the differences in student mathematics competence development; however, the findings are not conclusive. Moreover, COACTIV suggested that additional studies are needed in the domain of mathematics with teachers from different school types and training backgrounds before the final conclusions are made from the findings of the study (Kunter et al., 2013). The current study would provide detailed findings about a variety of teacher and instructional factors and their effect on student mathematics competence over the period of two years.

2.11. Relevance of the Study and Research Questions

A number of studies have worked on students' competence in Germany for instance the Programme for International Student Assessment (PISA), Third International Mathematics and Science Study (TIMSS), the panel study LOGIK, the European Child Care and Education Study, the project for the analysis of learning and achievement in mathematics (PALMA),the national DJI child panel study, COACTIV and BIKS study. Although, all these studies have contributed significantly to the research, most of the studies were either cross-sectional (PISA, TIMSS), or regional (PALMA, BIKS, LOGIK) or investigated the children from a different age group than the current study (BIKS, LOGIK, PISA, TIMSS, COACTIV). Cross-sectional studies only provide a picture of students' competence at a particular point and fail to show how students' competences develop. Moreover, cross-sectional studies are limited in drawing causal inferences (Frahm et al., 2011) and more longitudinal studies are needed to supplement the cross-sectional studies (Kunter et al., 2007). The studies that have explored teacher effects on students' learning or competence in Germany are mostly cross-sectional. The result from the meta-analyses done by Seidel and Shavelson (2007) have reported that although there are several studies on the effect of teacher variables on student learning, the studies failed to provide satisfactory findings regarding teacher effects on student learning (Frahm et al., 2011). That meta-analysis study has also used about 15 studies from Germany on this subject. Therefore, the findings regarding teacher effects on student learning and competence are inconclusive in general and particularly so in Germany.

When the PISA results were released for the first time, it was seen that German students scored below average in OECD countries in mathematics literacy. The reason behind those results could be that teachers are lacking in some important teaching components. As shown in the previous research, teachers are the most important part of educational effectiveness (Creemers, n.d.). COACTIV is one of those studies that investigated teacher instruction and student mathematics learning following the PISA results. COACTIV is a longitudinal study that is embedded in PISA 2003/04. The study has examined the structure, development and practical relevance of teachers' professional competence. COACTIV has examined the following dimensions of teaching; planning, interactive lessons, cognitive activation, stimulating students' motivation, promoting cognitive engagement and the fostering of core academic competencies. The study has shown significant effects of teachers' characteristics on students' achievement. For instance, teachers' domain-specific instructional knowledge is significant for students' progress in mathematics and 39% of the total variance is explained by the latent variable of pedagogical content knowledge between classes. The cognitive level of tasks, curricular level of tasks, and effective classroom management proved pivotal for students' mathematics achievement. Although, COACTIV provided significant findings in relation to the effects of teachers' content and pedagogical content knowledge on students' achievement, the study was conducted on a different age group. Both studies have some teacher effectiveness factors in common these include *teacher belief, professional competence, cognitive activation*, however, both studies have operationalized them differently. Like the COACTIV study the current study has the advantage of investigating those important dimensions of teaching from a representative school sample from all over Germany. Moreover, the current study is also longitudinal in nature but conducted on a different age-group (grade 5-7). The past research on teacher effectiveness has suggested doing more longitudinal studies in order to enhance the validity of the causal inferences in non-experimental settings (Rovan et al., 2002; Frahm et al., 2011). The current study would thus help to provide detailed findings on teacher effectiveness. The current study involves two measurement points of students' mathematics competence at a 2-year interval. During these two years the same teacher has taught the students and the design of the study allowed teacher data to be matched with respective student data. The two year duration of the study would help to get a better picture of teacher effects on their respective students.

In German teacher education programs, teachers are usually trained to teach two subjects but Baumert and Kunter (2013) reported that it is a common practice in German schools from grade 5 to 7 that teachers taught subjects at school that they haven't majored in at college. Teaching is domain-specific and teachers need to have in-depth understanding of the subject matter they teach so a lack of this in-depth knowledge could have crucial consequences on student mathematics competence. Baumert et al. (2013) argued that content knowledge is a pre-requisite for pedagogical knowledge and Shulman (1998) stated that effective teaching practice seems to be dependent on comprehensive domain-specific knowledge. It is based on the assumption that if a teacher does not have profound knowledge of the subject, pedagogical knowledge is not enough for effective instructional practices and vice-versa. Although, current study did not measure teacher subject-matter knowledge or pedagogical knowledge in particular but investigated the effectiveness of teachers' instruction (based on their subject-matter and pedagogical knowledge). However, determining that the reason behind teachers' effectiveness or ineffectiveness is subject-matter knowledge or pedagogical knowledge or both is beyond the scope of the current study.

Teacher effectiveness models and learning theories over the past years have shown a crucial paradigm shift about how teachers should teach. It is a change from teacher-centered instruction to student-centered instruction, from an authoritarian teacher to a facilitator and from direct instruction to process-oriented instruction. According to recent models of teacher effectiveness, teaching and learning are seen in the context of the social environment where they actually take place. Teachers' experience, prior knowledge and habits may resist accepting this change (Bolhuis, 2003). Even the naive teachers have their opinions and ideals about teaching. Hattie (2009) said that when teachers enter teacher education programs they already have their own notions of teaching, learning, assessment and curriculum that influence their teaching, classroom practices, and students' learning. Those notions may not come from their own experiences as teachers but maybe from their experiences as students, for instance copying the teachers they liked as students. It is not easy to change those concepts and habits and adopt new ideas particularly when the new ideas are very different from the old ones. The current study assumed that even if these teacher factors are excluded from the teacher effectiveness models, this does not mean they are not relevant to teachers and their teaching anymore. Therefore, in the current study teacher general beliefs, habits, approaches and teaching ideals are used as predictors of students' mathematics competence. This should help to see clarify the role of teachers' factors in students' mathematics competence and is addressed by the research question: Which teacher factors predict mathematics competence of secondary school students?

Seidel and Shavelson (2007) conducted a meta-analysis study that summarized the results of teacher effectiveness studies carried out in the last decade. This meta-analysis study provided important findings from the studies that were based on the current models of teaching and learning by distinguishing them on the basis of their designs (correlational survey or quasi experimental or experimental). Moreover, the study aimed to improve the future research on teacher effectiveness both theoretically and methodologically (Seidel & Shavelson, 2007) by providing important suggestions. The study has pointed out some problems in the current state of research which should be considered in any future research. The study has reported that most of the quasi experimental or experimental studies carried out in the last decade, measured teaching components proximal to executive learning while the survey design studies measured the teaching components distal to executive learning. Therefore, Seidel and Shavelson (2007) suggested that, in the future, survey studies should also measure teaching components proximal to executive learning i.e. domain-specific learning activities. Therefore, the current study has used an instructional questionnaire that aimed to measure the domain-specific learning activities in mathematics classroom. The research question addressing this issue is: Which instructional factors predict mathematics competence of the secondary school students?

Survey design studies have always dominated the research in the area of teacher effectiveness for obvious reasons. Survey research helps to collect data from big samples with fewer resources in comparison to other research designs (experiment, observation or video analysis). However, the effect sizes of teaching on students' outcomes are smaller in the findings of correlational survey studies in comparison to other research designs. This maybe because data collection through questionnaires is less reliable than observation or video analysis. But it is also true that collecting data through observation or video is not always possible for practical and ethical reasons. Moreover, correlational research has provided important findings in the area. Therefore, Raudenbush (2005) suggested that multiple methods of data collection might be fruitful in survey studies. Seidel and Shavelson (2007) in their meta-analyses study also suggested using a mix of data sources to measure teacher effectiveness. The current study assumed that collecting data from teachers on two separate questionnaires would help to give better insights about teaching effects on students' competence. The teacher factor questionnaire has measured the distal components of teaching and the instructional questionnaire has measured proximal components of teaching. This combination of data sources would not only provide more reliable results but would also help to see how the distal and proximal components of teacher effectiveness are related to each other. The research question addressing this is: What combination of teacher factors and instructional factors best predict mathematics competence of secondary school students?

The findings from the Seidel and Shavelson (2007) meta-analysis showed that proximal components of teaching are better predictors of student learning in comparison to distal components. Therefore, the current study investigated if the proximal or distal components of teaching are better predictors of student learning in German secondary schools.

The COACTIV study (2013) showed a number of significant findings in relation to teachers' professional knowledge and their students' mathematics achievement. The study showed that teachers in different school tracks vary in their professional knowledge. In Germany, teachers for different school tracks are trained in different teacher education programs. The curriculum of both teacher training programs is also different. In the teacher education programs for academic school tracks, the focus is primarily on content knowledge in comparison to pedagogical knowledge whereas teacher education programs for lower academic school tracks involve more pedagogical knowledge training and less content knowledge. However, the findings of the COACTIV study showed that teachers of the academic school track scored higher on both dimensions of professional knowledge: content knowledge and pedagogical content knowledge. This may be because the teachers with high grades are recruited for the academic school track and teachers with lower grades are selected for lower school tracks. The students from low socio-economic status and immigrant families are taught by less competent teachers (Baumert & Kunter, 2013) as typically the students from low SES and migrant backgrounds go to non-academic tracks and students from high SES go into the academic track (Baumert & Kunter, 2013). The current study has investigated if the teachers in different school tracks vary in effectiveness in order to see if the students of non-academic tracks are disadvantaged by being taught by less competent teachers.

2.12. School System and Teacher Education in Germany

As the sample of the study is from Germany, it is important to understand the unique German school system and teacher education system before proceeding into further details of the study. It is also important to understand the German school system because one of the research questions of the current study addressed each school type. The education system is the responsibility of each of Germany's 16 states and therefore each state can vary in its school system, however, the school systems are generally quite similar. The differences across states are kept within acceptable limits by a central coordinating committee, the standing conference of the Ministers of Education and Cultural Affairs (Kultusministerkonferenz or KMK) in order to allow the mobility of people between states (Cortina & Thames, 2013). In Germany, it is obligatory for children to enroll at school by the age of 6 and to attend 9 years of education (from grade 1 to grade 9). The most distinct feature of the German school system is the placement of children in various school tracks at an early age (of 10 years or 12 years in Berlin and Brandenburg State) on the basis of their cognitive abilities, perceived performance, and interest. There are 4 main different types of schools in which students are tracked after their elementary education. These schools generally teach the same courses at a different pace and with a different focus at each school, however, the curriculum varies not only in each school type but also in each school.

Lower secondary school (Hauptschule) provides a basic general education with a focus on vocational and hands-on training. Lower secondary school ends at the end of grade 9 and students then, usually start their job training and enroll part time in vocational schools. The second school type, middle secondary school (Realschule) offers a more extensive general education than lower secondary school and it ends after grade 10. Students then usually either start job training and enroll part time at vocational schools or extend their formal school education by entering grammar school at grade 10. Middle secondary school (Gymnasium) is higher in academic level than lower secondary school and lower than grammar school. Grammar school is the most academically challenging school type in Germany that teaches the extensive general education and continues from grade 5 to grade 12 (or 13 in some states). After finishing Gymnasium, student can enroll at university. Another type of school called Comprehensive school (Gesamtschule) enrolls students from different academic levels at the same school and assigns a certificate to them at the end of school according to their academic level and the number of years they attended the school which is either a Hauptschule, a Realschule or a Gymnasium school leaving certificate. In Comprehensive schools, students with similar abilities are taught together (cooperative type) or students are taught together as a year group except for the core subjects in which they are grouped on the basis of their ability. Schools with several tracks are mainly similar to comprehensive school (students from different academic level studying at same school).

The teacher education system in Germany is highly systematic and goes hand in hand with the German school system i.e. German teacher education programs differ on the basis of age level (elementary or secondary) and the type of school. Teacher education programs might differ across states but the KMK has recognized a number of teacher training certificates that are recognized all over the country. In general, teacher education programs are comprised of 2 phases. In phase I, teachers are trained for a period of 3-5 years at college. At the end of this training, the teacher has to pass a state examination which is followed by in-service teacher training in which teachers are mentored by experienced teachers and supervised by the state run teacher education institute where they also attend weekly seminars (Cortina & Thames, 2013). This in-service training lasts from one and a half to two years and is followed by the second state examination. After passing both examinations, teachers are usually employed at the type of school they are trained for with very little pressure to attend any further professional training and assessments in the rest of their career. During the teacher training program, teachers usually choose two subjects to teach. As teaching in grammar school could be challenging with respect to the content and in other school types with respect to the teaching skills (pedagogical skills), teacher training for grammar school focuses on content knowledge and for lower and middle secondary schools it focuses more on pedagogical skills (Baumert & Kunter, 2013). Hence, Germany has a unique school system and teacher education system that could play a significant role in students' performance.

Chapter 3

Methodology

On the basis of the theoretical framework, analytical framework and research questions of the current study provided in chapter 2 this chapter describes the research methodology of the study including the research design, selection of the sample, instruments used in the study, data collection and data analysis techniques. The current study has used National Educational Panel Study (NEPS) data. Therefore, before explaining the research methodology a brief introduction of NEPS and the reasons why NEPS data is used are provided for a better understanding of the methodology of the current research.

3.1. National Educational Panel Study (NEPS)

NEPS is a longitudinal study conducted by Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg. It is an interdisciplinary research program that aims to collect data on the educational, psychological, sociological and economical aspects of individuals across generations in formal, nonformal in informal contexts. (neps, n.a). Many national and international studies have collected data (both cross sectional and longitudinal) on related themes, for example Bildungsprozesse, Kompetenzentwicklungen und SelektionsentscheidungenimVor- und Grundschulalter (BIKS), Third International Mathematics and Science Study (TIMSS), Programme for International Student Assessment (PISA), International progress in reading literacy study (PIRLS), Programme for the International Assessment of Adult Competencies (PIACC), and Professional Competence of Teachers, Cognitively Activating Instruction, and Development of Students´ Mathematical Literacy (COACTIV), and provided important research findings, however NEPS is unique in many important ways. Unlike the aforementioned studies which tested participants at a single time point and provided findings about that specific time or the themes of the studies were limited and the sample was regional, NEPS is collecting data over the entire life span of anybody receiving education, on a wide range of themes and from all over Germany. The motivation behind such a large study is to cope with the challenges the country is facing in relation to the disappointing results of secondary students in comparison to other countries (as shown by PISA), inequalities in education and society and the increasing number of migrants. NEPS aimed to provide in-depth information on the processes of and returns to education (Blossfeld, Rossbach & Maurice, 2011).

The NEPS has divided educational careers into eight different stages. These eight stages are divided into 6 different cohorts on the basis of specific points in the educational system of Germany and the age of participants. These six cohorts include starting cohort new born, starting cohort kindergarten, starting cohort grade 5, starting cohort grade 9, starting cohort first year university students, and starting cohort adults. NEPS is simultaneously collecting data from all those six cohorts to provide data to the scientific community as quickly as possible for both cross-sectional and longitudinal research. Being an interdisciplinary study, NEPS has divided into five different pillars. Each pillar collects data on different dimensions of the study including measurement of competencies, learning environments, social inequality, educational decisions, educational acquisition of those with a migration background and returns to education. NEPS has a representative sample from all over Germany and is collecting data from more than 60,000 target persons. For more information about NEPS see Blossfeld, Rossbach and Maurice (2011).

The aim of NEPS is to provide the data to the national and international scientific community in the form of so-called anonymous scientific use files. The study has collected and is still collecting data for the various disciplines such as educational science, economics, psychology, and sociology concerned with educational and training processes.

The study has collected data on a variety of themes from stakeholders in the process of education including learners, teachers, school principals and parents.

3.2. Why NEPS Data is used

The design of my study is longitudinal in nature. The study aims to investigate the role of teacher factors (for example *teacher belief, professional training* etc.) and their instruction in the competence development of students. NEPS data was a suitable choice for the investigation of the research questions of the current study for the following reasons. Firstly, the data has provided the opportunity to investigate the effect of teachers on students learning longitudinally with a significantly large (151 teachers and their 1706 students) and representative sample size from all over Germany. It is important to note that originally the NEPS sample (of the chosen cohort for the current study) was about 500 teachers and above 5000 students, but due to the longitudinal structure of the current study the teachers who taught students for less than a period of two years were excluded from the study. However, the sample of excluded teachers was random and the sample was still representative of the whole country. Therefore, in the current study the same teachers had taught students for a period of two years (from the beginning of grade 5 to end of grade 6). To see the effects of teachers on students' competence, teachers should teach students for a meaningfully long period of time and NEPS data fulfills this precondition. Secondly, the NEPS collected data from teachers on the so called general teacher questionnaire. This data was potentially suitable to measure some of the important factors of teacher effectiveness described in theory. Thirdly, NEPS measured students' competencies at multiple time points during their school years. The current study has used NEPS cohort 3 data in which mathematics competence is measured every two years (in the beginning of grade 5 and grade 7). As described earlier, the same teachers that had taught students between both time points were looked at. Moreover, the NEPS team has followed the same framework to develop both competence tests. Therefore, it was possible to compare students' competence from both time points. The fourth reason is that NEPS had also collected data on teachers' mathematics instruction. Therefore, it was possible to look into the actual practices of teachers in the classroom and it was not necessary to rely only on the teachers' general beliefs and ideals about teaching. The data from the mathematics instructional questionnaire also helped to overcome the limitation of the general teacher questionnaire in which items were asked generally about teaching and not in relation to mathematics teaching. Fifth, the collection of data in the beginning of the study (grade 5) on the general teacher questionnaire and the collection of data on the instructional questionnaire in the middle of the study (grade 6) helped to relate teachers' effectiveness factors to students' competence. Lastly, the study aimed to measure the role of teacher effectiveness in students' competence development in natural settings and not in the observation or experimental settings where teachers could act differently. Thus the NEPS data was highly suitable for this study due to the longitudinal study, large sample size, the data on both teacher factors and instructional factors and the natural settings of the study.

NEPS has collected data on both German language and mathematics students and teachers in cohort 3 however, in order to exclude as many extraneous variables as possible, the current study has used only the mathematics data. As the medium of instruction in German schools, German language classes were not a good choice for this study because students do not learn German only in the classroom. Therefore, the contribution to language learning could be from other teachers and subjects and also from informal settings like home, playground etc. NEPS has collected data from different age groups; one other important decision was from which age group (or cohort) to use data. As the focus of the study was at school level and one of the research questions of the present study was to measure how teachers in different school tracks vary in effectiveness, the present study could use data either from cohort 3 (grade 5 to 8) or cohort 4 (cohort 9 to 12). Data from the cohort 4 could not be used because in cohort 4 mathematics competence is not repeatedly measured. Moreover, the TIMSS and PISA studies have investigated the secondary school age group 15 (same as cohort 4), therefore, the present study investigates the lower secondary school group (grade 5 to 7).

3.3. Data Collection

The study uses NEPS's cohort 3 secondary school data which collects data at three time points, first at the beginning of grade 5 from the teachers and the students, then in grade 6 from teachers and finally in the beginning of grade 7 from students. During this two year period students were taught by the same mathematics teachers. In Germany, the school year usually starts in the month of September and the data for the first wave, grade 5, was collected in the months of November and December in the year 2010. In this first wave, the data was collected from teachers on the general teacher questionnaire and students' mathematics competence was measured. In the second wave, in grade 6, data was collected again in the months of November and December in 2011 however only the data on teachers' mathematics instructional questionnaire was collected. In the third and the final wave, the data was collected in grade 7, in the months of November and December 2012 and the data on the students' mathematics competence test was also collected. The data about teachers' instruction was collected in the middle of the study (November and December, 2011) which was an ideal time to capture the teachers' instructional practices. Students' mathematics competence was measured at 2 time points. The first time it was measured at the beginning of grade 5 and the second time after two years at the beginning of grade 7. At the time of measurement of mathematics competence in grade 7, it is likely that there were new mathematics teachers, however as those teachers had been teaching for only two three months at the time of the competence test, the current study assumes that any effect on students' mathematics competence was from the teachers who taught them for previous two years.

3.4. Sample

The NEPS cohort 3 (grade 5), used multistage stratified cluster sampling which was drawn from officially recognized and state-approved secondary schools in Germany (Zinn, 2013). Generally, there are 7 different types of schools at the secondary level in Germany. These are grammar schools (Gymnasium), middle secondary schools (Realshule), lower secondary schools (Hauptschule), comprehensive schools (Gesamtschule), schools covering multi-tracks of secondary education, elementary schools and special schools. The special schools were excluded from this study

At the first stage of the selection process, the aforementioned six types of schools were distinguished from all over Germany. These school types served as stratums from which the schools were drawn proportionally to their number of classes. The final school sample consisted of 243 schools.

Next, from those 243 schools, grade 5 classes were randomly selected. Two classes were selected from each school (if available). In the third and final stage of sampling, all the students and teachers from the selected classes were invited to participate in the study. The final sample consisted of Germany born and immigrant students from Turkey and countries that comprised the former Soviet Union. For more details on the sampling see Zinn (2013).

The total sample consisted of 243 schools and approximately 5327 students and their mathematics teachers which were over 500 in number. However, because of the longitudinal nature of the study and that it was essential that that the same mathematics teachers taught the students for the full period of 2 years, all the teachers who had taught less than 2 years were excluded from the study. Hence, the students of those teachers were also excluded from the study. Then, the final sample size was 174 schools, 1906 students and their 174 teachers. However, the students from elementary schools also needed to exclude from the study at hand because of the structure of this school type. The structure of elementary school is different from other school types. Generally in German schools students are allocated to different academic tracks after grade 4 i.e. at the age of 10 and then usually they study in the same school for the rest of their school years. But from the total 16 states of Germany, two states (Berlin and Brandenburg) send students to different academic tracks (on the basis of their abilities) after grade 6 i.e. at the age of 12. This means in these types of schools, students are allocated to different school types in grade 7 and not in grade 5 like other schools of Germany. As time point 2 mathematics competence was measured in grade 7, the students from elementary schools were dispersed to different schools. For this reason it was not possible for NEPS to collect data from them therefore, the data on grade 7 mathematics competence of elementary school students was missing. The students who did not participate in the mathematics competence test at both time points were also excluded from the study. However, if the students only participated at one time point and not the other, they were not excluded as almost 24% of the sample students' were missing at time point 1 or at time point 2. The exclusion of this many students would result in a large loss of sample size. Therefore, they were kept in the study and the data imputed. Data imputation is a rather new statistical technique that replaces missing data by estimating values on the basis of available information. It is better method of tackling with missing value in comparison to other methods (list wise and pairwise deletion) because it avoids sample bias. The procedure of multiple imputation is described by Newmann (2003) as "a procedure by which missing data are imputed several times (e.g., using regression imputation) to produce several different complete-data estimates of the parameters. The parameter estimates from each imputation are then combined to give an overall estimate of the complete-data parameters as well as reasonable estimates of the standard errors". For more information about imputation see Rubin (1987) and Schafer (1997). The data was imputed by Full Information Maximum Likelihood Estimation (FIML) in Mplus. Multiple data sets were generated using multiple imputation in Mplus. In the current study, 1000 data sets were generated in each analysis to get consistent and reliable results.

The final sample is drawn from 5 school types (lower secondary school, middle secondary school, grammar school, comprehensive school and multi-track school). The sample comprised of 151 schools, 1706 students (male = 863, female = 830, missing = 13) and their 151 teachers (male = 41, female = 73, missing = 37). The details about students and teachers according to each school type and migration background are given in table 3.1.

3.5. Instruments of the Study

Although, using NEPS data for the current study was a good choice to achieve the aims of the present study, it was a challenge to use NEPS teacher questionnaires to measure teacher effectiveness because they were not designed to measure teacher effectiveness.

Table 3.1 Number of teachers and students from different school tracks and migration background

School type	Teachers	Students
Comprehensive school	12	101
Grammar	54	759
Middle secondary school	27	340
Lower secondary school	36	320
Multi-track school	22	186
Total	151	1706
Migration background		
Migrants	05	307
Non-migrants	108	919
Missing	38	480
Total	151	1706

Therefore, the teacher effectiveness construct was studied in detail and in the light of previous research and models of teacher effectiveness and the items from teacher questionnaires were selected to measure some important factors of teacher effectiveness.

Keeping in mind the nature of the study three instruments were used. As the focus of the study was to measure the role of the teachers and their teaching in students' mathematics competence development, the instrumentation of the study has focused on teachers. Two NEPS instruments were used which collected data about teachers and their teaching. The first is about the teacher factors and the second is about the instructional factors of the teachers. A third instrument used in the study was mathematics competence tests to measure students' mathematics competence. Before going to further details about each instrument used in the current study it is important to know that all the instruments of the study were developed and administered in the German language and later provided in English by NEPS to be used by the international research community. The details about instrument used in the present study are as follows.

3.5.1. Teacher questionnaire

The NEPS study has collected data from teachers on the so 'general teacher questionnaire'. It is a self-report questionnaire which measures information about sociodemographic data, migration background, native language, professional biography, completed and planned educational training and pedagogical ideals and concepts (Frahm et. al., 2011).

On the basis of the teacher effectiveness models and previous research on teacher effectiveness it was envisioned that some items from the general teacher questionnaire could serve the purpose of measuring teacher effectiveness covering some of the most important factors. The factors of teacher effectiveness which were found common in previous research and NEPS general teachers' questionnaire include planning (*lesson planning, creating interest in learning, individual needs of students*) , teacher belief about learning (*deep learning, constructivist instruction* and *transmissive instruction*), *stress in planning and classroom,* job satisfaction (*missing identification with job, job stress* and *extrinsic motivation*), *professional training,* and cooperation among teachers (*professional collaboration* and *exchange and coordination for teaching*). A theoretical basis is provided in chapter 2 for using items from the general teacher questionnaire as a measure of teacher effectiveness. The next step was to perform confirmatory factor analyses (CFA) to see the underlying structure of each factor in order to address the research question, "which factors relevant for teacher effectiveness can be analyzed using NEPS data?" CFA is a theory driven technique that statistically determines the relationship between the observed and unobserved variables (Schreiber et. al., 2010).

CFA has been done to determine the structure of the teacher effectiveness factors and factor loadings of the measured variables and to assess the model fit of each factor. The CFA models were specified and estimated in the Mplus version 7.11 with restricted maximum likelihood estimation (Muthén & Muthén, 1998-2015). The total sample consisted of 680 teachers which is sufficient for the stability of the estimated parameters. The sample for each CFA model could differ from 656 teachers to 679 teachers due to the missing values on the specific items involved in each CFA analyses. The sample size for each model is mentioned in each CFA table separately. It is important to note that CFA analyses were conducted not only on mathematics teachers but also on German language teachers as most of the teachers were teaching both subjects. The respondents ranged in age from about 25 to 62 years and their experience ranged from 0 to 35 years. Each CFA model with the items, standardized and unstandardized factor loadings (and standard errors) is given below. The number of items in each scale, reliability of each scale and fit indices of each scale are mentioned in the table 3.17.

Table 3.2 shows the CFA results from the scale *teacher belief about deep learning*. Each item was measured on a 4 point rating scale: 1= very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important. A higher score indicates teachers have positive *beliefs about deep*

Table 3.2: Standardised and unstandardised factor loadings (and standard errors) for the deep learning (*N*=678)

Item	*β*	B	SE
How important do you consider the students should build systematic expert knowledge	0.86	1.00	
How important do you consider the students should understand the subject matter in depth	0.52	0.52	3.41

learning. The table demonstrates the factor loadings for each observed variables on the *deep learning* construct. The items show good factor loadings of above .40 as recommended by Hair, Anderson, Tatham and Black (1998). The comparative fit index (CFI) = 0.99, Tucker-Lewis index (TLI) = 1.00, Root mean square error of approximation RMSEA = 0.00 and Standardized root mean residual SRMR = 0.00 indicate a good fit between the model and the observed data. The Cronbach α reliability = 0.62 is also acceptable considering the scale is comprised of only 2 items.

Table 3.3: Standardised and unstandardised factor loadings (and standard errors) for the belief about constructivist instruction (*N*=677)

Item	*β*	B	SE
My role as a teacher is to make it easier for the students to investigate	0.36	1.00	
How important do you consider the students should understand the subject matter in depth	0.40	1.67	0.29
Students should be given the possibility of reflecting on solutions themselves before the teacher shows the approach to the solution	0.56	1.23	0.20
Thinking and reasoning processes are more important than specific contents of the syllabus	0.41	1.19	0.21

Table 3.3 shows the CFA results for the items regarding *belief about constructivist instruction*. Each item was measured on a 4 point rating scale: 1= completely disagree, 2 = tend to disagree, 3 = tend to agree, 4 = completely agree. A higher score indicates the teachers have a positive *belief about constructivist instruction*. The factor loadings are moderate on three items and weak on one of the items. However, the item with a weak factor loading was also kept in the analyses because

theoretically it is a significant variable. The model fit is good (CFI = 0.99, TLI = 0.99, RMSEA = 0.01, SRMR = 0.01) and The Cronbach α is 0.54.

Table 3.4 shows the CFA results for the items regarding *belief about transmissive instruction*. Each item was measured on a 4 point rating scale: 1= completely disagree, 2 = tend to disagree, 3 = tend to agree, 4 = completely agree. A higher score on these items indicates the teachers have *belief about transmissive instruction*. The factor loadings are moderate and the model fit is good too (CFI = 1.00, TLI = 1.00, RMSEA = 0.00, SRMR = 0.00) and the Cronbach α is 0.49.

Table 3.4: Standardised and unstandardised factor loadings (and standard errors) for the belief about transmissive instruction (N=675)

Item	β	B	SE
It is better when the teacher and not the students decide what needs to be done	0.42	1.00	
The question of how much students will learn depends on their background knowledge, and that is why teaching of facts is so important	0.54	0.41	0.27
Classes should be based on problems with clear-cut and correct answers as well as on concepts that are quickly understood by the students	0.53	1.42	0.27

Table 3.5 shows the items and CFA results of the scale *lesson planning*. Each item was measured on 4 point rating scale: 1= very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important. A higher score indicates the teachers have a positive attitude towards *lesson planning*. The factor loadings are moderate. The CFI = 0.91 and TLI = 0.73 are low than the suggested cutoff (0.95), RMSEA = 0.13 which is higher than the suggested value (>0.08), however, SRMR = 0.04 is acceptable. The Cronbach α is also low (0.47). This maybe because all items are measuring different dimensions of *lesson planning*.

Table 3.6 shows the CFA results from the scale *planning about creating interest in learning*. Each item was measured on a 4 point rating scale: 1= very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important. A higher score indicates the teachers have a positive attitude towards *creating interest in learning*. The factor loadings are moderate to high and the model fit is good CFI = 0.99, TLI = 1.00, RMSEA = 0.00, SRMR = 0.00. The Cronbach α = 0.67 is moderate.

Table 3.5: Standardised and unstandardised factor loadings (and standard errors) for the lesson planning (*N*=677)

Item	*β*	B	SE
It is better when the teacher and not the students decide what needs to be done	0.42	1.00	
The question of how much students will learn depends on their background knowledge, and that is why teaching of facts is so important	0.54	0.41	0.27
Classes should be based on problems with clear-cut and correct answers as well as on concepts that are quickly understood by the students	0.53	1.42	0.27

Table 3.7 shows the CFA results from the scale *planning for individual needs of students*. Each item was measured on a 4 point rating scale: 1= very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important. A higher score the teachers have a positive attitude towards considering the *individual needs of students*. The factor loadings are moderate to high and the model fit is good CFI = 0.99, TLI = 1.00, RMSEA = 0.00, SRMR = 0.00. The Cronbach α is .55.

Table 3.6: Standardised and unstandardised factor loadings (and standard errors) for creating interest in learning (*N*=676)

Item	*β*	B	SE
How important do you consider creating interest in teaching subjects	0.93	1.00	
How important do you consider increasing the pleasure in learning and willingness to perform	0.55	0.48	4.19

Table 3.8 shows the CFA results from the scale *stress in planning and classroom*. More knowledge about planning and classroom should result in low stress. Each item was measured on a 5 point rating scale:

Table 3.7: Standardised and unstandardised factor loadings (and standard errors) for individual needs of students (*N*=676)

Item	*β*	B	SE
How important do you consider being informed about personal problems of the students	0.83	1.00	
How important do you consider considering the personal situation when assessing students	0.46	0.50	3.20

1= not stressful at all, 2 = rather not stressful, 3 = partly stressful, 4 = rather stressful, 5 = stressful. The factor loadings are weak to high but the model fit is good CFI = 1.00, TLI = 1.00, RMSEA = 0.00, SRMR = 0.00. The Cronbach α is .50. This scale is also kept in the study despite one low factor loading because factor is assumed to be an important indicator of teacher effectiveness.

Table 3.8: Standardised and unstandardised factor loadings (and standard errors) for the stress in planning and classroom (*N*=676)

Item	*β*	B	SE
In what areas do you experience stress in class and during the preparation of classes? methodological requirements for carrying out classes	0.78	1.00	
In what areas do you experience stress in class and during the preparation of classes? The effort needed during the planning of classes	0.41	0.58	0.14
In what areas do you experience stress in class and during the preparation of classes? Different learning abilities of students	0.36	0.49	0.12

Table 3.9 shows the CFA results from the scale *missing identification with job*. Each item was measured on a 4 point rating scale: 1= does not apply at all, 2 = does not apply much, 3 = apply quite well, 4 = applies fully. A higher score indicates the teachers lack identification with their job. The response format was recoded and therefore, a high score on these items indicates identification with the job. The factor loadings are good but the model fit is not sufficient. CFI (0.93) and TLI (0.89) are lower than the suggested score of 0.95, RMSEA = 0.10 is high-

er (it should be low than 0.08), however, SRMR = 0.00. The Cronbach α is good 0.79.

Table 3.9: Standardised and unstandardised factor loadings (and standard errors) for the missing identification with job (*N*=674)

Item	*β*	B	SE
I have to force myself to go to school	0.66	1.00	
I am glad when I can close the school door behind me	0.68	0.98	0.07
Spare time and hobbies give me more satisfaction than job	0.50	0.70	0.06
I can imagine other jobs that I would prefer	0.62	0.87	0.07
I can hardly cope with the nervous exhaustion of the teaching job	0.60	0.79	0.06

Table 3.10 shows the CFA results from the scale *job stress*. Each item was measured on a 4 point rating scale: 1= does not apply at all, 2 = does not apply much, 3 = apply quite well, 4 = applies fully. Like the scale *missing identification with job*, the responses were recoded and a higher score indicates less stress at job. The factor loadings are high and the model fit is perfect CFI = 1.00, TLI = 1.00, RMSEA = 0.00, SRMR = 0.00. The Cronbach α also fits well (0.83).

Table 3.10: Standardised and unstandardised factor loadings (and standard errors) for the job stress (*N*=656)

Item	*β*	B	SE
What is the stress factor for you at work? Missing professional appreciation	0.70	1.00	
What is the stress factor for you at work? Few opportunities for advancement at the school	0.85	0.33	0.07
What is the stress factor for you at work? Competition among colleagues	0.82	0.34	0.07

Table 3.11 shows the CFA results from the scale *extrinsic motivation* for job. Each item was measured on a 4 point rating scale: 1= does not apply at all, 2 = does not apply much, 3 = apply quite well, 4 = applies fully. A higher score indicates the teachers are highly motivated towards

the job. The factor loadings are moderate to good and the model fit is perfect. The CFI (1.00), TLI (1.00), RMSEA = 0.00, SRMR = 0.00. The Cronbach α is moderate 0.66.

Table 3.11: Standardised and unstandardised factor loadings (and standard errors) for the extrinsic motivation (*N*=673)

Item	*β*	B	SE
How important do you consider for your job as a teacher? Much spare time	0.55	1.00	
How important do you consider for your job as a teacher? Good pay	0.82	1.44	1.18
How important do you consider for your job as a teacher? Job security	0.52	0.90	0.09

Table 3.12 shows the CFA results from the scale *professional collaboration*. Each item was measured on a 6 point Likert scale: 1= never, 2 = less than once a year, 3 = once a year, 4 = three to four times a year, 5 = monthly, 6 = weekly. A higher score indicates the teachers frequently

Table 3.12: Standardised and unstandardised factor loadings (and standard errors) for the professional collaboration(*N*=674)

Item	*β*	B	SE
How often do you and your colleagues cooperate on a regular basis at your school? Preparing teaching learning material	0.76	1.00	
How often do you and your colleagues cooperate on a regular basis at your school? Preparing teaching units	0.85	1.21	0.06
How often do you and your colleagues cooperate on a regular basis at your school? Jointly planning classes	0.77	1.23	0.06
How often do you participate in the team discussions on the age group you are teaching	0.60	0.61	0.04

collaborate with their colleagues. The factor loadings are good to high. The CFI (0.93) and TLI (0.89) are good but RMSEA = 0.08 which should be lower than 0.08. SRMR is perfect too (0.00). The Cronbach α is good 0.81.

Table 3.13 shows the CFA results from the scale *exchange and coordination for teaching with other teachers*. Each item was measured on a 6 point Likert scale: 1= never, 2 = less than once a year, 3 = once a year, 4 = three to four times a year, 5 = monthly, 6 = weekly. A higher score indicate the teachers frequently *exchange and coordinate for teaching*. The factor loadings are moderate and the model fit is perfect (CFI = 1.00, TLI = 1.00, RMSEA = 0.00, SRMR =0.00) however, Cronbach α is low (0.45).

Table 3.13: Standardised and unstandardised factor loadings (and standard errors) for the exchange and coordination for teaching (*N*=667)

Item	*β*	B	SE
How often do you participate in the exchanging teaching material with colleagues	0.57	1.00	
How often do you participate in developing a syllabus or a part of it	0.52	1.15	0.17
How often do you participate in discussing the learning process of individual students	0.57	1.47	0.22

In general, the factor loadings for the scales were moderate to good with few low factor loadings. However, the few scales with low factor loadings were neither trimmed nor excluded from the scale because of the theoretical importance of the variables. The model fit for most of the scales was good but the Cronbach α for some was low. This may be due to the few items in each scale or the measurement of different dimensions of each scale. The number of items, Cronbach α and model fit indices are shown together for the scale again in the table 3.14. The correlations among the scales are weak to low. The correlations are provided in the table 4.2 in chapter 4.

3.5.2. Demographic variables

Along with these teacher factor scales some other single items measuring the teachers' demographic characteristics were also included in the teacher factor questionnaire.

Table 3.14: Teacher factor scale items, reliability, and model fit indices

Scale	Items	α	CFI	TLI	RMSEA	SRMR
Deep learning	2	0.62	0.99	1.00	0.00	0.00
Constructivist instruction	4	0.54	0.99	0.99	0.01	0.01
Transmissive instruction	3	0.49	1.00	1.00	0.00	0.00
Lesson planning	4	0.47	0.91	0.73	0.13	0.04
Creating interest in learning	2	0.67	0.99	1.00	0.00	0.00
Individual needs of students	2	0.55	0.99	1.00	0.00	0.00
Stress in planning and classroom	3	0.50	1.00	1.00	0.00	0.00
Missing identification with job	5	0.79	0.93	0.89	0.01	0.04
Job stress	3	0.83	1.00	1.00	0.00	0.00
Extrinsic motivation	3	0.66	1.00	1.00	0.00	0.00
Professional collaboration	4	0.81	0.99	0.97	0.08	0.00
Exchange and coordination for teaching	3	0.45	1.00	1.00	0.00	0.00

CFI = The comparative fit index; TLI = Tucker-Lewis index; RMSEA = Root mean square error of approximation; SRMR = Standardized root mean residual; α = Cronbach alpha reliability

The information provided on these items is only about the mathematics teachers that were included in the final sample and not from the teachers on which CFA was performed. The details about each item are as follows

3.5.2.1. Gender

Are you male or female? Please check where applicable. (1=male, 2=female). From the total 151 teachers the sample included male ($N = 43$), female ($N = 73$) and missing ($N = 37$).

3.5.2.2. Migration

Do you have a so-called migration background, i.e. you or at least one parent was born abroad. Categories (1 = yes, I was born abroad, 2 = Yes, I was born in Germany but at least one parent was born abroad, 3 = no). The frequency and percentages in each category are given in the table 3.15.

3.5.2.3 Age

Question stem: When were you born? Five age categories were provided which are explained in the table 3.15 with the frequency and percentage of teachers in each category.

3.5.2.4. Experience

Question stem: How long have you been working in your job? Please subtract longer periods of work stoppages and round them up to full years. Please enter figures (open response answering format). Later the scale was transformed into 8 respective categories which are explained in the table 3.15 along with the frequency and percentage of teachers in each category.

3.5.2.5. Professional training scale

In addition to the single items, professional training items were also included in the questionnaire. These items acquired information from teachers about their professional training (both pre-service and in-service) and their plan to participate in further training in future. All items were dichotomous with a yes or no response format (or provided as dichotomous items to the researchers), therefore, it was not required to perform a CFA on these items and only a sum score of these items has been done to measure teachers' professional training. However, the calculated Cronbach alpha reliability was acceptable $\alpha = 0.76$. Higher scores on these items indicate higher professional training skills. The item stem and response format of each item of the professional training scale is as follows:

Item1: Have you ever started a teacher's course of study? Dichotomous response format (0= no, 1=yes).

Item2: Have you successfully completed your teacher training? Please check where applicable? Dichotomous response format (0= no, 1=yes).

Item3: Have you ever participated in the following training activities during the past 12 months? Sitting in classes ate the other schools? Dichotomous response format (0= no, 1=yes).

Item4: How many days have you participated in the training measures in the above sense during the past 12 months? Participation and no participation in training are measured within the last 12 months. This means no matter how many times the teacher has participated in professional training, the item is provided to researchers in a dichotomous format (0= no, 1=yes).

Item5: Would you prefer to attend more training programs than you actually have during the past 12 months? Dichotomous response format (0= no, 1=yes).

The descriptive data of all scales and items from the teacher factor questionnaire is provided in table 3.16. The number of teachers on each sub scale is always less than the total sample of teachers (n=151). This is due to the missing data on the teacher factor questionnaire. About 25% of the total sample of teachers refused to respond to that questionnaire and only provided information on their demographic characteristics but they

Table 3.15: Frequency and percentage of teachers on age and experience

	Frequency	Percentage
Categories for age		
Before 1950	05	3.04
1950-1959	50	33.6
1958-1969	23	15.4
1969-1979	24	16.1
After 1979	11	7.4
Missing	36	24.1
Categories for experience		
0 up to below 5 years	16	10.7
5 up to below 10 years	17	11.4
10 up to below 15	11	7.04
15 up to below 20	06	4.00
20 up to below 25	06	4.00
25 up to below 30	11	7.04
30 up to below 35	26	17.4
35 and more	07	4.07
Missing	51	33.0
Categories for migration background		
Yes, I was born abroad	03	2.1
I was born in Germany but at least one parent was born abroad	02	1.4
No	108	72.5
Missing	38	24.1

are still included in the study if they taught their students for the whole period of the study (i.e. two years). However, the data was missing at random and therefore I decided to not to exclude those teachers from the analysis but to impute the data. The data was imputed by Full Information Maximum Likelihood Estimation (FIML) in Mplus. Multiple data sets were generated using multiple imputation in Mplus. In the current study, 1000 data sets were generated in each analysis to get consistent results and reliable results.

3.5.3. Instructional questionnaire. The teacher factor questionnaire only provided information about the *teachers' beliefs, professional training, and job satisfaction* etc. It lacked in the aspect of the instructional practices of the teachers in the classroom. Moreover, that questionnaire was similar for both mathematics and German language teachers and as such does not measure teacher effectiveness specifically in relation to mathematics teaching. Therefore, another questionnaire is used in the current study to measure the teachers' practices in the mathematics classroom.

This questionnaire, designed by the NEPS only for mathematics teachers, aims to measure the quality of instruction. NEPS has employed the Bolhuis, (2003) model of teaching and learning competence and SSCO model (structure, support, challenge, orientation) and extension of Bolhuis (2003) model by Seidel and Shavelson (2007) for the development of this questionnaire. The main components of the Bolhuis model are domain of learning (mathematics, science etc.), time for learning, organization for learning, social context, goal setting, execution of learning, evaluation (formative and summative) and regulation and monitoring. For more details about this model see Seidel and Shavelson (2007). The Bolhuis, model is implemented in a way that a part of the information is collected from students in the form of a questionnaire (e.g. goal setting and helping students to make them their own goals) and the rest of the information is collected from the teachers through a self-report questionnaire.

The current study I focus on those constructs of the questionnaire that are related to the organization and carrying out of learning in the classroom, social settings, *student engagement* in the process of learning and evaluation. These are *cooperative learning, student engagement, cognitive activation, cognitively challenging tasks* and *differentiation*. I am aware that there are some factors of instructional effectiveness other than the factors included in the current study that are important for instance classroom environment, classroom management, however, they

Table 3.16: Descriptive data of demographics and scales on teacher factor questionnaire

	N	*M*	SD
Age	113	2.88*	1.103
Gender	114	1.64	.482
Experience	100	4.41	2.466
Migration background	113	2.93	.346
Deep learning	114	6.921	.9420
Constructivist instruction	113	13.68	1.371
Transmissive instruction	108	8.537	1.456
Lesson planning	116	12.95	1.711
Creating interest in learning	115	7.434	.7623
Individual needs of students	116	6.655	1.030
Stress in planning and classroom	102	9.607	2.005
Missing identification with job	92	19.36	2.900
Job stress	96	10.40	2.882
Extrinsic motivation	107	7.981	1.806
Professional collaboration	94	15.60	4.375
Exchange and coordination for teaching	108	13.12	2.249
Professional training	80	2.087	.8743

*Age was measured in categories (see table 3.18) therefore, it could be only reported in categories

they could not be included in this study due to the unavailability of data on those factors. NEPS has provided only the theoretical basis of the questionnaire and no information is provided about the scaling of the questionnaire. Therefore a confirmatory factor analysis was conducted to see the underlying structure of the items gathered by NEPS to measure each construct. The CFA models were specified and estimated in Mplus version 7.1 with restricted maximum likelihood estimation (Muthén & Muthén, 1998-2015). The confirmatory factor analysis was performed for 6 different scales. These are *cooperative learning, student engagement, cognitive activation, cognitively challenging tasks* and *differentiation* (adaptive instruction). In general the items showed good factors loadings for each construct i.e. above 0.40 except 5 items in 5 different scales (1 in *cooperative learning,* 2 *student engagement,* 1 in cognitive activation) and therefore, those items were excluded from the scale as recommended by Hair, Anderson, Tatham and Black (1998). The CFA results for the each construct are given in the tables below. It is important to note that the CFA was performed not only on the mathematics teachers that are included in the study but also on the teachers that were excluded from the study for not having taught for the period of two years. The large sample size for CFA is helpful for the stability of parameters. This analysis was done not only on the teachers that participated in grade 5 but also on the teachers that joined the study in grade 6. Therefore, the sample is bigger than the sample of the current study i.e. (N = 642). However, it could differ for each scale depending on the missing values on each scale. The number of participants in each scale CFA is mentioned in each CFA table.

Table 3.17 shows the CFA results from the scale *cooperative learning* during

Table 3.17: Standardised and unstandardised factor loadings (and standard errors) for the cooperative learning (N=642)

Item	β	B	SE
How often do you use the following social methods of learning in this mathematics classroom…….			
Working with small group of students	0.68	1.00	
Partner work	0.56	0.68	0.06
Discussion rounds	0.48	0.93	0.11
Peer tutoring	0.54	1.09	0.11
Project-based learning	0.53	0.69	0.08

mathematics instruction. Each item was measured on a 6 point Likert scale measuring the frequency of use of *cooperative learning*: 1= never, 2 = once or twice per semester, 3 = every other month, 4 = every two to four weeks, 5 = once a week, 6 = nearly every hour. A higher score indicates the frequent usage of *cooperative learning* in the classroom. The table demonstrates the factor loadings for each of the observed variables. The items show good factor loading of above .40 as recommended by Hair, Anderson, Tatham and Black (1998). However, the model fit indices are insufficient with CFI = 0.94, slightly lower than the suggested criteria. TLI = 0.88 which is low, RMSEA = 0.08 is high, it should be lower than 0.08 but SRMR = 0.03 is good. Therefore, the model fit is mediocre. The Cronbach α reliability = 0.67, which is also acceptable considering the scale is measuring different ways of *cooperative learning*.

Table 3.18 shows the CFA result from the scale use of *student engagement* in the classroom. Like social methods each item was measured on a 6 point Likert scale measuring the frequency of use of *student engagement*: 1= never, 2 = once or twice per semester, 3 = every other month, 4 = every two to four weeks, 5 = once a week, 6 = nearly every hour. A higher score indicates the frequent use of *student engagement* in classroom. The factor loadings are moderate. The model fit is very good CFI = 0.98, TLI = 1.01, RMSEA = 0.00 and SRMR = 0.00. However, the Cronbach α reliability = 0.46 is low. But it's acceptable considering the scale has only two items.

Table 3.18: Standardised and unstandardised factor loadings (and standard errors) for the student engagement (N=641)

Item	β	B	SE
How often do you use the following social methods of learning in this mathematics classroom……			
The class and I discuss together	0.62	1.00	
A student present something to the classroom	0.53	0.80	0.04

Table 3.19 shows the CFA results from the scale *cognitive activation*. The scale was measured on the 5 point Likert scale: 1 = very rarely, 2 = rarely,

Table 3.19: Standardised and unstandardised factor loadings (and standard errors) for the cognitive activation (*N*=638)

Item	*β*	B	SE
How often do the following statements apply to math lessons in the classroom			
The students …….			
Are asked questions that show if they are able to critically assess and analyze the subject matter	0.73	1.00	
Are requested by me to relate to the questions and comments of their classmates	0.65	0.80	0.13
Actually relate to the questions and comments of their classmates	0.59	0.79	0.14
Are asked questions during which the subject matter has to be critically reviewed	0.78	1.14	0.06

3 = sometimes, 4 = often and 5 = very often. A higher score indicates the frequent usage of techniques that foster *cognitive activation* among students. The factor loadings are moderate to high but the model fit is poor (CFI = 0.00, TLI = -2.44, RMSEA = 0.79 and SRMR = 0.07), however, the reliability is good α = 0.78.

Table 3.20 shows the CFA results for the construct *cognitively challenging tasks*.

The scale is measured on a 5 point Likert scale: 1 = strongly disagree, 2 = rather not correct, 3 = partly correct, 4 = rather correct, 5 = strongly agree. A higher score indicates the frequent usage of *cognitively challenging tasks* in classroom. The factor loadings are moderate to high. The-model fit is good (CFI = 0.96, TLI = 0.98, RMSEA = 0.12 and SRMR = 0.02) for all fit indices except RMSEA, which is very high. The scale reliability is good α = 0.80.

Table 3.21 shows the CFA results from the scale *differentiation*. The scale is measured on a 5 point Likert scale: 1 = strongly disagree, 2 = rather not correct, 3 = partly correct, 4 = rather correct, 5 = strongly agree. A hi-

Table 3.20: Standardised and unstandardised factor loadings (and standard errors) for the cognitively challenging task (*N*=639)

Item	*β*	B	SE
To what extent do the following statements apply to the assignments you give your students during math lessons			
Assignments that do not only involve the identification of standard solutions but also the selection of the right approach	0.71	1.00	
I give the assignments in which students need time to think in order to find solutions	0.65	0.81	0.04
I give them assignments in which students have to show different approaches	0.74	1.10	0.07
I give them assignments that require explanation and in depth comments rather than simple solutions	0.72	1.06	0.07

Table 3.21: Standardised and unstandardised factor loadings (and standard errors) for the differentiation (*N*=634)

Item	*β*	B	SE
To what extent do the following statements apply to your mathematics lessons in this classroom……….			
I demand considerably less from students who are less capable	0.43	1.00	
I form group of students with same capabilities	0.56	1.35	0.12
I assign students homework ranging in complexity based on their capability	0.70	2.00	0.18
I allow students who work faster to move on to the next assignment while I am working with the ones that work slower	0.47	1.08	0.14
If student have difficulties in understanding, I give them additional assignments	0.55	1.28	0.16
I give more capable students extra assignments that are really challenging for them	0.66	1.52	0.19

gher score indicates the teachers consider the different abilities of students in the classroom. The factor loadings are moderate to high. The model fit is CFI = 0.94, TLI = 0.91 a bit lower than the criteria (0.95), RMSEA = 0.07 and SRMR = 0.03 are good. The reliability is moderate α = 0.68.

The number of items in each scale, reliability and model fit indices are given in table 3.22.

The descriptive data from the instructional questionnaire is provided in table 3.23. As it can be seen in the table about 90 – 95 teachers responded to the instructional questionnaire and the total teachers sample is 151. The data was imputed for those teachers who did not

Table 3.22: Teacher factor scale items, reliability and model fit indices

Scale	Items	α	CFI	TLI	RMSEA	SRMR
Cooperative learning	5	.67	.95	.88	.08	.03
Student engagement	5	.46	.98	1.01	.00	.00
Cognitive activation	5	.78	.00	-2.44	.79	.07
Cognitively challenging tasks	5	.80	.96	.98	.12	.02
Differentiation	6	.68	.94	.91	.07	.03

CFI = The comparative fit index; TLI = Tucker-Lewis index; RMSEA = Root mean square error of approximation; SRMR = Standardized root mean residual; α = Cronbach alpha reliability

participate in the analysis. The correlations among the scales are weak to low. The correlations are provided in table 4.2 in chapter 4.

Table 3.23: Descriptive data of scales on instructional questionnaire

Scale	*N*	*M*	SD
Cooperative learning	90	18.47	4.517
Student engagement	93	8.354	2.282
Cognitive activation	92	13.66	2.913
Cognitively challenging tasks	94	13.11	2.505
Differentiation	93	11.11	2.479

3.5.4. Mathematics competence test

The mathematics competence tests are regular pencil and paper tests. The tests aim to measure the secondary school students' ability to apply mathematics knowledge and skills in real life situations. The framework of the test is based on two dimensions to structure mathematical processes: content areas and cognitive components (Schnittjer & Duchhardt, 2015). These content areas are quantity, space and shape, change and relationships, data and chance. The cognitive components are applying technical skills, modelling, arguing, communicating, representing and problem solving. The contents share an approximately equal number of items in the test and the six cognitive components are distributed over the items (Schnittjer & Duchhardt, 2015). More details about the framework of the test can be found in Neumann et al. (2013) and Ehmke et al. (2009). The details about each content area and the cognitive components follow (source: Schnittjer & Duchhardt, 2015). A more detailed description about scaling of the competence test can be found in Pohl and Carstensen (2012a) and Duchhardt & Gerdes, 2012). Both competence tests (grade 5 and 7) followed the same framework. Some details about each competence test are as follows:

The Grade 5 competence test consisted of 24 items. The content quantity has 8 items in the test, space and shape has 5 items, change and relationship has 6 items, data and chance has 5 items. The response format was a simple multiple choice (12 items), complex multiple choice (1 item), short constructed response (11 items). In the simple multiple choice (MC) each item had four response options with one correct answer and three distractors, the complex multiple choice (CMC) item consisted of a number of subtasks with one correct answer out of two response options and the short-constructed response (SCR) items required a response in the form of a number (Pohl & Carstensen, 2012a). In the grade 7 competence test there are 23 items and almost all are multiple choice (MC) response format items. All the items are binary response format except the complex multiple choice (CMC) items (Rohwer, 2015)

Due to security reasons the items of the questionnaire are not provided to the researchers. One sample item is given in table 3.24 from the grade 5 test. This sample item belonged to the content area "space & shape". "Modeling" and "technical abilities and skills" are involved in this item. The tests were administered in German. Therefore, the item was originally in German and translated by the researcher.

A WLE (weighted maximum likelihood estimate) was used as the measure of mathematics competence in the current study instead of sum scores. Like a sum score, WLE does not take into account the

Table 3.24. Example item from grade 5 competence test

Mr. Braun has a rectangular plot and he wants to fence it. After calculations he bought a 40 meter long fence
The plot has a width of 8 m.
What is the length of the plot?
5 meter
8 meter
12 meter
16 meter

Source: Schnittjer & Duchhardt (2015)

measurement error, however, WLE better estimates individual scores and therefore, students' ability in comparison to sum score as WLE facilitates both the adequate treatment of missing responses and comparability of competence scores longitudinally (Pohl & Carstensen, 2012). In NEPS competence scores, the means of WLE score are constrained to zero. Scores below zero indicate the student's ability is below average and scores above zero shows the students' ability is above average (Pohl & Carstensen, 2012). For more details about WLE scores in NEPS data see Pohl and Carstensen, (2012).

3.6. Data Analysis

Data was analyzed by using the Mplus software package version 7.11. Although, the data has a multilevel structure, with students nested in teachers, the study has a single level analysis. The reason for not doing the multilevel analyses is that I aimed to measure the individual competence of students, not at the class level, because in multilevel analyses the class mean is taken into account. Secondly, for multilevel analyses the class size should be meaningfully large. However, in the current study, in some cases the class size is very small. Therefore, for multilevel analyses, I would have to delete the teachers with small numbers of students which would result in a small sample size. However, the study has taken into account the multilevel structure of the sample by using TYPE = COMPLEX in the analyses. Type = COMPLEX do corrections to the standard error and chi-square of the model fit that take into account stratification, non-independence of observations, and unequal probability of selection (Muthén & Muthén, 1998-2015). The data was analyzed through the application of linear regression, multiple regression, hierarchical multiple regression and multi-group analysis according to the research questions. The details about how each research question is analyzed are given below. For more details on the research question see chapter 2.

3.6.1. Research question 1

Which teacher factors predict mathematics competence development of secondary school students?

This question was analyzed using linear regression for each teacher factor and instructional factor. The factors that did not predict MC7 significantly were excluded from further analysis on the basis of the result from the linear regression analysis.

3.6.2. Research question 2

Which instructional factors predict mathematics competence development of secondary school students?

The question was analyzed by using linear regression for each teacher factor and instructional factor. The factors that did not predict MC7 significantly were excluded from further analysis on the basis of the result from the linear regression analysis.

3.6.3. Research question 3

How do the combination of teacher factors and instructional factors predict students' mathematics competence?

This question was analyzed by performing multiple regressions. To analyze this question at first, the analysis was done with teacher and instructional factors to see the effect of these factors on mathematics competence. Then, students' mathematics competence grade 5 (MC5) was added into the model to see if the teachers' factors still have an effect on grade 7 mathematics competence.

3.6.4 Research question 4

Do teachers in different school tracks vary in effectiveness?

This question analyzed how teachers in lower secondary school, middle secondary school, multi-track school, comprehensive school and grammar school vary in effectiveness. In Germany, more competent teachers are selected and trained for higher school tracks and the less competent teachers are trained for the lower school tracks. Moreover, the teachers for different school tracks are trained differently in Germany (the details are discussed under the topic *German education system* earlier in this chapter). For instance, the teachers for the academic school track are trained with a focus on content knowledge and teachers for non-academic school tracks are trained with a focus on pedagogical knowledge. The concept behind this is that the teachers in the academic track would have to face more challenging situations with respect to the content of the subject and the teachers in the non-academic tracks would need more pedagogical skills to teach students with comparatively low competence. As the teachers in different school tracks have different level of competence and have attended different teacher training they might vary in effectiveness too. Moreover, TALIS (2009) (OECD's international study about teachers' beliefs and practices) mentioned that teacher beliefs and practices are formed by cultural and pedagogical traditions. While TALIS referred to the national cultures and pedagogical traditions, the current study assumes that the culture and traditions of teacher training institutes for each school track could also vary in teacher and instructional factors. On the basis of these facts and assumptions, this research question aims to measure if teachers in different school tracks vary in effectiveness. It is expected that students in non-academic school tracks might be at disadvantage due to their teachers' effectiveness. The question was analyzed by conducting a multi-group analysis in Mplus 7.11. The descriptive statistics of teachers of each school type are given in the tables 3.25, 3.26, 3.27, 3.28 and 3.29.

Table 3.25: Descriptive data of lower secondary school teachers on teacher and instructional effectiveness scales

Scale	*N*	*M*	SD
Deep learning	31	6.774	1.055
Constructivist instruction	31	13.51	1.609
Transmissive instruction	30	8.633	1.790
Lesson planning	31	12.93	1.749
Creating interest in learning	30	7.600	0.621
Individual needs of students	31	6.774	1.055
Stress in planning and class-room	22	9.590	1.868
Missing identification with job	21	18.95	3.278
Job stress	21	10.57	2.618
Extrinsic motivation	29	8.241	1.618
Professional collaboration	22	16.81	4.625
Exchange and coordination for teaching	31	13.38	2.139
Professional training	20	1.800	1.005
Cooperative learning	24	18.50	5.013
Student engagement	25	7.880	2.147
Cognitive activation	25	12.48	2.874
Cognitive challenging tasks	25	12.00	2.020
Differentiation	25	11.60	2.362

Table 3.26: Descriptive data of middle secondary school teachers on teacher and instructional effectiveness scales

Scale	*N*	*M*	SD
Deep learning	20	6.900	0.788
Constructivist instruction	20	13.85	1.565
Transmissive instruction	18	9.111	1.278
Lesson planning	20	13.50	1.504
Creating interest in learning	20	7.600	0.753
Individual needs of students	20	6.600	0.994
Stress in planning and class-room	19	10.26	1.939
Missing identification with job	15	19.53	2.695
Job stress	19	10.21	2.878
Extrinsic motivation	18	8.000	1.533
Professional collaboration	17	15.47	4.810
Exchange and coordination for teaching	18	13.22	2.510
Professional training	14	2.142	0.949
Cooperative learning	14	18.50	3.797
Student engagement	13	14.00	2.798
Cognitive activation	14	8.857	1.915
Cognitive challenging tasks	15	12.92	2.555
Differentiation	13	10.92	2.596

Table 3.27: Descriptive data of teachers of multi-track school on teacher and instructional effectiveness scales

Scale	*N*	*M*	SD
Deep learning	15	7.000	1.195
Constructivist instruction	14	13.57	1.089
Transmissive instruction	12	8.416	2.108
Lesson planning	15	13.26	1.907
Creating interest in learning	15	7.533	0.833
Individual needs of students	15	7.200	0.861
Stress in planning and classroom	15	9.866	2.231
Missing identification with job	15	20.26	1.980
Job stress	14	11.21	3.945
Extrinsic motivation	15	8.466	1.187
Professional collaboration	14	16.78	3.786
Exchange and coordination for teaching	12	13.66	2.806
Professional training	10	2.300	0.948
Cooperative learning	10	20.30	3.860
Student engagement	10	8.600	2.412
Cognitive activation	11	15.36	1.689
Cognitive challenging tasks	11	14.27	2.412
Differentiation	10	11.80	3.881

Table 3.28: Descriptive data of comprehensive school teachers on teacher and instructional effectiveness scales

Scale	*N*	*M*	SD
Deep learning	10	6.500	0.849
Constructivist instruction	10	14.40	1.074
Transmissive instruction	10	7.700	1.059
Lesson planning	10	12.30	1.337
Creating interest in learning	10	7.300	0.823
Individual needs of students	10	6.900	1.197
Stress in planning and classroom	09	9.555	1.666
Missing identification with job	09	19.44	2.185
Job stress	08	10.25	2.121
Extrinsic motivation	09	7.444	2.505
Professional collaboration	07	17.85	3.670
Exchange and coordination for teaching	07	14.14	1.573
Professional training	08	2.125	0.834
Cooperative learning	07	17.71	5.468
Student engagement	07	6.857	2.672
Cognitive activation	08	12.00	1.603
Cognitive challenging tasks	08	11.87	1.356
Differentiation	08	11.75	2.187

Table 3.29: Descriptive data of grammar school teachers on teacher and instructional effectiveness scales

Scale	*N*	*M*	SD
Deep learning	37	7.054	0.814
Constructivist instruction	37	13.54	1.238
Transmissive instruction	38	8.447	0.950
Lesson planning	39	12.69	1.764
Creating interest in learning	39	7.205	0.800
Individual needs of students	39	6.282	0.998
Stress in planning and classroom	36	9.083	2.156
Missing identification with job	33	18.96	3.367
Job stress	33	10.06	2.805
Extrinsic motivation	35	7.742	2.091
Professional collaboration	34	14.08	3.918
Exchange and coordination for teaching	39	12.66	2.094
Professional training	29	2.206	0.726
Cooperative learning	35	18.11	4.509
Student engagement	36	8.805	2.327
Cognitive activation	35	14.02	3.213
Cognitive challenging tasks	36	13.83	2.709
Differentiation	36	10.75	2.116

Chapter 4

Empirical Findings

This chapter describes the results and interpretations of the analyses of the empirical data of the study. Each of the research questions and the underlying hypothesis of each research question are addressed separately using the relevant statistical techniques.

Table 4.1 provides a descriptive analysis about the teachers' background variables and teacher effectiveness characteristics. Multiple regression was performed in the Mplus 7.11 in order to measure the association between teachers' background variables and teachers' effectiveness factors. A significant positive association is shown with the "+" sign and significant negative association is shown with the "-" sign and blank cells show no association. For instance the more experience a teacher has, it is more likely that they endorse the *belief in deep learning*.

Further, before moving to the results from the main research questions of the study, the control variables of the study are discussed. Some important student factors that could predict students' competence on a theoretical basis are controlled for in the current study. These factors include student gender, cognitive ability, students' MC5, socio-economic status (SES), students' migration background and school type. It was important to control for some variables because they have a probability to predict grade 7 mathematics competence that should not be ignored e.g. grade 7 mathematics competence depends strongly on grade 5 competence.

Of the above mentioned variables the current study did not include cognitive ability in the study as a control variable because, as described in chapter 3, the mathematics competence test was developed to measure the two dimensions: mathematics ability and cognitive ability

Table 4.1. shows the multiple regressions of teachers' background variables and teacher effectiveness factors			
Predicted variables	Predictor variables		
	Female	Years of experience	Age
Deep learning		+	
Constructivist instruction			
Transmissive instruction		+	
Lesson planning	+		
Creating interest in learning	+		-
Individual needs of students			
Professional collaboration		-	
Exchange and coordination for teaching		-	+
Professional training			+
Job stress	-		
Extrinsic motivation			+
Missing identification with job			
Stress in planning and classroom			
Cooperative learning		-	+
Student engagement			
Cognitive activation	+		
Cognitive challenging tasks			-
Differentiation		-	
Note: "+" sign indicates the positive significant association, "-" sign indicates the negative significant association and blanks show no association. Significance was tested at 5% level.			

(Schnittjer & Duchhardt, 2015). Therefore, cognitive ability is already part of the MC5 score. Moreover, the current study has assumed that factors like student gender, socio-economic status (SES) and migration background already has an influence in the students' MC5. Therefore, only MC5 and school type were included as control variables in the study. This balanced selection of the control variables would help to not overestimate or under estimate the effect of teacher factors on students' grade 7 mathematics competence. A multiple linear regression analysis was performed using both control variables to see if both variables predict grade 7 mathematics competence and should be included in the analysis or not. The results from the analysis are given in the table 4.2. It is important to note that the significance level of regression coefficients and correlations is set to (*p < .05) for all the analysis provided in this chapter and in order to see the effect size see R^2 value.

Table 4.2. Linear regression analysis predicting grade 7 mathematics competence (MC7) from MC5 and school type

	B	SE	β
MC5	0.75*	0.03	0.70*
School type	0.03	0.02	0.11
R^2	0.58		

The total sample for this analysis was 151 teachers and their 1706 respective students. The results showed that MC5 is a strong predictor of grade 7 mathematics competence (β = .70), however, school type does not predict mathematics competence significantly (β = .11). The school type was categorized on the basis of the academic level of each school track: the lower secondary school was assigned the value of 1 and grammar school was assigned the value of 5. On the basis of these results, only mathematics competence grade 5 was included as a control variable in the following analysis. A linear regression was performed to measure how much variance in grade 7 mathematics competence is explained by MC5 and found that it explained 56% of the total variance. The results are shown in table 4.3. The total sample for this analysis was 151 teachers and their 1706 respective students.

The data shows that (see table 4.4) most of the intercorrelations between teacher and instructional factors are not correlated or weakly correlated, having a correlation ranging from (r = .00 to r = .18). Deep learning has a moderate and significant correlation with *lesson planning* (r = 50) and direct instruction (r = 42). The moderate correlation with *lesson planning* is theoretically supported because *lesson planning* is important for the deep learning of students. However, the correlation with direct instruction is unexpected because deep learning requires the direct involvement of students in learning and the role of the learner is not passive as the in direct instruction. *Lesson planning* has a weak correlation with teacher factors except *creating interest in learning* with which it has a moderate correlation of (r = .45). This is because *creating interest in learning* is a component of *lesson planning*; therefore, the teachers who do *lesson planning* also consider *creating interest in learning* in their lessons. Teacher cooperation sub-factors *professional collaboration* and *exchange and coordination for teaching* have a high correlation of (r= .69) as both belong to the same factor of teacher cooperation.

Some of the instructional factors like student engagement, cognitive challenging tasks, and *cooperative learning* have moderately significant correlations around (r =.40) because they all have a similar theoretical basis of "learning as construction of knowledge", however, the moderate correlations show that all factors are measuring different dimensions of teacher effectiveness. In general, the correlations between both teacher factors and instructional factors are weak to moderate which shows that multicollinearity is not a problem for the analysis of the current study.

Table 4.3. Linear regression analysis predicting MC7 from MC5

	B	SE	β
MC5	0.80*	0.03	0.75*
R^2	0.56		

4.1. Research Question 1

Which teacher factors predict mathematics competence development of secondary school students?

Table 4.4. Intercorrelations for teacher factors and instructional factors

	DL	CoI	DI	LP	CI	IN	SPC	MI	JS	EM	PC	ECT	PT	CL	SE	CA	CCT	DIF
DL	1																	
CoI	.01	1																
DI	.42	-.13	1															
LP	.50*	.02	.34	1														
CI	.30*	.27*	.02	.45*	1													
IN	.07	.21	.05	.21*	.33*	1												
SPC	.15	.13	.01	.07	.11	.09	1											
MI	.27	.15	.02	.15	.35*	.16	.10*	1										
JS	.00	.16	.05	.00	.10	.20	.16	.29*	1									
EM	.06	-.12	.20	.00	-.12	-.02	-.17	.11	.13	1								
PC	.07	-.03	.11	.06	.04	.19	.08	.08	.29	.25*	1							
ECT	.02	.07	.02	.15	.05	.20	.20*	.16	.15	.11	.69*	1						
PT	.01	-.08	.04	.08	.02	.09	.10	.07	.07	.20	.00	.02	1					
CL	.03	.21*	.10	.20	.09	-.01	.18	.29*	.15	.04	.09	.38	-.13	1				
SE	.20	.24*	.01	.24*	.19	.08	.03	.25*	.04	.06	.05	.21	.10	.44	1			
CA	.29*	.22	.18	.43*	.31*	.09	.10	.24*	.01	.11	.08	.21	.26	.42*	.38*	1		
CCT	.19	.28*	.08	.34*	.25*	.10	.20	.30*	.23	.00	.07	.15	.07	.39	.29*	.62*	1	
DIF	.06	.18	.23*	.09	-.13	.00	.03	.03	.17	.02	.14	.41	-.11	.40*	.14	.16	.18	1

Note: Deep learning (DL), Constructivist instruction (CoI), Transmissive instruction (DI), Lesson planning (LP), Creating interest in learning (CI), Individual needs of students (IN), Stress in planning and classroom (SPC), Missing identification with job (MI), Job Stress (JS), Extrinsic motivation for job (EM), Professional collaboration (PC), Exchange and coordination for teaching (ECT), Professional training (PT), Cooperative learning (CL), Student engagement (SE), Cognitive activation (CA), Cognitively challenging tasks (CCT), Differentiation (DIF)

This research question was analyzed by applying linear regression on each factor of teacher effectiveness, if the factors turned out as a significant predictor of student mathematics competence, multiple regression was applied by controlling for previous mathematics competence and if the factor still predicted student mathematics competence significantly then it was included in the analyses of further research questions.

4.1.1. Hypothesis 1

Teachers' positive *belief about deep learning* predict the students' grade 7 mathematics competence

Table 4.5. Linear regression analysis predicting MC7 from deep learning

	B	SE	β
Deep learning	0.23*	0.06	0.16*
R^2	0.02		

Hypothesis 1 is based on the assumption that if a teacher believes in deep learning or the development of in-depth knowledge among students it would have positive effect on student mathematics competence. Table 4.5 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1654 respective students. The result showed that positive *belief about deep learning* has a small but significant effect (β = .16) on students' MC7. *Teacher belief about deep learning* explained the total variance of 2%. In the next step, multiple linear regression was performed to control the students' grade 5 mathematics competence (MC5) in the model in order to see whether *belief about deep learning* still predicted MC7 after adding MC5. The results are presented in table 4.6. The total sample for this analysis was 151 teachers and their 1706 respective students. It can be seen that after having such a strong predictor of MC5, the deep learning regression coefficient went down (β from .23 to .08), however, it is still significant. Both the variables together explained 57%

of the total variance. The MC5 alone explained 56% of the total variance; therefore deep learning explained 1% of the total variance.

Table 4.6. Multiple regression analysis predicting MC7 from belief about deep learning and MC5

	B	SE	β
Deep learning	0.08*	0.03	0.06*
MC5	0.79*	0.02	0.74*
R^2	0.57		

4.1.2. Hypothesis 2

Teachers' positive *belief about constructivist instruction* positively predicts students' mathematics competence

Table 4.7. Linear regression analysis predicting MC7 from belief about constructivist instruction

	B	SE	β
Constructivist instruction	-0.05	0.05	-0.05
R^2	0.00		

The hypothesis 2 is based on the assumption that teachers' positive *belief about constructivist instruction* positively predicts students' mathematics competence. Table 4.7 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1657 respective students. The results show that the positive *belief about constructivist instruction* of teaching did not predict students' mathematics competence (β = -0.05), therefore, the hypothesis is rejected. The factor *constructivist belief* is excluded from further analysis.

4.1.3. Hypothesis 3

Teachers' positive *belief about transmissive instruction* positively predicts the students' mathematics competence

Hypothesis 3 is based on the assumption that positive *belief about transmissive instruction* positively predicts students' mathematics

Table 4.8. Linear regression analysis predicting MC7 from beliefs about transmissive instruction

	B	SE	β
Direct instruction	0.09	0.05	0.09
R^2	0.01		

competence. The results are shown in table 4.8 from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1642 respective students. The result showed that direct instruction did not predict students' mathematics competence (β = 0.09). The factor *belief about transmissive instruction* is excluded from further analysis.

Table 4.9. Linear regression analysis predicting MC7 from missing identification with job

	B	SE	β
Missing identification with job	0.00	0.08	0.01
R^2	0.00		

4.1.4. Hypothesis 4

Teachers' *missing identification with job* negatively predicts students' mathematics competence

Hypothesis 4 is based on the assumption that if a teachers' missing identification with their job negatively predicts students' mathematics competence. Table 4.9 shows the results from the linear regression analysis regarding this hypothesis. The result showed that a lack of identification with the job did not predict students' mathematics competence (β = .01), therefore, the hypothesis is rejected. The factor *missing* *identification with job* is excluded from further analysis. The total sample for this analysis was 148 teachers and their 1601 respective students.

4.1.5. Hypothesis 5

Teachers' *job stress* negatively predicts the students' mathematics competence

Table 4.10. Linear regression analysis predicting MC7 from job stress

	B	SE	*β*
Job stress	-0.01	0.01	-0.04
R^2	0.00		

Hypothesis 5 is based on the assumption that if teachers have stress in their job this would negatively predict students' mathematics competence. Table 4.10 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 150 teachers and their 1620 respective students. The result showed that *job stress* did not predict students' mathematics competence significantly (β = -.04), therefore, the hypothesis is rejected. The factor *job stress* is excluded from further analysis.

4.1.6. Hypothesis 6

Teachers' high *extrinsic motivation* for the job positively predicts the students' mathematics competence

Table 4.11. Linear regression analysis predicting MC7 from extrinsic motivation of job

	B	SE	*β*
Extrinsic motivation	0.00	0.08	0.01
R^2	0.01		

Hypothesis 6 is based on the assumption that high *extrinsic motivation* in teachers positively predicts students' mathematics competence. The total sample for this analysis was 150 teachers and their 1630 respective students. Table 4.11 shows the results from the linear regression analysis regarding this hypothesis. The result showed that *extrinsic motivation* did not predict students' mathematics competence (β = 0.01), therefore, the hypothesis is rejected. The factor *extrinsic motivation* for job is excluded from further analysis.

4.1.7. Hypothesis 7

Teachers' consideration of the *individual needs of students* while planning positively predicts the students' mathematics competence

The hypothesis 7 assumed that if a teacher considers the *individual needs of students* while planning it positively predicts students' mathematics competence. Table 4.12 shows the results from the linear

Table 4.12. Linear regression analysis predicting MC7 from individual needs of students

	B	SE	β
Individual needs of students'	-0.26	0.06	-0.20
R^2	0.04		

regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1660 respective students. The results showed that considering the *individual needs of students* significantly but negatively affect the students' mathematics competence (β = -.20). The *individual needs of students* explained total variance of 4%. In the next step, multiple linear regression was performed by controlling for students' MC5 in order to see whether it still predicts MC7 after adding grade MC5. The results are presented in the table 4.13. The total sample for this analysis was 151 teachers and their 1706 respective students. It can be seen that after having such a strong predictor of MC5, the *individual needs of students* regression coefficient went down (from -.20 to -.08), however, it is still significant. Both the variables together explained

57% of the total variance, however, most of the variance is explained by the MC5, as MC5 alone explained 56% of the variance (see table 4.3) and *individual needs of students* explained 1% of the total variance.

Table 4.13. Multiple regression analysis predicting MC7 from individual needs of students and MC5

	B	SE	β
Individual needs of students'	-.08*	0.02	-0.06*
MC5	0.78	0.02	0.74
R^2	0.57		

4.1.8. Hypothesis 8

Teachers' *lesson planning* positively predicts the students' mathematics competence

Hypothesis 8 is based on the assumption that *lesson planning* positively predicts students' mathematics competence. Table 4.14 shows

Table 4.14. Linear regression analysis predicting MC7 from lesson planning

	B	SE	β
Lesson planning	0.01	0.04	0.03
R^2	0.00		

the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1660 respective students. The results show that *lesson planning* did not predict students' mathematics competence (β = 0.03), therefore, the hypothesis is rejected. The *lesson planning* factor is excluded from further analysis.

4.1.9. Hypothesis 9

Teachers' focus on *creating interest in learning* while planning predicts the students' mathematics competence

Table 4.15. Linear regression analysis predicting MC7 from creating interest in learning

	B	SE	*β*
Creating interest in learning	-0.11	0.08	-0.07
R^2	0.00		

Hypothesis 9 is based on the assumption that *creating interest in learning* positively predicts students' mathematics competence. Table 4.15 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1656 respective students. The results showed that *creating interest in learning* did not predict students' mathematics competence (β = 0.03), therefore, the hypothesis is rejected. The factor *creating interest in learning* is excluded from further analysis.

4.1.10. Hypothesis 10

Teachers' professional collaboration with other teachers positively predicts students' mathematics competence

Hypothesis 10 is based on the assumption that teachers' professional

Table 4.16. Linear regression analysis predicting MC7 from professional collaboration

	B	SE	*β*
Professional collaboration	-0.06*	0.01	-0.20*
R^2	0.04		

collaboration positively predicts students' mathematics competence. Table 4.16 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 149 teachers and their 1617 respective students. The results showed that professional collaboration has a significant but negative effect on students' mathematics competence (β = -.20). Professional collaboration explained 4% of the total variance. In the next step, multiple linear regression was performed by adding the students' MC5 in the model in order to see whether it still predicts MC7 after adding grade MC5. The results are presented in table 4.17. The total sample for this analysis was 151 teachers and their 1706 respective students. It can be seen that after having such a strong predictor of MC5, the regression coefficient of professional collaboration went down (β = -.06), however, it is still significant. Both the variables together explained 57% of the total variance, however, most of the variance is explained by the MC5 (β = .78*).

Table 4.17. Multiple regression analysis predicting MC7 from professional collaboration and MC5

	B	SE	β
Professional collaboration	-0.02*	0.00	-0.06*
MC5	0.78*	0.02	0.74
R^2	0.57		

4.1.11. Hypothesis 11

Teachers' *exchange and coordination for teaching* in the activities with other teachers positively predicts the students' mathematics competence

Table 4.18. Linear regression analysis predicting MC7 from exchange and coordination for teaching

	B	SE	β
Exchange and coordination for teaching	-0.10*	0.02	-0.17*
R^2	0.03		

Hypothesis 11 is based on the assumption that teachers' *exchange and coordination for teaching* positively predicts students' mathematics competence. Table 4.18 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 151 teachers and their 1647 respective students. The results showed that *exchange and coordination for teaching* has a significant but negative effect on students' mathematics competence (β = -.17). *Exchange and* *coordination for teaching* explained 3% of the total variance. Next, a multiple linear regression was performed by adding the students' MC5 in the model in order to see whether it still predict MC7 after adding the MC5 grade. The results from the multiple linear regression are presented in table 4.19. The total sample for this analysis was 151 teachers and their 1706 respective students. The results show the regression coefficient of *exchange and coordination for teaching* went down (β = -.06), however, it is still significant. Both the variables together explained 57% of the total variance. 56% of the variance is explained by MC5 (see table 4.2) and 1% by teachers' *exchange and coordination for teaching*.

Table 4.19. Multiple regression analysis predicting MC7 from exchange and coordination for teaching and MC5

	B	SE	β
Exchange and coordination for teaching	-0.03*	0.01	-0.06*
MC5	0.79	0.02	0.74
R^2	0.57		

4.1.12. Hypothesis 12

Teachers' *stress in planning and classroom* predicts the students' mathematics competence

Table 4.20. Linear regression analysis predicting MC7 from stress in planning and classroom

	B	SE	β
Stress in planning and classroom	-0.16*	0.08	-0.11*
R^2	0.01		

Hypothesis 12 is based on the assumption that *stress in planning and classroom* would result in negative effect on students' MC7. Table 4.20 shows the result from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 150 teachers and their 1631 respective students. The results showed that stress in planning and classroom has a significantly negative effect on students' mathematics competence (β = .11). The factor explained 1% the total variance at the significance level of ($p < .10$). In the next step, multiple linear regression was performed by controlling for MC5 to see whether it still predicts MC7 after adding grade MC5. The results from multiple linear regression are presented in table 4.21. The total sample for this analysis was 151 teachers and their 1706 respective students. The results shows that after having such a strong predictor of MC5, the regression coefficient of *stress in planning and classroom* went down (β = -.06); however, it is still significant and negative. Both the variables together explained 57% of the total variance, from which 1% is explained by *stress in planning and classroom*.

Table 4.21. Multiple regression analysis predicting MC7 from stress in planning and classroom and MC5

	B	SE	β
Stress in planning and classroom	-0.04*	0.01	-0.06*
MC5	0.79*	0.02	0.74*
R^2	0.57		

4.1.13. Hypothesis 13

Teachers' *professional training* predicts the students' mathematics competence

Table 4.22. Linear regression analysis predicting MC7 from professional training

	B	SE	β
Professional training	0.05	0.08	0.03
R^2	0.00		

Hypothesis 13 is based on the assumption that teachers' professional training positively predicts students' mathematics competence. Table 4.22 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 147 teachers and their 1573 respective students. The results show that teachers' professional training does not predict students' mathematics competence (β = 0.03), therefore, the hypothesis is rejected. The factor professional training is excluded from further analysis.

4.2. Research Question 2

Which instructional factors predict mathematics competence of secondary school students?

On the basis of the theoretical framework provided in chapter 2, it was assumed that instructional quality has a positive effect on students' mathematics competence. The following hypotheses were designed to measure how instructional quality factors effects students' mathematics competence.

4.2.1. Hypothesis 14

The teachers' use of *cooperative learning* during instruction positively predicts students' mathematics competence

Table 4.23. Linear regression analysis predicting MC7 from cooperative learning

	B	SE	β
Cooperative learning	-0.00	0.01	-0.01
R^2	0.00		

Hypothesis 14 is based on the assumption that *cooperative learning* processes positively affect students' mathematics competence. Table 4.23 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 148 teachers and their 1580 respective students. The result shows that *cooperative learning* activities did not predict students' mathematics competence (β = -0.01), therefore, the hypothesis is rejected. The factor *cooperative learning* is excluded from further analysis.

4.2.2. Hypothesis 15

Student engagement in the classroom predicts students' mathematics competence

Table 4.24. Linear regression analysis predicting MC7 from student engagement

	B	SE	β
Student engagement	0.09*	0.03	0.16*
R^2	0.02		

Hypothesis 15 is based on the assumption that teachers' use of student engagement during instruction positively predicts students' mathematics competence. The total sample for this analysis was 148 teachers and their 1582 respective students. The results showed that *student engagement* has a significant effect on students' mathematics competence (β = .16, p < .001). The factor explained 2% of the total variance at the significance level of (p < .05). In the next step, multiple linear regression was performed by adding the students' (MC5) in the model in order to see whether it still predicted MC7 after adding grade MC5. The results from the multiple linear regression are presented in the table 4.25. The total sample for this analysis was 151 teachers and their 1706 respective students. The results show that the regression coefficient of *student engagement* went down (β = .06), however, it is still significant (p < 0.01). Both the variables together explained 57% of the total variance, however, 56% of the variance is explained by MC5 alone (see table 4.3) and, therefore, *student engagement* explained 1% of the total variance.

Table 4.25. Multiple regression analysis predicting MC7 from Student engagement and MC5

	B	SE	β
Student engagement	0.03*	0.01	0.06*
MC5	0.79*	0.02	0.74
R^2	0.57		

4.2.3. Hypothesis 16

Teachers' use of *cognitive activation* in the classroom predicts students' mathematics competence

Table 4.26. Linear regression analysis predicting MC7 from cognitive activation

	B	SE	β
Cognitive activation	0.04	0.02	0.10*
R^2	0.01		

Hypothesis 16 is based on the assumption that cognitively activating students during instruction positively predict students' mathematics competence. Table 4.26 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 148 teachers and their 1578 respective students. The results show that *cognitive activation* weakly predict students' mathematics competence (β = .10), therefore, the hypothesis is accepted. A multiple linear regression was performed by adding the students' MC5 in the model in order to see whether it still predicts MC7 after adding grade MC5. The results from the multiple linear regression are presented in table 4.29. The total sample for this analysis was 151 teachers and their 1706 respective students. The results show that the regression coefficient of *cognitive activation* went down (β = .02) and is no longer significant. Both the variables together explained 57% of the total variance, which shows even after controlling for MC5, *cognitive activation* explained 1% of the total variance.

Table 4.27. Linear regression analysis predicting MC7 from cognitive activation and MC5

	B	SE	β
Cognitive activation	0.01	0.01	0.03
MC5	0.79*	0.02	0.75*
R^2	0.57		

4.2.4. Hypothesis 17

Teachers' use of *cognitively challenging tasks* in students' assignments predicts students' mathematics competence

Table 4.28. Multiple regression analysis predicting MC7 from cognitively challenging task

	B	SE	β
Cognitively challenging tasks	0.09*	0.02	0.19*
R^2	0.03		

Hypothesis 17 is based on the assumption that assigning *cognitively challenging tasks* in classroom positively predicts students' mathematics competence. Table 4.28 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 148 teachers and their 1582 respective students. The result shows that *cognitively challenging tasks* have a significant effect on students' mathematics competence (β = .19), therefore, the hypothesis is accepted. *Cognitively challenging tasks* also explain 3% of the total variance. Therefore, a multiple linear regression was performed by adding the students' MC5 in the model in order to see whether it still predict MC7 after adding grade MC5. The results from the multiple linear regression are presented in the table 4.29. The total sample for this analysis was 151 teachers and their 1706 respective students. The results show that the regression coefficient for *cognitively challenging tasks* went down (β = .02) and is no longer significant. Both the variables together explained 57% of the total variance and *cognitively challenging tasks* explained 1% of the total variance.

Table 4.29. Multiple regression analysis predicting MC7 from cognitively challenging tasks and MC5

	B	SE	β
Cognitively challenging tasks	0.01*	0.01	0.02
MC5	0.79*	0.02	0.75*
R^2	0.57		

4.2.5. Hypothesis 18

Teachers' who apply *differentiation* during carrying out lessons positively predicts students' mathematics competence

Table 4.30. Linear regression analysis predicting MC7 from differentiation

	B	SE	*β*
Differentiation	-0.05*	0.02	-0.10*
R^2	0.01		

Hypothesis 18 is based on the assumption that usage of adaptive instruction in classroom has a positive effect on students' mathematics competence. Table 4.30 shows the results from the linear regression analysis regarding this hypothesis. The total sample for this analysis was 148 teachers and their 1578 respective students. The results show that *differentiation* has a weak effect on students' mathematics competence (β = -.10, $p < 0.05$) in fact, it has a negative effect. However, *differentiation* explained 1% of the total variance. Therefore, a multiple linear regression was performed by adding the students' MC5 in the model in order to see whether it still predicts MC7 after adding grade MC5. The results from the multiple linear regression are presented in table 4.31. The total sample for this analysis was 151 teachers and their 1706 respective students. The results show that the regression coefficient *cognitively challenging tasks* went down (β = -.03) and is no longer significant. Both the variables together explained 57% of the total variance and *differentiation* explained 1% of the total variance.

Table 4.31. Linear regression analysis predicting MC7 from differentiation and MC5

	B	SE	*β*
Differentiation	-0.02	0.02	-0.10
MC5	0.79	0.01	0.75*
R^2	0.57		

4.3. Research question 3

What combination of teacher and instructional factors best predict mathematics competence of secondary school students?

This question was analyzed by a performing multiple regressions analysis on teacher and instructional factors to see the effect of these factors on mathematics competence. The multiple regression analysis was performed by controlling students' MC5 in order to see how strongly teacher and instructional factors predict students' mathematics competence. The hypotheses underlying this research question are as follows.

4.3.1. Hypothesis 19

Which combination of teacher factors predicts students' grade 7 mathematics competence?

Table 4.32. Multiple regression analysis predicting MC7 from teacher factors

	B	SE	β
Deep learning	0.25*	0.06	0.18*
Individual needs of students	-0.21*	0.06	-0.16*
Professional collaboration	-0.04	0.02	-0.13*
Exchange and coordination for teaching	0.00	0.03	0.00
Stress in planning and classroom	-0.09	0.02	-0.13*
R^2	0.11		

These hypotheses were analyzed by carrying out a multiple linear regression analysis. The analysis shows which combination of teacher factors predict MC7 and how much variance is explained by these teacher factors. Only those teacher factors are included in this analysis that significantly predicted MC7 in the previous linear regression analyses.

The results are shown in table 4.32. The total sample for this analysis was 151 teachers and their 1660 respective students. Some of the teacher factors significantly predict mathematics competence. These are teachers' positive *belief about deep learning* which has a regression coefficient of β = .18, followed by *individual needs of students* (β = -.16), followed by *professional collaboration* (β = -.13), then *stress in planning and classroom* (β = -.13). *Exchange and coordination for teaching* was significant in the linear regression results but is no longer significant in multiple linear regression (β = 0.00). The results showed that a positive *belief about deep learning* positively predicts MC7 which is in line with what was expected from previous literature. However, for the other factors this is not the case. The factors like *individual needs of students* and *professional collaboration* were expected to have positive effect on MC7 but they showed significant negative effect. *Stress in planning and classroom* has a negative effect on MC7 according to the expectations. It was an exploratory analysis based on the assumption that stress during teaching activities (planning and classroom) might indicate teachers' low teaching skills. The combination of teacher factors together explained 11% of the total variance which suggests these teacher factors are important. Moreover, it also seems that distal indicators of teachers' effectiveness are important predictors of students' mathematics competence.

4.3.2. Hypothesis 20

Which combination of instructional factors predicts students' MC7?

The analysis shows which combination of instructional factors predicts MC7 and how much variance is explained by the instructional factors. Only those instructional factors are included in this analysis that significantly predicted MC7 in the previous linear regression analyses.

The results show, in table 4.33., that some of the instructional factors significantly predicted mathematics competence. The total sample for this analysis was 148 teachers and their 1583 respective students. *Student engagement* positively predicted MC7 recording a regression coefficient of $\beta = .15$ followed by *cognitively challenging tasks* ($\beta = .18$) and differentiation ($\beta = -.10$). However, *cognitive activation* no longer showed significant results. *Cognitively challenging tasks* showed significant effects on MC7 and confirmed the theoretical assumption. However, *differentiation* has shown a negative effect which was not expected on the basis of previous literature. In total, the teachers' factors explained 6% of the total variance in MC7. This shows teachers' actual instruction in the classroom significantly predict MC7, however, the literature suggested that instructional factors (proximal indicators) would explain more variance than general teacher factors (distal indicators). This is not confirmed from the results of the current study. As can be seen in table 4.32 and 4.33 distal indicators explained more variance than proximal indicators.

Table 4.33. Multiple regression analysis predicting MC7 from instructional factors

	B	SE	β
Student engagement	0.09*	0.03	0.15*
Cognitive activation	-0.03	0.02	-0.07
Cognitively challenging tasks	0.09*	0.02	0.18*
Differentiation	-0.05*	0.02	-0.10*
R^2	0.06		

4.3.3. Hypothesis 21

How much variance in MC7 is explained by the combination of teacher factors and instructional factors?

The hypothesis 21 was analyzed by carrying out a multiple linear regression analysis in order to see how much variance is explained together by teacher and instructional factors. Only those teacher factors are included in this analysis that significantly predicted MC7 in the previous multiple regression analyses (hypothesis 19 and 20). The total sample for this analysis was 151 teacher and their 1667 respective students. The results are shown in table 4.34. The results showed that both teacher and instructional factors together explain 16% of the total variance. This shows teacher factors and instructional factors are important predictors of students' mathematics competence. However, the question is, do these factors predict MC7, when the MC5 is controlled for.

Table 4.34. Multiple regression analysis predicting MC7 from teacher and instructional factors

	B	SE	β
Deep learning	0.25*	0.06	0.18*
Individual needs of students	-0.21*	0.05	-0.16
Professional collaboration	-0.04*	0.02	-0.13*
Stress in planning and classroom	-0.09*	0.02	-0.13
Student engagement	0.09*	0.03	0.15*
Cognitive activation	-0.03	0.02	-0.07
Cognitively challenging tasks	0.09	0.02	0.18
Differentiation	-0.05*	0.02	-0.10*
R^2	0.16		

4.3.4. Hypothesis 22

Do teacher and instructional factor explain the variance when MC5 is controlled for

In hypothesis 22 multiple regression was performed to predict MC7 from teacher factors, instructional factors and MC5 in order to see if teacher and instructional factors still have an effect on student MC7 when MC5 is controlled for. The results are shown in table 4.35. The total sample for this analysis was 151 teachers and their 1706 respective students. The regression coefficients of most of the factors became insignificant except *deep learning, individual needs of students, stress in planning and classroom* and *student engagement.* Hence teacher factors (distal indicators) are stronger predictors of MC7 in comparison to instructional factors (proximal indicators). The total variance explained is 59% from which 56% is explained by MC5 (see table 4.3). This shows that only a relatively small amount of variance is explained by teacher and instructional factors when MC5 is controlled for.

Deep learning (β= .10*) and *student engagement* (β = .03*) have a significant positive effect while *stress in planning and classroom* has a negative effect (β = -.14*). The later was predicted to have negative effect. However, *individual needs of students* has a negative effect too, contrary to expectations (β = -.14). If a teacher

Table 4.35. Multiple regression analysis predicting MC7 from teacher factors, instructional factors and MC5

	B	SE	β
Deep learning	0.10*	0.03	0.07*
Individual needs of students	-0.06*	0.03	-0.05*
Professional collaboration	-0.01	0.01	-0.04*
Stress in planning and classroom	-0.14*	0.01	-0.06*
Student engagement	0.03*	0.01	0.05*
Cognitive activation	0.00	0.01	-0.01
Cognitively challenging tasks	-0.00	0.01	-0.00
Differentiation	-0.02	0.01	-0.04*
MC5	0.76*	0.02	0.71*
R^2	0.59		

reported that he takes care of *individual needs of students,* it showed negative effect on MC7. The scatter plot is presented (see figure 2) in order to see the relationship between teachers' score on considering *individual needs of students* scale and the difference between students grade 5 and grade 7 mathematics competence. The figure shows that there is no linear trend between both variables. However, the students' mathematics competence difference between MC5 and MC7 was always positive (i.e. above 0 and with a mean above 0) when their teachers scored lowest on the individual needs scale (a score of 4). If the teacher scored 5 the mean is still above 0, but the difference between both grades' competence is below 0 for few number of students. If the teacher scored higher (from 6 to 8) on the individual needs scale the students' competence difference has a general trend of a mean of 0 and their students scored both below and above 0. The trend is clearer in the line graph (see figure. 3). The higher a teacher scored on individual needs the lower is the students' mathematics competence growth (from grade 5 to 7). However, the relationship is probably not a cause-effect relationship between *individual needs of students* and student mathematics competence growth. It could be the other way around, i.e. the teacher takes care of the individual needs of those students who are less competent in mathematics.

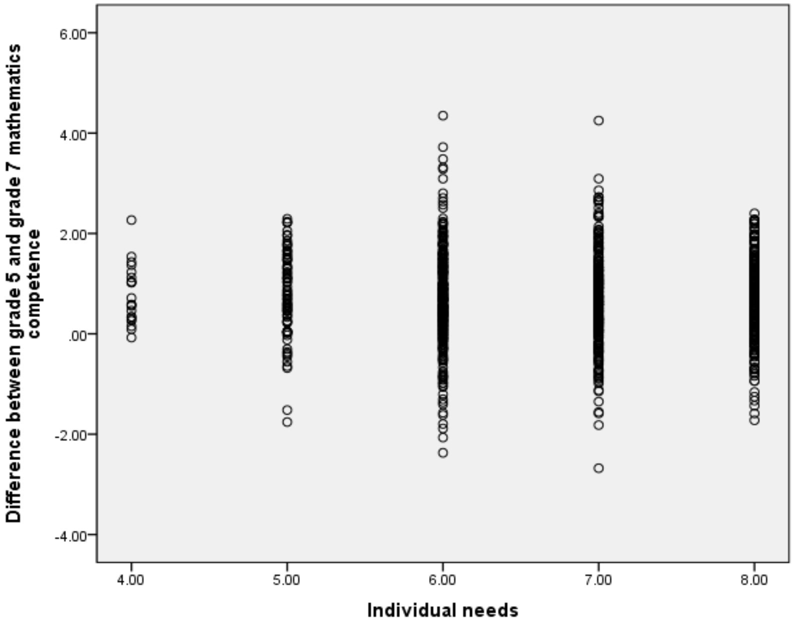

Figure 2 showing teachers' score on individual needs scale and the difference between students' competence from grade 5 to grade 7.

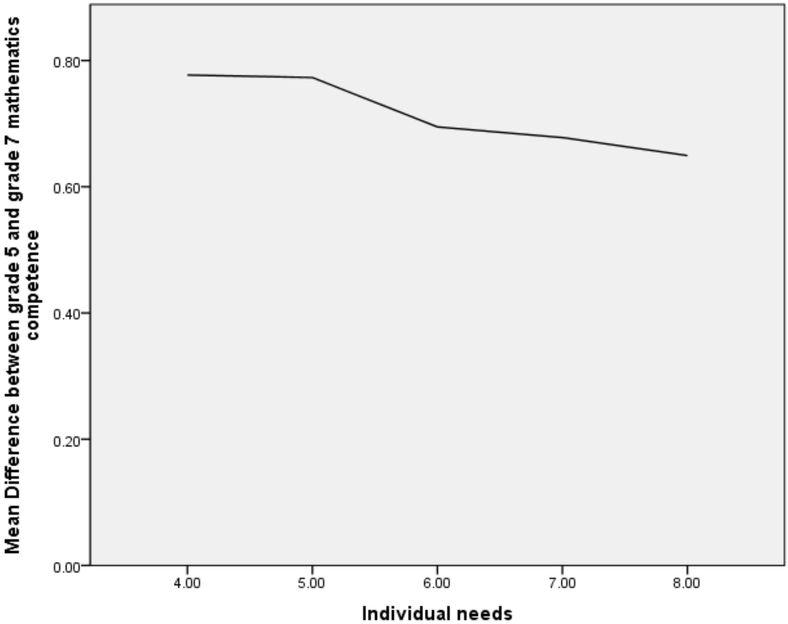

Figure 3 showing teachers' score on individual needs scale and the difference between students' competence from grade 5 to grade 7.

4.4. Research question 4

Do teachers in different school tracks vary in effectiveness?

A multi-group analysis was performed in Mplus 7.11 to investigate this research question. Multiple regression was performed on all the teacher and instructional factors along with MC5 on 5 school types including lower secondary school, middle secondary school, multi-track school, comprehensive school and grammar school. The purpose of the analysis was to see if teachers in different school tracks vary in effectiveness. The aim was to measure if students from any of these school types are at a disadvantage with regard to their teachers' effectiveness. The descriptive statistics (sample size, mean and standard deviations) of each school type teachers are given in chapter 3 (see table 3.25, 3.26, 3.27, 3.28 and 3.29). The analysis was performed by controlling students' MC5.

The results from the lower secondary schools are shown in table 4.36. It can be seen in the results that none of the teachers' factors significantly predicted student MC7. This shows that teachers and instructional factors have no effect on student competence and the students' own competence is the sole significant predictor of their future competence. The results from the middle secondary schools are shown in table 4.37. It can be seen in the results that like lower secondary school, in middle secondary school none of the teacher and instructional factors significantly predicted MC7. MC5 alone explained 49% of the total variance. From these results we can say that students own competence is the sole predictor of their future competence and

teacher and teaching factors do not play much role in middle secondary schools.

Table 4.36. Multiple regression analysis predicting MC7 from teacher and instructional factors and MC5 in lower secondary school

	B	SE	β
MC5	0.64*	0.14	0.62*
Deep learning	0.05	0.25	0.04
Individual needs of students	0.09	0.14	0.09
Professional collaboration	-0.07	0.05	-0.34
Exchange and coordination for teaching	0.19	.15	0.36
Stress in planning and classroom	-0.00	.10	-0.01
Student engagement	0.02	.09	0.06
Cognitive activation	-0.06	.07	-0.16
Cognitively challenging tasks	0.03	.08	0.07
Differentiation	-0.07	.10	-0.18
R^2	0.67		

The results from the multi-track schools are shown in table 4.38. It can be seen from the results that in multi-track schools, among all teacher

Table 4.37. Multiple regression analysis predicting MC7 from teacher and instructional factors and MC5 in middle secondary school

	B	SE	β
MC5	0.65*	0.10	0.61*
Deep learning	-0.02	0.10	-0.02
Individual needs of students	-0.01	0.11	-0.01
Professional collaboration	-0.01	0.04	-0.06
Exchange and coordination for teaching	0.07	0.09	0.03
Stress in planning and classroom	0.02	0.07	0.03
Student engagement	0.03	0.06	0.07
Cognitive activation	0.03	0.06	0.09
Cognitively challenging tasks	0.07	0.06	0.16
Differentiation	-0.05	0.05	0.13
R^2	0.49		

and instructional factors, *student engagement* is the sole significant predictor of mathematics competence. The variance explained by previous mathematics competence is lower than in other school tracks but still is a strong predictor.

Table 4.38. Multiple regression analysis predicting MC7 from teacher and instructional factors and MC5 in multi-track school

	B	SE	β
MC5	0.39*	0.12	0.35*
Deep learning	0.02	0.14	0.02
Individual needs of students	0.05	0.13	0.05
Professional collaboration	-0.08	0.05	-0.35
Exchange and coordination for teaching	0.06	0.08	0.14
Stress in planning and classroom	0.07	0.09	0.12
Student engagement	0.13*	0.05	0.28*
Cognitive activation	0.10	0.06	0.27
Cognitively challenging tasks	0.07	0.06	0.18
Differentiation	-0.02	0.06	-0.04
R^2	0.53		

The results from the comprehensive schools are shown in table 4.39. It can be seen that in multi-track schools, *student engagement* is the only significant predictor ofMC7 among teacher and instructional factors.

Table 4.39. Multiple regression analysis predicting MC7 from teacher and instructional factors and MC5 in comprehensive school

	B	SE	*β*
MC5	0.70*	0.08	0.69*
Deep learning	0.00	0.07	0.00
Individual needs of students	-0.05	0.06	-0.05
Professional collaboration	-0.01	0.02	-0.08
Exchange and coordination for teaching	-0.04	0.05	-0.09
Stress in planning and classroom	0.00	0.04	0.01
Student engagement	0.00	0.03	0.01
Cognitive activation	0.00	0.04	0.00
Cognitively challenging tasks	-0.03	0.03	-0.08
Differentiation	0.00	0.03	0.00
R^2	0.50		

The results from the grammar schools are shown in table 4.40. It can be seen from the results that the regression coefficients of most of the teacher and instructional factors do not significantly predict MC7. The only significant predictor among teacher and instructional factors is *stress in planning and classroom which showed negative effect as expected*. This might indicate that grammar school teachers might lack in teaching skills therefore, they face stress in teaching activities, however, the study did not explore the reason of the *stress in planning and classroom*. Again MC5 has a strong effect on MC7 (β = .67). The factors together explained 52% of the total variance.

Table 4.40. Multiple regression analysis predicting MC7 from teacher and instructional factors and MC5 in the grammar school

	B	SE	β
MC5	0.73*	0.07	0.67*
Deep learning	0.06	0.08	0.05
Individual needs of students	-0.11	0.07	-0.11
Professional collaboration	0.03	0.02	0.11
Exchange and coordination for teaching	-0.00	0.06	-0.01
Stress in planning and classroom	-0.08*	0.04	-0.16*
Student engagement	0.03	0.04	0.07
Cognitive activation	0.02	0.03	0.07
Cognitively challenging tasks	-0.05	0.04	-0.14
Differentiation	-0.04	0.03	-0.10
R^2	0.49		

Chapter 5

Discussion

In this chapter, the main findings of the study are summarized and later the findings from each research question are interpreted and discussed. The limitations and implications of the study are also discussed and recommendations for future research given.

5.1. Summary

The current study is conducted using longitudinal large scale assessment data collected by NEPS. The current study is longitudinal and correlational in nature. The study measured the impact of teacher effectiveness on students' mathematics competence. It is assumed that in order to measure the effect of teacher effectiveness on students' competence, it is important that the teachers taught their students for a significant period of time. Therefore, in the current study, the teachers investigated in the study taught the same students mathematics for a period of two years. Students' mathematics competence was measured through standardized tests developed by NEPS first in grade 5 and later in grade 7. Teacher effectiveness was measured through various distal and proximal indicators of teacher effectiveness. Distal indicators were the teacher factors of effectiveness and proximal indicators are the instructional factors of teacher effectiveness. Data on both distal and proximal indicators were collected through self-report questionnaires. NEPS has collected data on a general teacher questionnaire and a mathematics instruction questionnaire. I have performed CFA in order to determine the construct validity of items to measure teacher effectiveness.

It was expected that a bivariate cross-sectional analysis to predict MC7 would be an overestimation of the effects of distal and proximal factors, however, controlling for MC5 to predict MC7 would result in a very conservative model. Therefore, the analysis was performed both ways. First, (in the first and second research questions) linear regression was performed on each distal and proximal factor in order to see its effect on students' mathematics competence. If a factor turned out as a significant predictor then multiple regression was performed by controlling for MC5. In the following chapter, if the factor is mentioned as a significant predictor, it means the factor has shown significant effects even when the MC5 is controlled for. Second, if a factor still turned out as significant predictor of MC7, multiple regression was performed on MC7 by all significant distal factors and proximal factors (research question 3) in order to see how much variance is explained by each group of factors and which factors (proximal or distal) are more significant predictors of MC7. Later, multiple regression was performed by controlling for MC5 in each multiple regression analysis to see if distal and proximal factors still predict MC7 when MC5 is controlled for. Because it was multiple regression and therefore, assuming that model was not an overestimation, results are discussed before and after controlling for MC5. Lastly, multiple regression was performed on each school type separately, while controlling for MC5.

Among the distal indicators, teacher *belief about deep learning*, addressing *individual needs of students* during teaching, *professional collaboration* (among colleagues) and *stress in planning and classroom* significantly predicted students' mathematics competence. However, among those factors only *belief about deep learning* has a positive effect on students' mathematics competence and the rest of the three factors showed negative effects. The negative effect of *stress in planning and classroom* was, as expected, because *stress in planning and classroom* may be an indication the teachers have less teaching ability. In previous research, the *individual needs of students* have also shown a negative effect on student learning at times, which may be because when a teacher labels a student as less competent, the teacher expect less from the student which may result in student's poor performance (Hattie, 2009). *Professional collaboration* has a negative effect on students' mathematics competence which was not expected and it is difficult to suggest why. However, it was found that more experienced teachers collaborate less than less experienced teachers. Thus it may be that less experienced teachers need assistance in teaching and therefore they collaborate more which shows a negative effect which is actually not the effect of collaboration rather their lack of expertise in teaching. Among the proximal indicators, the current study has found that *student engagement, cognitively challenging tasks* and *differentiation* have a significant effect on students' competence. These findings were in line with the findings from previous research. *Student engagement* and *cognitively challenging tasks* showed positive effect and *differentiation* showed a negative affect which might be because of teacher's inappropriate use of *differentiation*.

In general, distal indicators explained more variance in student outcomes in relation to proximal indicators which is in contrast to the expectations from previous research that suggested proximal indicators are the strong predictor of student outcomes because they are proximal to the teaching-learning process (Seidel & Shavelson, 2007).

5.2. Research Question 1

Which teacher factors predict mathematics competence development of secondary school students?

5.2.1. Teacher belief

The study predicted that the *teachers' belief about deep learning* would be positively correlated with students' competence. This has been confirmed by the results of the current study. Teachers who believed in deep learning seem to have a positive effect on student competence. However, the effect was significant but not strong. Many studies have measured the effects of different dimensions of teachers' beliefs on student outcomes but no study has measured *belief about deep learning* on student outcomes. Theoretically, the finding is plausible because previous research has found support for teachers' beliefs influencing their behavior in the planning and classroom (Pajares, 1992) and teacher classroom behavior influencing student outcome (TALIS, 2009). Moreover, Kunter et al. (2013) considers different dimensions of teacher belief as the foundation of quality teaching.

Constructivist belief did not have any effect on student mathematics competence. These results are not in line with findings from previous research for instance Kunter et al., (2013), Dubberke et al. (2008) and Staub and Stern (2002). One explanation may be that the beliefs were not measured specifically in relation to mathematics teaching in the current study as it is important to measure teacher beliefs in a domain-specific context. For instance Hattie (2009) has reported that *constructivist beliefs* are effective for mathematics learning but less effective than *transmissive beliefs* in the domain of reading. The effect of *transmissive belief* was also measured in the current study. No effect of *transmissive beliefs* on student mathematics competence was found. This is in line with the results from the previous research in relation to mathematics learning. For instance Staub and Stern (2002) in their study predicted that *transmissive beliefs* might be more effective for teaching computation in mathematics but found that *transmissive beliefs* were not more effective than *constructivist belief* in teaching computation.

In general, *transmisisve* and *constructivist beliefs* did not show any effect on student mathematics competence. Findings from previous research regarding the association between teachers' beliefs and practices and its influence on student outcomes are also mixed and inconclusive. TALIS (2009) found that in general, there was no significant association between teachers' belief and practices. Furthermore, no association was found between *transmissive beliefs* and the structuring of the classroom as expected, rather, a positive relationship was found between *constructivist beliefs* and the structuring of classrooms. Like TALIS (2009) the current study also found a weak but positive correlation between *constructivist belief* and student-centered classroom activities like *cooperative learning, student engagement* and *cognitively challenging tasks*. However, the reason behind this weak association could be teachers' inability to apply constructivist activities in the classroom as reported by TALIS (2009). Furthermore, it might be possible that if beliefs and practices were both measured in a domain-specific context they might show a strong positive association while in the current study only teachers' practices were measured in a domain-specific context.

5.2.2. Job satisfaction

The current study has measured three aspects of *job satisfaction; missing identification with job, job stress* and *extrinsic motivation*. In general, *job satisfaction* is not considered as an important predictor of student outcomes in educational research. However, the current study predicted that *job satisfaction* could have effect on student outcomes although, the findings related to *job satisfaction* of teachers and their effects on student outcomes are mixed. TALIS (2009) has found that in general teachers are satisfied with their jobs in most of the countries the study was conducted in although this may be because teachers who are not satisfied with their job often leave the profession. *Job satisfaction* may not have a direct effect on student outcomes but previous research has shown that job satisfaction is related to teacher instruction. TALIS (2009) has found that although teacher beliefs and classroom practices have no relation with teachers' *job satisfaction*, the classroom environment is associated with *job satisfaction*. The current study did not find any direct effect of job satisfaction on students' mathematics competence and no significant correlations were found between teacher and instructional factors except for *missing identification with job* and *stress in planning and classroom* which shows that teachers who identify less with their jobs also feel stress in teaching activities. Female teachers turned out to be more stressed out with their job in comparison to male teachers. *Job stress* implies a lack of appreciation, insufficient opportunities of advancement and competition among colleagues which shows teachers' lack of satisfaction with the available opportunities of professional development and appreciation in their jobs. In general, teachers in Germany are satisfied with their jobs except for professional development opportunities in which teachers are less satisfied.

5.2.3. Planning

The following three aspects of *planning* were investigated in the current study; *lesson planning, creating interest in learning* and *individual needs of students. Lesson planning* and *creating interest in learning* did not show any significant effect on students' mathematics competence which was expected given previous research did not show a direct effect of planning on student learning. Imwoldet et al. (1984) in their quasi experiment study found that teachers' who planned the lessons did not teach very differently from the teachers who taught without planning except they gave more directions to students and their classroom was more silent. *Individual needs of students* showed a negative effect on students' mathematics competence which was not expected from the literature, although previous empirical research has shown both negative and positive effects at times. Stronge (2007) mentioned that teachers who plan teaching according to students' interest and the *individual needs of students* meet students both cognitive and affective needs. However, Hattie (2009) reported in his meta-analysis study that in some studies, addressing the *individual needs of students* during teaching showed a negative effect on student outcomes and is because sometimes teachers label students according to their performance and therefore, expects less form weak students which results in negative effect on students' outcomes. This may show that teachers misunderstand the idea behind considering the *individual needs of students* in instruction. *Lesson planning* showed a moderately significant association with *creating interest in learning* which shows that teachers who do *lesson planning* also take care of *creating interest in learning* while planning. *Lesson planning* also showed a weak but significant correlation with teachers' *beliefs about deep learning, cognitive activation, cognitively challenging tasks student engagement* and *creating interest in learning with cognitive activation* and *cognitively challenging tasks* which shows that teachers who want their students to actively participate in the learning process focus on planning lessons. Therefore, planning might not directly affect student outcomes but rather through teaching methods and the quality of classroom activities. Female teachers reported that they do *lesson planning* often and think more about *creating interest in learning* in comparison to their male counterparts. Teacher age was negatively associated with *creating interest in learning* while controlling for other variables. This shows that older teachers think less about *creating interest in learning* which is plausible as student centered learning is a rather new concept in the teaching-learning process.

5.2.4. Stress in planning and classroom

No research was found on this construct and it was included in the current study on an exploratory basis assuming that *stress in planning and classroom* should have a negative effect on student outcomes. As expected the factor showed a negative effect on students' mathematics competence. The teachers not only feel stress in a real classroom situation which could be challenging because of many factors (like classroom size, student behavior, students with different needs etc.) but also in planning. The current study did not investigate the reasons for this stress, therefore, it is difficult to explain the actual reasons for the stress, however, it could be that the teaching is more challenging than the teachers' actual capabilities, the teachers suffer burn out, competition or a lack of cooperation among colleagues. The current study also found that male teachers feel more stress in comparison to female teachers. Moreover, the study found a moderate correlation between *stress in planning and classroom* and *missing identification with job* which may show that *stress in planning and classroom* causes *missing identification with job* or vice versa, however, *stress in planning and classroom* showed no association with any other aspects of *job satisfaction* (*job stress* or *extrinsic motivation for job*). However, this causal relation cannot be claimed on the basis of this analysis.

5.2.5. Cooperation among teachers

In the current study two aspects of *cooperation among teachers* were investigated; *professional collaboration* and *exchange and coordination for teaching*. Contrary to expectations *professional collaboration* showed a negative effect on student mathematics competence. However, both theoretically and empirically, *professional collaboration* is a rather new construct and no clear evidence is yet known about the effects of the construct. *Professional collaboration* is not only a new construct in educational research but also in teachers' practices. TALIS (2009) has found that few teachers engage in *professional collaboration* and *professional collaboration* is indirectly positively related to student outcomes. Moreover, TALIS (2009) has found that more experienced teacher collaborate more often with their colleagues. The current study has found not only the negative effect of *professional collaboration* on student outcomes but also found that the more experience a teacher has, the less they collaborate with their colleagues. It might be because *professional collaboration* is related to one's individual development as a professional (TALIS, 2009) and therefore, more experienced teachers might consider themselves highly professional and feel less need of collaboration with other teachers or they might not need to collaborate because they know how to tackle the challenges of teaching. This may be the reason inexperienced teachers collaborate more and therefore a lack of experience may be the reason for their students' low competence and not the teachers' collaboration.

Like *professional collaboration, exchange and coordination for teaching* is also a new construct in educational research but according to the research that has been done it is more related to teacher professionalism and the learning environment in the school and classroom and thus it is expected that there would be less direct effect on student outcomes (TALIS, 2009; Clement & Vandenberghe, 2000).However the current study found a negative effect which was not expected from the literature. The construct is highly correlated with collaboration among teachers, however no clear differences were found regarding teachers' behavior towards both constructs. This is in contrast to Steinert et al. (2006) who found that teachers exchange and coordinate more often than collaborating with each other. A weak but significant correlation was found between *exchange and coordination for teaching* and *stress in planning and classroom* and *individual needs of students*. This may indicate that when teachers face stress in the teaching process, they more often look for help and, hence, participate in cooperative activities with their colleagues because both factors showed a negative effect on students' competence. This is also supported by the current study that found more experienced teachers exchange and coordinate less which may be because experienced teachers face less stress and therefore, they don't need to cooperate with other teachers.

5.2.6. Professional training

The current study has measured *professional training* through teachers' certification and their participation in professional development activities. Based on the literature, teacher *professional training* and student achievement was expected to have a positive effect on students' mathematical competence. TALIS (2009) stated that *professional training* affects teacher beliefs and practices and Baumert et al. (2010) stated that pedagogical knowledge gained in *professional training* affects student achievement. However, current study did not find any significant effect of teachers' *professional training* on student competence. The empirical evidence from previous studies about teacher certification and student achievement is mixed and inconclusive. Wilson, Floden, and Ferrini-Mundy (2001) stated that the research about the significance of *professional training* is minimal and inconclusive. Darling-Hammond (2000) found that teachers with state certification are positively associated with students' achievement scores in mathematics and reading and teachers who were not certified or were not fully certified showed a negative relationship with students' scores on average. Goldhaber and Brewer (2000) found that teachers with certification have a positive effect on their students' achievement, however, the students of teachers with no full certification also performed similarly as students' of fully certified teachers in mathematics and science. Moreover, Rowan, Correnti, and Miller (2002) found that teachers with certifications do not have a positive effect on student achievement in mathematics. It may be the case that teachers' certificates are not the best way of measuring teachers' professional skills in relation to student achievement. Therefore, it's probably better to measure teacher competence through their content and pedagogical knowledge as done by Baumert et al. (2013) in COACTIV study as they found clear positive results.

5.3. Research Question 2

Which instructional factors predict mathematics competence development of the secondary school students?

5.3.1. Cooperative learning

Cooperative learning appeared as an insignificant predictor of student competence in the current study; however, *cooperative learning* has shown a rather positive effect on student achievement in previous research. Slavin (1995) has reviewed the studies conducted to measure the effectiveness of *cooperative learning* using different models of *cooperative learning* and reported that in general the studies showed consistently significant positive effects on student achievement. Further, Slavin (1995) pointed out the reasons why *cooperative learning* methods sometimes did not show positive results; these are a lack of individual accountability, types of group interactions and contribution of group members to learning. Unfortunately, not all of these aspects of *cooperative learning* were measured in the current study which may be the reason for the ineffectiveness of the *cooperative learning* method; however, it is difficult to say which factor/ factors exactly were the reason for this.

5.3.2. Student engagement

The findings from the current study are consistent with the findings from previous research (Brozo, Shiel & Topping, 2008; Yair, 2007; Kirsch et al. 2002; Farkas et al., 1990). *Student engagement* significantly predicted student competence, although the effect was not strong, this may be because the construct was measured by only two items.

5.3.3. Cognitive activation

Cognitive activation weakly but positively predicted mathematics competence in the current study which is not in line with the results from the previous studies (Kunter et al., 2013; Baumert et al., 2010; Rakoczy, 2007) that found that *cognitive activation* is a strong predictor of student achievement. Therefore, in this study, *cognitive activation* should have shown positive effects on student competence given that teachers had scored moderate to high on the usage of *cognitive activation* during instruction factor. This may be because teachers did not understand well the idea of *cognitive activation* or teachers who don't practice *cognitive activation* in their classroom also reported that they practice *cognitive activation* in classrooms because it is socially desirable to do so and therefore the effect of *cognitive activation* appeared as weak in the current study. Therefore, teachers' self-report might not be a reliable way of measuring *cognitive activation* because the studies that showed positive effects of *cognitive activation* have measured *cognitive activation* through other means. It is also supported by the findings from the Kunter et al. (2007) which reported that German secondary classrooms generally lack in the practice of *cognitive activation* and therefore, the reporting by a majority of teachers of moderate to high use of *cognitive activation* in their classrooms may not be reliable which would confirm Meyer (2015) who stated that it is difficult to measure deep structure constructs.

5.3.4. Cognitively challenging tasks

Like *cognitive activation, cognitively challenging tasks* also weakly but significantly predicted the mathematics competence of students, however, the effect was stronger than *cognitive activation*. Theoretically this construct is important (Scheerens, 2004; Doyle, 1986) but the empirical evidence regarding this construct is as yet insufficient. Nevertheless, a number of studies have reported that *cognitively challenging tasks* develop higher order learning and promote student outcomes (Pianta & Hamre, 2009; Rakoczy, 2007; Pianta & Hamre, 2005). Furthermore Hattie's (2009) meta-meta-analyses showed a significant effect of cognitively challenging goals on student outcomes. The construct showed a moderate association with cognitive activation in the current study which indicates that both constructs are close and promote insightful learning.

5.3.5. Differentiation

The current study found the negative effect of *differentiation* on student competence which was not expected on the basis of theory, however, the previous research on *differentiation* showed mixed results with some studies showing a positive effect of *differentiation* on student achievement and some showing negative effects (Scheerens, 2007). He found in his meta-analyses study in mathematics teaching that *differentiation* showed a positive effect in 25 studies, 9 studies showed negative effects and 66 studies showed no significant effect and in other subjects in general, *differentiation* showed a negligible effect.

Tomlinson (2001) stated that often teachers understand *differentiation* as assigning more work to some students and less to others, which is not accurate and is ineffective. He further added for effective use of *differentiation,* content, process and product are very important, however, *differentiation* does not mean to expect different levels of outcomes from students with different abilities as Gamoran and Weinstein

(1998) also stated that equity is a condition for *differentiation*. Scheerens (2007) stated that *differentiation* particularly depends on types of school and classroom organization. However, no differences were found regarding *differentiation* among teachers in different school types in the current study. The negative effect of *differentiation* might be because, like the *individual needs of students*, teachers do not understand well the idea behind *differentiation* or may not know how to implement *differentiation* in class. However, nothing can be said conclusively on the basis of this study as teachers' understanding of *differentiation* or the way they apply it was not measured in the present study.

5.4. Research Question 3

What combination of teacher and instructional factors best predict mathematics competence of secondary school students?

Previous research suggested that instructional factors are more important than teacher factors in determining student learning (Seidel & Shavelson, 2007). However, the results from the current study showed that teacher factors turned out to be more significant in determining student competence in comparison with instructional factors as teacher factors explained 11% of the variance and instructional factors only explained 6% of the total variance in student competence when MC5 was not controlled for and the variance decreased once MC5 was controlled for. Although, it is not claimed that instructional factors are less important than teacher factors, it surely suggests that teacher factors are equally important in determining teacher effectiveness. This showed that teacher factors cannot be overlooked while measuring teacher effectiveness. Teacher belief, pedagogical skills and their professionalism are the teacher factors that make them effective. Teacher belief to offer *deep learning* in the classroom seemingly affects their practices in the classroom and hence results in a positive effect on student outcomes. The current study found that teachers are aware of considering the *individual needs of student* while teaching; however, they might not fully understand the idea behind individual needs or are may not be well trained in tackling the different *individual needs of students*. They may simply label students and expect less from low performing students. There could indicate a need to better train the teachers during their *professional training* about how to deal with students with different needs in order to help them to perform better. It may also indicate that teachers lack skills in planning and classroom management because the current study found that they feel stress while planning and in classroom management. In the current era, it is expected that teachers should offer *cognitively challenging instruction* which requires teachers to be fully equipped with these skills because *cognitively challenging instruction* requires careful planning and vigorous classroom management skills. Along with the pedagogical skills, German teachers need to be encouraged to participate often in professional activities as the current study has found that German teachers do not often participate in professional activities like cooperation among teachers. This is particularly true for the experienced teachers.

A small effect of instructional factors on student mathematics competence confirmed the findings from the previous studies like Pekrun et al. (2007) who reported in the findings from the PALMA study that in Bavaria, teachers' instruction lacks in effectiveness and their instruction is insufficient to increase student learning. Moreover, Kunter et al. (2007) reported that instructional strategies that promote insightful learning are barely offered in German schools. The small effects of effective instructional strategies like *cognitive activation* showed that German teachers need to improve those instructional strategies both in quantity and quality.

5.5. Research Question 4

Do teachers in different school tracks vary in effectiveness?

From the results from different school types, none of the teacher and instructional factors appeared as significant in relation to student competence development when MC5 was controlled for. No particular pattern was found in the results except students' previous competence as the sole predictor of later competence among all school types. The only significant predictor in grammar schools was *stress in planning and classroom* showing a negative effect on competence and *student engagement* in multi-track schools showed a positive effect on competence. This showed that teachers at grammar schools may lack in planning and the skills required in class. Baumert et al. (2010) found that students' with high previous knowledge require teachers with high subject matter knowledge. However, the results from the current study showed that students with higher prior knowledge not only need teachers with high subject-matter knowledge but also with high teaching skills so that they won't experience stress in teaching activities. No effect of the large range of teacher and instructional factors on student outcomes in each school type suggests that teacher may lack in professional skills and that *professional training* needs to be improved to contribute to students' learning according to their needs.

Previous research has shown that students from high school tracks need teachers with high subject-matter knowledge and students from low school track need teachers with high pedagogical skills. Grammar school teachers reported higher ratings on subject-matter knowledge activities (e.g. *cognitive activation* and *cognitively challenging tasks*) than other school types' teachers however, teachers from grammar school also reported more *stress in planning and classroom*. However, all school type teachers reported almost the same amount of *stress in planning and classroom*.

5.6. Limitations

One of the limitations of this research is the data on the general teacher questionnaire was not measured specifically in relation to mathematics teaching. However, the data about teacher instruction was measured in relation to their mathematics teaching.

DISCUSSION

Due to the longitudinal structure of the study, many teachers and students were excluded from the study for not being in the same class for the period of two years. Teachers who taught less than the period of two years were excluded from the study and, therefore, their students were also excluded from the study. However, the sample bias was measured by comparing the responses of teachers on questionnaires between teachers who remained in the study and the teachers who were excluded and no significant differences were found among both groups. 25% of the final teacher sample that taught students for the period of two years declined to respond to the questionnaires, however, the missing data was completely at random and therefore, it was imputed to deal with the missing values.

The study has covered all the main school types of Germany except the elementary schools which only exist in two of the 16 states of Germany (Berlin and Brandenburg). The sample from elementary schools needed to be excluded because at measurement time point 2 all the students were moved to another school and therefore, their data was missing at the time point 2. However, this study has nonetheless covered more school types than any other study carried out in the recent past in Germany except PISA.

As student mathematics competence was measured in the beginning of grade 5 and then in the beginning of grade 7, the teachers which are the sample of the current study have taught students from grade 5 to grade 7 (two years). The data for time point 2 was collected at the beginning of grade 7, when the students were already taught by new teachers for a period of 1 to 2 months. However, the study has assumed that the effect on student mathematics competence would be from their teachers who had taught for the previous two years because research has shown that teachers’ effects remain for a rather long period of time.

5.7. Implications and Recommendations

The current study has measured the effects of teacher factors and their instruction on students' mathematics learning and found that teacher factors and their instruction as measured by NEPS are not contributing enough to their students' learning of mathematics. This suggests three things; first, although results from previous research have shown teacher effectiveness is the most important indicator of student learning, German instruction in schools is not effective enough to support student mathematics competence development and German schools do not offer insightful learning., The has been repeatedly found by the main studies in Germany such as PALMA (2007) and COACTIV (2007) which have reported similar results as current study.

Secondly, it is difficult to measure teachers' and their teaching effects. The development in students' mathematics competence was measured every two years which is a significant period of time with respect to measuring teachers' and teaching effects on student learning, however, it is not long enough to change students' self-concept and motivation about mathematics. Thus, students' self-concept and motivation from grade 5 to 7 rather stayed stable during the period of two years and therefore MC5 was the best predictor of MC7.

Thirdly, self-report might not be the best way of measuring teacher effectiveness. The current study has followed a surface approach to measuring teacher effectiveness. On the one hand, the current study has the advantage of representative large scale longitudinal data but on the other hand, this methodology could not look in-depth into the teacher factors and their instruction in the classroom and relied merely on teacher self-report. The findings from the meta-analysis study of Seidel and Shavelson (2007) reports that correlational studies showed rather weak effects between teaching and student learning. Although the results of other main studies in Germany are not very different from the current study, these studies were able to identify where the gaps lie in teacher instruction which the current study could not. This is a drawback associated with large scale assessments. Other ways of measuring teacher effectiveness for example through quasi-experiments, testing teachers, videoing, student interviews etc. as used by some other studies in Germany showed better and clear results, for instance PALMA and COACTIV. However, the direction of the findings between the current study and past research is generally the same i.e. student oriented, cognitively activating and challenging instruction is needed. Although, it is difficult to conduct observational, video based and experimental study on a large scale with a representative sample because of a lack of resources, it is still necessary to measure teacher effectiveness in those ways in order to get in-depth results.

Future research should consider measuring teacher factors through tests based on items on real life situations for instance to measure the teachers' belief about the types of instruction that they endorse. This would also help in inferring the results from teachers' responses because items would be clearer unlike in the current study in which, at times, it is not certain how teachers understand each factor. Teacher' understanding of each factor may be different from that of the researcher which wouldn't be the case if the items were shaped as real life situations. Teacher instruction should be measured through video recording or observation of teachers during instruction. This would help to establish a common criterion of assessing teacher instruction, independent of any social desirability effects. This would help in getting clear and in-depth results both about teacher factors and their instruction and would reduce the bias inherent in self-report questionnaires.

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Abel, M. H., & Sewell, J. (1999). Stress and burnout in rural and urban secondary school teachers. *The Journal of Educational Research, 92*(5), 287-292.

Abrami, P. C. (1995). *Classroom connections: Understanding and using cooperative learning*. Toronto: Harcourt Brace.

Anderson, L. W. (1991). *Increasing teacher effectiveness*. Paris: UNESCO, IIEP.

Anderson, L. W. (2004). *Increasing teacher effectiveness*. (Second Edition) Paris: UNESCO. IIEP.

Askew, M., Brown, M., Rhodes, V., William, D., & Johnson, D., (1997). The contribution of professional development to effectiveness in the teaching of numeracy. *Teacher Development, 1*(3), 335-356.

Ausubel, D. P. (1961). In defense of verbal learning. *Educational Theory 11*, 15-25.

Baumert, J., Blum, W., & Neubrand, M. (2001). Surveying the instructional conditions and domain-specific individual prerequisites for the development of mathematical competences. Paper presented at the special meeting on the co-ordination of national teacher components for PISA, 2003, 28 may 2001, Munich, Germany.

Baumert, J., Klieme, E., Neubrand, M., Prenzel, M., Schiefele, U., Schneider, W.,Stanat, P., Tillmann, J. & Weiß, M. (2001). PISA 2000. Basiskompetenzen vonSchülerinnen und Schülern im internationalen Vergleich. Opladen Leske +Budrich.

REFERENCES

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., Klusmann, U., Krauss, S., Neubrand, M., & Tsai, Y.-M. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom and student progress. *American Educational research Journal, 47*(1), 133-180.

Baumert, J. & Kunter, M. (2013). The COACTIV model of teachers' professional competence. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers* (pp. 25-48). New York, NY: Springer.

Baumgartner, L. M. (2001). An update on transformational learning theory. In S. B. Merriam (Ed.), *The new update on adult learning theory: New Directions for Adult and Continuing Education*, (pp. 15-24). San Francisco, CA: Jossey-Bass.

Biggs, J. B., & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO Taxonomy*. New York, NY: Academic Press.

Blazar, D., Litke, E., & Barmore, J. (2016). What does it mean to be ranked a "high" or "low" value-added teacher? Observing differences in instructional quality across districts. *American Educational Research Journal*, 53(2), 324-359.

Blossfeld, H., Maurice, J. V. & Schneider, T. (2011).The national educational panel study: need, main features, and research potential. In H. Blossfeld, H. Rossbach & J. V. Maurice. (Eds.), *Education as a lifelong process: The German national Educational panel study* (pp 5-17). Wiesbaden, Germany: Springer.

Blum, W., Neubrand, M., Ehmke, T., Senkbeil, M., Jordan, A., Ulfig, F., & Carstensen, C. H. (2004). Mathematische Kompetenz. In M. Prenzel, J. Baumert, W. Blum, R. Lehmann, D. Leutner, M. Neubrand, R. Pekrun,

REFERENCES

H.-G. Rolff, J. Rost & U. Schiefele (Eds.), PISA 2003. *Der Bildungsstand der Jugendlichen in Deutschland – Ergebnisse des zweiten internationalen Vergleichs* (pp. 47-92). Munster: Waxmann.

Bodovski, K., & Farkas, G. (2007). Mathematics growth in early elementary school: The roles of beginning knowledge, student engagement, and instruction. *Elementary School Journal, 108*, 115-130.

Borman, G. D., & Overman, L. T. (2004). Academic resilience in mathematics among poor and minority students. *Elementary School Journal, 104,* 177-195.

Bolhuis, S. (2003). Towards process-oriented teaching for self-directed lifelong learning: A multidimensional perspective. *Learning and Instruction, 13*(3), 327-347.

Borg, M. G., Riding, R. J., & Falzon, J. M. (1991). Stress in teaching: A study of occupational stress and its determinants, job satisfaction and career commitment among primary school teachers. *Educational Psychology: An International Journal of Experimental Educational Psychology, 11*(1), 59-75.

Borich, G.D. (1996). *Effective teaching methods,* 3rd edition. New York, NY: Macmillan.

Bransford, J. D., Ann, L. B. and Rodney, R. C. (eds). 2000. *How People Learn: Brain, Mind, Experience and School (*pp. 3-23). Washington D.C: National Academy Press.

Brophy, J. (2001). Generic aspects of effective teaching. In M. C. Wang & H. J. Walberg, *Tomorrow's teachers*. McCutchan publishing company.

REFERENCES

Brophy, J., & Good, T. (1986).Teacher behavior and student achievement. In M. Wittrock (Ed.), *Handbook of research on teaching* (pp. 328-375). New York, NY: Macmillan.

Brozo, W. G., Shiel, G., & Topping, K. (2008). Engagement in reading: Lessons learned from three PISA countries. *Journal of Adolescent and Adult Literacy, 51,* 304-315.

Cambourne, B. (2003, December). Conditions for learning. Paper presented at South Carolina Reading Initiative Professional Development Day, Columbia, SC.

Campbell, R.J., Kyriakides, L., Muijs, R.D., & Robinson, W. (2003). Differential teacher effectiveness: towards a model for research and teacher appraisal. *Oxford Review of Education, 29*(3), 347-362.

Campbell, R.J., Kyriakides, L., Muijs, R.D., & Robinson, W. (2004). *Assessing teacher effectiveness: A differential model*. London, UK: Routledge.

Carol, J. (1963). A model of school learning. *Teachers College Record, 64,* 723-733.

Chandramma, M. (2013). *Job Satisfaction and Teaching Effectiveness of Teacher Educators*. Lap Lambert Academic Publishing.

Clement, M. & Vandenberghe, R. (2000). Teachers' professional development: A solidarity or collegial adventure? *Teaching and Teacher Education, 16,* 81-101.

Cortina, K. S. & Thames, M. H. (2013). Teacher education in Germany. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers: Results from the COACTIV project* (pp. 49-62). New York, NY: Springer.

REFERENCES

Cochran-Smith, M. & Zeichner K. M. (2005). Studying teacher education: The report of the AERA panel on research and teacher education. Erlbaum, Mahwah.

Covino, E. A., & Iwanicki, E. F. (1996). Experienced teachers: Their constructs of effective teaching. *Journal of Personnel evaluation, 10*(1), 325-363.

Creemers, B. P. M., (1994). *The effective classroom*. London: Cassell.

Creemers, B. P. M. (2002). From school effectiveness and school improvement to Effective school improvement: Background, theoretical analysis and outline of the empirical study. *Educational Research and Evaluation, 8*(4), 343-362.

Creemers, B. P. M. (2007) Educational effectiveness and improvement: The development of the field in mainland Europe. In: Townsend, T. (ed) *International Handbook of School Effectiveness and Improvement,* (pp. 223-242). New York, NY: Springer.

Creemers, B. P. M. & Kyriakides, L., (2008). *The dynamics of educational effectiveness: A contribution to policy, practice and theory in contemporary schools*. London: Routledge.

Creemers, B. P. M. (n.a.). The comprehensive model of educational effectiveness: Background, major assumptions and description. Retrieved on July 27, 2016 from https://www.rug.nl/staff/b.p.m.creemers/the_comprehensive_model_of_educational_effectiveness.pdf

Danielson, C. (1996). *Enhancing professional practice: A framework for teaching*. Alexandria: ASCD.

REFERENCES

Donovan, S. M., and Bransford, J. D. (Eds), (2005). *How Students Learn: Mathematics in the Classroom*. Washington, DC: National Academies Press.

Darling-Hammond, L. (2000). Reforming Teacher Preparation and Licensing: Debating the Evidence. *Teachers College Record, 102*(1), 28-56.

Doyle, W. (1977). Learning the classroom environment: An ecological analysis. *Journal of Teacher Education, 28*(6), 51-55.

Doyle, W. (1986). Classroom organization and management. In M.C. Wittrock (Ed.), *Handbook of Research on Teaching, Third Edition* (pp. 392-431). New York, NY: Macmillan.

Doyle, W. (2008).*Who will teach our children?* Phoenix, AZ: Arizona Town Hall.

Dubberke, T., Kunter, M., McElvany, N., Brunner, M., & Baumert, J. (2008). Lerntheoretische U¨ berzeugungen von Mathematiklehrkräften:Einflüsse auf die Unterrichtsgestaltung und den Lernerfolg von Schülerinnenund Schülern: Mathematics teachers' beliefs about teaching and learning: Effects on quality of instruction and student learning outcomes. *Zeitschrift für Pädagogische Psychologie, 22,* 193–206.

Elmore, R. in Wong, H. (2009). Teachers are the greatest assets. *Teachers Net Gazette*.

Ernest, P. (1999). Forms of knowledge in mathematics and mathematics education: Philosophical and rhetorical perspectives. *Educational Studies in Mathematics, 38*(1), 67-83.

REFERENCES

Farkas, G., Grobe, R. R., Sheehan, D., & Shaun, Y. (1990). Cultural resources and school success: Gender, ethnicity, ad poverty groups within urban school district. *American Sociological Review, 55*, 127-142.

Floden, R. E. (2001). Research on effects of teaching: A continuing model for research on teaching. In V. Richardson (Ed.), *Handbook of research on teaching* (pp. 3-16). Washington, DC: American Educational Research Association.

Frahm, S., Goy, M., Kowalski, K., Sixt, M., Strietholt, R., Blatt, I. & Kanders, M. (2011).Transition and development from lower secondary to upper secondary school. In H. Blossfeld, H Rossbach & J. V. Maurice. (Eds.), *Education as a lifelong process: The German National Educational Panel Study* (pp 217-232). Wiesbaden, Germany: Springer.

Gage, N. L. (1965). Desirable behaviors of teacher. *Urban Education, 1*(2), 85-95.

Gamoran, A. & Weinstein, M. (1998). Differentiation and opportunity in restructured schools. *American Journal of Education, 106*(3), 385-415.

Gilberts, G.H., & Lignugaris-Kraft, B. (1997). Classroom management and instruction competencies for preparing elementary and special education teachers. *Teaching and Teacher Education, 13*(6), 597-610.

Glass, G. V. (n.a.). Grouping students for instruction: Executive summary. Retrieved on 19 August 2016 from http://nepc.colorado.edu/files/Chapter05-Glass-Final.pdf

Glazerman, S., Mayer, D., & Decker, P. (2006). Alternative routes to teaching: The impacts of teach for America on student achievement and other outcomes. *Journal of Policy Analysis and Management, 25*(1), 75-96

Golby, M., & Viant, R., (2007). Means and ends in professional development. *Teacher Development, 11*(2), 237-243.

REFERENCES

Goldhaber, D. D., & Brewer, D. J. (2000). Does teacher certification matter? High school teacher certification status and student achievement. *Educational Evaluation and Policy Analysis 22*(2), 129-145.

Grenno, J. G., Collins, A. M., & Resnick, L. B. (1996). Cognition and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of Educational Psychology* (pp.15-46). New York: MacMillian.

Hamre, B. K. & Pianta, R. C. (2005). Can instructional and emotional support in the first grade make a difference for children at risk of school failure? *Child Development, 76*, 949-967.

Hattie, J. (2003, October). Teachers make a difference: What is the research evidence? Paper presented at the Australian Council for Educational Research Annual Conference on Building Teacher Quality, Melbourne. Retrieved on July 20, 2016 from https://cdn.auckland.ac.nz/assets/education/hattie/docs/teachers-make-a-difference-ACER-(2003).pdf

Hattie, J. C. (2009). *Visible Learning: A Synthesis of over 800 meta-analyses relating to achievement*. Oxon, UK: Routledge.

Imwold, C. H., Rider, R. A., Twardy, B. M., Oliver, P. S. Griffin, M., & Arsenault, D. N. (1984). The effect of planning on the teaching behavior of preservice physical education teachers. *Journal of Teaching in Physical Education, 4*(1), 50-56

National Educational Panel Study. Retrieved on December 2015, from https://www.neps-data.de/.

Johnson, B. (1997). An organizational analysis of multiple perspectives of effective teaching: Implications of teacher evaluation. *Journal of Personnel Evaluation in Education, 11*(1), 69-87.

REFERENCES

Kennedy, G., Krause, K.-L., Judd, T., Churchward, A., & Gray, K. (2008). First year students' experiences with technology: Are they really digital natives? *Australian Journal of Educational Technology, 24*(1), 108-122.

Kirsch, I., De-Jong, J., Lafontaine, D., McQueen, J., Mendelovits, J., Monseur, C. (2002). Reading for change: Performance and engagement across countries. Paris: Organisation for Economic Co-operation and Development.

Kistner S., Rakoczy, K., Otto, B., Klieme, E., & Büttner, G., (2015). Teaching learning strategies: The role of instructional context and teacher beliefs. *Journal for Educational Research, 7*(1), 176-197.

Krauss, S., Brunner, M., Kunter, M., Baumert, J., Blum, W., Neubrand, M., & Jordan, A. (2008b). Pedagogical content knowledge and content knowledge of secondary mathematics teachers. *Journal of Educational Psychology, 100*(3), 716-725.

Kulik, C., & Kulik, J.A. (1982). Effects of ability grouping on secondary school students: A meta-analyses of evaluation findings. *American Educational Research Journal, 19,* 415-428.

Kunter, M., Klusmann, U., Dubberke, T., Baumert, J., Blum, W., Brunner, M., et al. (2007). Linking aspects of teacher competence to their instruction: Results from the COACTIV project. In M. Prenzel (Ed.), *Studies on the educational quality of schools: The final report on the DFG priority programme* (pp. 32-52). Münster, Germany: Waxmann.

Kunter, M., Kleickmann, T., Klusmann, U., & Richter, D. (2013). The development of teachers' professional competence. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers* (pp. 63-77). New York, NY: Springer.

REFERENCES

Kunter, M., & Voss, T. (2013). The model of instructional quality in COACTIV: A multicriteria analysis. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers* (pp. 97-124). New York, NY: Springer.

Kunter, M., & Baumert, J. (2013). The COACTIV research program on teachers' professional competence: Summary and discussion. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers: Results from the COACTIV project (Mathematics Teacher Education No. 8)* (pp. 345-368). New York: Springer.

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T. & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology, 105*(3), 805-820.

Kyriacou, C., & Sutcliffe, J. (1977). The prevalence of stress among teachers in medium-sized mixed comprehensive school. *Research in Education, 18,* 75-79.

Kyraicou, C. & Sutcliffe, J. (1978). Teacher stress: Prevalence, sources and symptoms. *British Journal of Educational Psychology, 48,* 159-167.

Kyriakides, L., Campbell, R. J., & Gagatis, A. (2000). The significance of the classroom effect in primary schools: An application of Creemers comprehensive model of educational effectiveness. *School Effectiveness and School Improvement, 11*(4), 501-529.

Kyriakides, L., Campbell, R.J., & Gagatsis, A. (2000). The significance of the classroom effect in primary schools; An application of Creemers comprehensive model of educational effectiveness. *School Effectiveness and School Improvement, 11*(4), 501-529.

Kyriakides, L., & Creemers, B.P.M. (2011). Can schools achieve both quality and equity? Investigating the two dimensions of educational effectiveness . *Journal of Education for Students Placed at Risk, 16*(4), 237- 254.

Kyriakides, L. & Creemers, B. P. M. (n.a.). The impact of quality of teaching on student outcomes: Implications for policy and practice on teacher professional development. Retrieved on April 4, 2014 from http://www.ivalua.cat/documents/1/19_10_2011_15_49_28_ponencia_taula2_kyriakidis.pdf

Levine, D.U., & Lezotte, L.W. (1990). Unusually effective schools: A review and analysis of research and practice. Madison, WI: The National Center for Effective Schools Research and Development.

Markley, T. (2004). Defining the effective teacher: Current arguments in education. Retrieved on September 15, 2015 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.549.7407&rep=rep1&type=pdf

Medley, D., & Mitzel, H. (1963). Measuring classroom behavior by systematic observation. In: N.L. Gage (Ed.), *Handbook of research on teaching.* Chicago: Rand McNally.

Meyer, H. (2015). The German tradition of didactics and recent research findings about teaching and learning. Retrieved on May 2016 from http://www.schulpaedagogik-heute.de/conimg/Archiv/SH_11/06_02.pdf

Mouly, G. J. (1963). *The science of educational research.* New York, NY: American Book Company.

REFERENCES

Muijs, D., & Reynolds, D. (2001). *Effective Teaching: Evidence and practice*. London: Sage.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19*(4), 317-328.

Neumann, D. A. (2003). Longitudinal modeling with randomly and systematically missing data: A simulation of Ad Hoc, Maximum Likelihood, and multiple imputation techniques. *Organizational Research Methods*, 6(3), 328-362.

Newmann, F. M. (Ed.). (1992). *Student engagement and achievement in American secondary schools*. New York, NY: Teachers College Press.

Organisation for Economic Cooperation and Development (OECD) (2003). The PISA 2003 assessment framework – mathematics, reading, science and problem solving knowledge and skills. Paris: OECD.

OECD (2008). *Ten steps to equity in education: OECD policy brief*. OECD, Paris.

Organisation for Economic Co-Operation and Development (OECD) (2009). Teaching practices, teachers' beliefs and attitudes. *Creating effective teaching and learning environments: First results from TALIS*, (pp. 88-135): Retrieved from http://www.oecd.org/berlin/43541655.pdf

OECD (2009b). *Creating effective teaching and learning environments: First results from TALIS*, OECD, Paris.

OECD (2010), *PISA 2009 Results: Learning to Learn – Student Engagement, Strategies and Practices (Volume III)*. Retrieved on February, 2016 from *http://dx.doi.org/10.1787/9789264083943-en*

REFERENCES

OECD (2013). Teaching and Learning International Survey (TALIS) 2013: Conceptual framework. OECD: Paris.

Ololube, N.P. (2006). Teachers job satisfaction and motivation for school effectiveness: An assessment. *Essays in Education*. ERIC number: ED496539.

Pajares, M.F. (1992). Teacher belief and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307-332.

Philipou, G., & Christou, C. (1997). A study of teachers' conceptions about mathematics. E. Pehkonen, (ed.), *Proceedings of the 21st International Conference for the Psychology of Mathematics education, 4,* pp. 9-16. University of Helsinki.

Pianta, R. C. & Hamre, B. K. (2009). Measurement and improvement of teacher-child interactions: Implications for policy and accountability frameworks of standardized observation. *In American Educational research association handbook on educational policy*. New York: Routledge.

Prakasha, G. S., Jamavaya, H. R. & Malesha, T. (2011). *Teacher effectiveness depends on job satisfaction: A study*. Lap Lambert Academic Publishing.

RAND. Retrieved on December 10, 2013 from http://www.rand.org/education/projects/measuring-teacher-effectiveness/teachers-matter.html

Rakoczy, K., Eckhard, K., Drollinger-Vetter, B., Lipowsky, F., Pauli, C. & Reusser, K. (2007). Structure as a quality feature in mathematics instruction: Cognitive and motivational effects of structured organisation of the learning environment vs. a structured presentation of learning content. In M. Prenzel (Ed.), *Studies on the educational quality of schools: The final report on the DFG priority programme* (pp. 101-120). Münster, Germany: Waxmann.

REFERENCES

Raudenbush, S. W. (2005). Learning from attempts to improve schooling: The contribution of methodology. *Educational Researcher, 34*(5), 25–31.

Ross, J. A. (1998). The antecedents and consequences of teacher self-efficacy. In J. Brophy (Ed.*) Advances in research on* teaching, Vol 7, (pp. 49-74). Greenwich, CT: JAI Press.

Roulet, G. (2000). Exemplary mathematics teachers: Subjects, conceptions and instructional practices. P. Ernest (ed.) *Philosophy of Mathematics Education, 13*. Available at http://www.ex.ac.uk/~PErnest/thesis/cover_pg.htm.

Rowan, B., Correnti, R., & Miller, R. J. (2002). What large-scale survey research tells us about teacher effects on student achievement: Insights from the prospects study of elementary schools. *Teacher College Record, 104*, 1525-1567.

Rubin, D. B. (1987). *Multiple imputation for non-response in surveys*. New York, NY: John Wiley.

Sander, W. (1999). Private schools and public school achievement. *Journal of Human Resources, 34*(4), 697-709.

Schafer, J. L. (1997). *Analysis of incomplete multivariate data*. New York, NY: Chapman and Hall.

Scheerens, J. (1990). School effectiveness and the development of process indicators of school functioning. *School Effectiveness and School Improvement, 2*(1), 61- 80.

Scheerens, J. (1995). The selection and definition of international indicators on teachers. In *J. Scheerens (Ed.), Measuring the quality of schools* (pp. 61-79). Paris: OECD.

REFERENCES

Scheerens, J., & Bosker, R. J. (1997). *The foundations of educational effectiveness*. Oxford, UK: Pergamon.

Scheerens, J. (2000). *Improving school effectiveness*. Paris: UNESCO.

Scheerens, J., (2004). Review of school and instructional effectiveness research: Contribution to chapter 3 of the 2004 EFA global monitoring report. Retrieved on June, 2014 from: http://portal.unesco.org/education/en/file_download.php/23880a1c51a21961999fe362fcefde1dScheerens.pdf

Scheerens, J. (2007). Conceptual framework for the PISA 2009 context questionnaires and thematic reports. Paper presented to the PISA governing board, Oslo, Norway.

Schofield, H.L., & Start, K.B. (1978). Mathematics attitude and achievement among student teachers. *The Australian Journal of Education 22*(1), 72-82.

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A. & King, J. (2006). Reporting structural equational modeling and confirmatory factors analysis results: A review. *The Journal of Educational Research, 99*(6), 323-338.

Seidel, T., & Shavelson, R. J. (2007). Teaching effectiveness research in the past decade: The role of theory and research design in disentangling meta-analysis results. *Review of Educational Research, 77*(4), 454-499.

Shulman, L. S. (1998). Theory, practice and the education of professionals. *The Elementary School Journal, 98*, 511-526.

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice* (2nd ed.). Boston: Allyn & Bacon.

Slavin, R.E. (1996). *Education for All*. Lisse, Netherlands: Swets & Zeitlinger.

REFERENCES

Smith, F. (1995). Let's declare education a disaster and get on with our lives. *Phi Delta Kappan, 76*(8), 584-590.

Sparks, D. (2004). Broader purpose calls for higher understanding. *Journal of Staff Development, 25*(2), 46-50.

Staub, F. C., & Stern, E. (2002). The nature of teachers' pedagogical content beliefs matters for students' achievement gains: Quasi-experimental evidence from elementary mathematics. *Journal of Educational Psychology, 94*(2), 344-355.

Steinert, Y., Mann, K., Centeno, A., Dolmans, D., Spencer, J., Gelula, M., & Prideaux, D. (2006). A systematic review of faculty development initiatives designed to improve teaching effectiveness in medical education. *Medical Teacher, 28*, 497-526.

Stipek, D. J., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education.*17, 213-226.

Stronge, J. H. (2007). *Qualities of effective teachers (2nd ed.)*. Alexandria, VA: Association for Supervision and Curriculum Development.

Swank, P. R., Taylor, R., Brady, M., Cooley, R., & Freiberg, J. (1989). Outcomes of grouping students in mainstreamed middle school classrooms. *National Association of Secondary School Principals Bulletin, 73*(516), 62-66.

Thompson, A.G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D.A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127–146). Reston, VA: National Council of Teachers of Mathematics.

REFERENCES

Tomilson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Trendall, C. (1989). Stress in teaching and teacher effectiveness: A study of teachers across mainstream and special education. *Educational Research, 31*, 52-58.

Volet, S. (1995). Process oriented instruction: A discussion. *European Journal of Psychology of Education, 10*(4), 449-459.

Vosniadou, S. (1994). Capturing and modeling the process of conceptual change. *Learning and Instruction, (4),* 45-69.

Walberg, H. (1984a). Improving the productivity of America's schools. *Educational Leadership, 41*(8), 19-27.

Wang, M. C. & Walberg, H. J. (2001). Tomorrow's teachers. McCutchan publishing company.

Wenglinsky, H. (2000). *How teaching matters: Bringing the classroom back into discussions of teacher quality*. Princeton, NJ: Educational Testing Service.

Wilcox-Herzog, A. (2002). Is there a link between teachers' beliefs and behaviors? *Early Education and Development, 13*(1), 81-106.

Wilson, S. M., Floden, R., & Ferrini-Mundy, J. (2001). Teacher preparation research: Current knowledge, gaps, and recommendations. A research report prepared for the U.S. Department of Education. Seattle: Center for the Study of Teaching and Policy, University of Washington.

Woolfolk, A. E. (1985). Research perspectives on classroom communication. *Theory Into Practice, 24,* 3-7.

REFERENCES

Yair, G. (2000). Educational battlefields in America: The tug-of-war over students' engagement with instruction. *Sociology of Education, 73*, 155-174.

Appendix I: Demographic variables and professional training scale

Demographic variables		
Serial number	Item statement	Response format
01	When were you born?	1 = before 1950 2 = 1950-1959 3 = 1960-1969 4 = 1970-1979 5 = after 1979
02	How long have you been working in your job? Please subtract longer periods of work stoppages and round them up to full years.	0-4 5-9 10-14 15-19 20-24 25-29 30-34 35-39 40 or more
03	Are you male or female? Please check where applicable	1 = male 2 = female
04	Do you have a so-called migration background, i.e. you or at least one parent was born abroad?	1 = Yes, I was born abroad 2 = Yes, I was born in Germany, but at least one parent was born abroad 3 = No
Professional training		
05	Have you ever stated a teacher's	0 = No

	course of study?	1 = Yes
06	Have you successfully completed your teacher training? Please check where applicable.	0 = No 1 = Yes
07	Have you ever participated in the following training activities during the past 12 months? Sitting in on classes at the other schools	0 = No 1 = Yes
08	How many days have you participated in training measures in the above sense during the past 12 months? No participation in further training measures within the last 12 months?	0 = No 1 = Yes
09	Would you prefer to attend more training programs than you actually did during the past 12 months?	0 = No 1 = Yes

Appendix II: Teacher factor questionnaire

Response format

1 = very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important

Serial number	Item statement
Belief about deep learning	
10	How important do you consider the students should build systematic expert knowledge
11	How important do you consider the students should understand the subject matter in depth
Belief about constructivist instruction	
12	My role as a teacher is to make it easier for the students to investigate and explore things
13	Students learn best when they try to find solutions to problems independently
14	Students should be given the possibility of reflecting on solutions themselves before the teacher shows the approach to the solution
15	Thinking and reasoning processes are more important than specific contents of the syllabus
Belief about transmissive instruction	
16	It is better when the teacher and not the students decide what needs to be done
17	The question of how much students will learn depends on their background knowledge, and that is why teaching of facts is so important
18	Classes should be based on problems with clear-cut and correct answers as well as on concepts that are quickly understood by the students

Lesson planning	
19	How important do you consider methodically and didactically clever structuring of classes and imparting of knowledge?
20	How important do you consider orientation towards objective criteria when assessing students
21	How important do you consider imparting comprehensive expert knowledge
22	How important do you consider focusing on the task prescribed by the syllabus
Creating interest in learning	
23	How important do you consider creating interest in teaching subjects
24	How important do you consider increasing the pleasure in learning and willingness to perform
25	Individual needs of students
26	How important do you consider being informed about personal problems of the students.
27	How important do you consider considering the personal situation when assessing students
Stress in planning and classroom	
28	In what areas do you experience stress in class and during the preparation of classes? Methodological requirements for carrying out classes
29	In what areas do you experience stress in class and during the preparation of classes? The effort needed during the planning of classes
30	In what areas do you experience stress in class and during the preparation of classes? Different learning abilities of students
Missing identification with job	
31	I have to force myself to go to school
32	I am glad when I can close the school door behind me
33	Spare time and hobbies give me more satisfaction than job

34	I can imagine other jobs that I would prefer
35	I can hardly cope with the nervous exhaustion of the teaching job
Job stress	
36	What is the stress factor for you at work? Missing professional appreciation
37	What is the stress factor for you at work? Few opportunities for advancement at the school
38	What is the stress factor for you at work? Competition among colleagues
Extrinsic motivation	
39	How important do you consider for your job as a teacher? Much spare time
40	How important do you consider for your job as a teacher? Good pay
41	How important do you consider for your job as a teacher? Job security
Professional collaboration	
42	How often do you and your colleagues cooperate on a regular basis at your school? Preparing teaching learning material
43	How often do you and your colleagues cooperate on a regular basis at your school? Preparing teaching units
44	How often do you and your colleagues cooperate on a regular basis at your school? Jointly planning classes
45	How often do you participate in the team discussions on the age group you are teaching
Exchange and coordination for teaching	
46	How often do you participate in the exchanging teaching material with colleagues
47	How often do you participate in developing a syllabus or a part of it
48	How often do you participate in discussing the learning process of individual students

Appendix III: Instructional factor questionnaire

Response format (cooperative learning and student engagement)

1= never, 2 = once or twice per semester, 3 = every other month, 4 = every two to four weeks

5 = once a week, 6 = nearly every hour

Serial number	Item statement
Cooperative learning	
How often do you use the following social methods of learning in this mathematics classroom…….	
01	Working with small group of students
02	Partner work
03	Discussion rounds
04	Peer tutoring
05	Project based learning
Student engagement	
How often do you use the following social methods of learning in this mathematics classroom……	
06	The class and I discuss together
07	A student present something to the classroom

Response format (cognitive activation)

1 = very rarely, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often.

Serial Number	Item statement
Cognitive activation	
How often do the following statements apply to math lessons in the	

classroom The students are	
08	asked questions that show if they are able to critically assess and analyze the subject matter
09	requested by me to relate to the questions and comments of their classmates
10	actually relate to the questions and comments of their classmates
11	asked questions during which the subject matter has to be critically reviewed

Response format (cognitively challenging tasks and differentiation)

1 = strongly disagree, 2 = rather not correct, 3 = partly correct, 4 = rather correct, 5 = strongly agree

Serial Number	Item statement
Cognitively challenging tasks	
To what extent do the following statements apply to the assignments you give your students during math lessons	
12	assignments that do not only involve the identification of standard solutions but also the selection of the right approach
13	I give the assignments in which students need time to think in order to find solutions
14	I give them assignments in which students have to show different approaches
15	I give them assignments that require explanation and in depth comments rather than simple solutions
Differentiation	
To what extent do the following statements apply to your mathematics lessons in this classroom..........	
16	I demand considerably less from students who are less capa-

	ble
17	I form group of students with same capabilities
18	I assign students homework ranging in complexity based on their capability
19	I allow students who work faster to move on to the next assignment while I am working with the ones that work slower
20	if student have difficulties in understanding, I give them additional assignments
21	I give more capable students extra assignments that are really challenging for them

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The study aims to investigate the role of teacher factors and their instruction in the mathematics competence development of students. The design of my study is longitudinal in nature. National Educational Panel (NEPS) data is used to investigate the effect of teachers on students' mathematics competence development from grade 5-7 with a sample of 151 teachers and their 1706 students. Teacher effectiveness was measured through self-report questionnaires and mathematics competence was measured through standardized tests at the beginning of grade 5 and grade 7. Multiple regression analyses and multi-group analyses were carried out in Mplus 7.11 to analyze the research questions. The study found that the following distal indicators are significant predictors of mathematics competence belief about deep learning, professional collaboration, individual needs of students, and stress in planning and classroom. Among proximal indicators student engagement, cognitively challenging tasks and differentiation showed the significant effect. Distal indicators explained 11% and proximal indicators explained 6% of the total variance in mathematics competence of students. The study found that distal indicators are stronger predictors of mathematics competence than proximal indicators and therefore importance of distal factors cannot be undermined. A multi-group analysis was performed in order to examine do teachers in different school tracks vary in effectiveness. However, no meaningful pattern of difference was found. Implications of the findings are discussed.

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