

Ulrika Ekstam

Educational support in lower secondary mathematics instruction; teacher quality, teacher characteristics and their interrelations





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## Abstract

This study investigates educational support for lower secondary mathematics instruction, teacher quality, teacher characteristics and their interrelations. Particular emphasis was placed on differentiation practices and teacher efficacy beliefs for teaching students in need of educational support in mathematics. Previous research has indicated that among in-school factors, the teacher has one of the greatest impacts on student performance. Furthermore, high teacher quality has been recognised as a right for all students, high or low performing. As teacher efficacy beliefs are noted to be context and subject specific, this thesis sought to complement and extend previous research in the field of educational support for lower secondary mathematics instruction.

For studies I, II and III, answers from 27 special education teachers and 42 mathematics teachers in Swedish-speaking lower secondary schools in Finland were received with an electronic questionnaire. Different models of educational support and nine differentiation practices in mathematics in lower secondary education were examined (Study I). The results indicated that the most frequently used model for educational support in mathematics was the pull-out model, and flexible student grouping was used by almost all mathematics teachers in grade 9. Both special education and mathematics teachers used the differentiation practices almost to the same extent. Studies II and III focused on teacher characteristics and their relation to teacher efficacy beliefs for teaching students in need of support. More specifically, Study II examined the effect of teacher characteristics (certification, experience and gender [mathematics teachers]) on teacher efficacy beliefs. Study II also investigated mathematics teachers' perceived pedagogical knowledge for teaching low-performing students and special education teachers' perceived subject knowledge in mathematics. The results indicated that special education teachers had higher teacher efficacy beliefs than mathematics teachers for teaching students in need of mathematics support. However, mathematics teachers exhibited high self-perceived pedagogical knowledge for teaching students in need of support, while special education

teachers self-perceived moderate subject knowledge in mathematics. The relation between teacher efficacy beliefs, certification and teacher experience on the use of differentiation practices was also examined (Study III). The results indicated that level of teacher efficacy beliefs was related to the frequency of use of differentiation in content, the use of manipulative tools and for co-teaching.

Study IV investigated how subject knowledge and individual interest in mathematics relate to teacher efficacy beliefs for teaching students in need of educational support in mathematics. The participants were 57 special education pre-service teachers at a Swedish-language university in Finland. Teacher efficacy beliefs included three sub-domains: instruction, adapting instruction for different needs and motivating students. The results from Study IV indicated that interest in mathematics had a positive impact on all three teacher efficacy beliefs sub-domains, while subject knowledge had a positive impact on only one sub-domain – instruction – and only via interest.

The results from this thesis indicate that teacher efficacy beliefs is an important and complex teacher characteristic for teaching students in need of support in mathematics. As the main component of inclusive education, differentiation requires teachers to have various skills and abilities; therefore, cooperation between special education and mathematics teachers should be encouraged and supported.

**Keywords:** differentiation, educational support in mathematics, teacher characteristics, teacher efficacy beliefs, teacher quality

## Abstrakt

Avhandlingen undersöker stöd för elevens lärande i matematik i åk 7-9 samt sambandet mellan matematik- och speciallärares yrkesrelaterade kompetenser. Olika differentieringsmodeller och lärarens upplevda självförmåga att undervisa elever i behov av stöd i matematik var ett särskilt tyngdpunktsområde. Tidigare forskning har indikerat att bland de skolrelaterade faktorer som påverkar elevens lärande, har läraren den största inverkan och man har dessutom uppmärksammat betydelsen av att alla elever har lärare med hög kompetens inom specifika områden (t.ex. ämne eller stadium), både för hög- och lågpresterande elever. Eftersom lärarens upplevda självförmåga anses vara beroende av både kontext och ämne, strävar denna avhandling till att komplettera forskningen om undervisning för elever i behov av stöd i matematik i åk 7-9, med fokus på dessa aspekter.

Studie I, II och III baserar sig på data från elektroniska enkäter besvarade av 27 speciallärare och 42 matematiklärare i finlandssvenska skolor med undervisning i åk 7-9. Modeller för hur stödet i matematik är ordnat, samt olika differentieringsmodeller undersöktes (Studie I). Resultaten visade att den mest använda modellen för stöd i matematik var den modell där eleven får sin undervisning (stöd) utanför klassrummet, antingen individuellt eller i smågrupp av en speciallärare. Flexibla undervisningsgrupper användes också av de flesta matematiklärare i åk 9. Både matematik- och speciallärares använde differentieringsmodellerna i stort sett i samma utsträckning.

Studie II och III fokuserade på lärarens yrkesrelaterade kompetenser i förhållande till lärarens upplevda självförmåga att undervisa elever med behov av stöd i matematik. Mer specifikt undersökte Studie II hur lärarnas behörighet, arbetserfarenhet och lärargrupp inverkar på lärarens upplevda självförmåga att undervisa elever i behov av stöd i matematik. Speciallärares rapporterade en högre nivå av upplevd självförmåga att undervisa elever i behov av stöd i matematik, än vad matematiklärarna gjorde. Matematiklärarna ansåg sig ha en hög pedagogisk kunskap att undervisa dessa elever, medan speciallärares ansåg sig endast ha moderata matematikkunskaper. Lärarens nivå av upplevd självförmåga, behörighet och

arbetsfarenhet i relation till differentieringsverktyg undersöktes i Studie III. Resultaten från Studie III visade att hög nivå av upplevd självförmåga hade positivt statistiskt signifikant samband med lärarens användning av differentiering av stoff, konkretiseringsmaterial och samundervisning.

Studie IV undersökte hur ämneskunskaper i och intresse för matematik påverkar lärarens upplevda självförmåga att undervisa elever i behov av stöd i matematik. Eftersom lärarens upplevda självförmåga anses få sin grund redan under lärarutbildningen gjordes en separat datainsamling för denna studie. En elektronisk enkät med frågor angående intresse, upplevd självförmåga att undervisa elever i behov av stöd i matematik (undervisning, att anpassa undervisningen enligt elevens behov och att motivera elever) och matematikkunskaper (motsvarande kunskaper i slutet grundskolan) besvarades av 57 speciallärarstuderande fördelade över studieår 1 till 5. Resultaten visade att det individuella intresset för matematik påverkade alla delområden av upplevd självförmåga, medan matematikkunskaper endast inverkar på den upplevda självförmågan om de är kopplade till intresse, och då också endast till delområdet upplevd självförmåga att undervisa.

Resultaten från denna avhandling tyder på att lärarens upplevda självförmåga att undervisa elever i behov av stöd i matematik är en komplex lärarkompetens som ännu behöver utvärderas genom ytterligare forskning. Även lärarens förmåga att differentiera undervisningen är av stor betydelse för elever i behov av stöd i matematik. Eftersom detta kräver att läraren besitter specifika kompetenser och förmågor (både ämnesmässiga och pedagogiska) borde ett aktivt samarbete mellan special- och matematiklärare uppmuntras och möjliggöras, gärna redan under lärarutbildningen.

**Sökord:** differentiering, läraregenskaper, lärarkompetens, stöd för elevens lärande i matematik, upplevd självförmåga



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## List of original publications

- Study I:** Ekstam, U., Linnanmäki, K., & Aunio, P. (2015). Educational support for low-performing students in mathematics: The three-tier support model in Finnish lower secondary schools. *European Journal of Special Needs Education*, 30(1), 75-92. doi:10.1080/08856257.2014.964578
- Study II:** Ekstam, U., Korhonen, J., Linnanmäki, K., & Aunio, P. (online 2017). Special education and subject teachers' self-perceived readiness to teach mathematics to low-performing middle school students. *Journal of Research in Special Educational Needs*. doi:10.1111/1471-3202.12393
- Study III:** Ekstam, U., Linnanmäki, K., & Aunio, P. (under review). The impact of teacher efficacy beliefs on educational differentiation practices in lower secondary mathematics instruction.
- Study IV:** Ekstam, U., Korhonen, J., Linnanmäki, K., & Aunio, P. (2017). Special education pre-service teachers' interest, subject knowledge, and teacher efficacy beliefs in mathematics. *Teaching and Teacher Education*, 63, 338-345. <https://doi.org/10.1016/j.tate.2017.01.009>

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# 1. Introduction

Basic competence in mathematics is more important for people than ever, not only for use in everyday life, but also because labour markets and society expect employees and citizens to possess a certain level of mathematical knowledge. Poor performance in mathematics negatively affects not only the individual but also society as a whole, and can even have long-term effects on the national economy (European Commission, 2013). Results from the Programme for International Student Assessment (PISA) in 2012 found that roughly one in four students in the Organisation for Economic Co-operation and Development (OECD) countries failed to reach a proficiency level in mathematics (OECD, 2016). The report showed that these students have less motivation and self-confidence in mathematics and a tendency to skip more classes than better-performing students (OECD, 2016). Actions to reduce the incidence of low-performing students include identifying and designing a tailored strategy, providing early educational support, creating supportive learning environments, and inspiring and motivating students to make the most of the education opportunities (OECD, 2016). Teachers play an important role in fulfilling these expectations.

Over the years, many researchers have frequently discussed student performance in mathematics and the reasons for variations in their performance. While major differences are recognised between countries, significant within-country, between schools and within-school differences also exist (OECD, 2013). Concerning the within-school differences, teacher quality and teacher characteristics have been found to have the greatest effect on student performance (Hattie, 2009; McCaffrey, Lockwood, Koretz & Hamilton, 2003; Rowan, Correnti & Miller, 2002). The teacher effect is stronger in mathematics than in other subjects such as reading, for students from a low socio-economic area (Nye, Konstantopoulos & Hedges, 2004) and for students in need of educational support (Levi, Einav, Raskind, Ziv & Margalit, 2013). The teacher effect is also found to increase and become more important by grade (Jepsen, 2005), and it is related to differences in teacher characteristics

(Clotfelter, Ladd & Vigdor, 2007; Feng & Sass, 2013; Hannula & Oksanen, 2013; Holzberger, Philipp & Kunter, 2013; OECD, 2016).

Teacher characteristics traditionally refer to subject knowledge, certification and experience; however, during the last decade, the importance of teachers' attitudes and teaching beliefs in relation to student performance have also been acknowledged (Bong & Skaalvik, 2003; Bursal, 2010; Evans, 2011; Gresham, 2008; Kim, Sihn & Mitchel, 2014; Tschannen-Moran, Woolfolk Hoy & Hoy, 1998). For example, Hattie (2015) reported in his meta-analysis that collective teacher efficacy, which refers to teachers' shared belief that the collective efforts of the whole faculty can have positive impacts on student achievement (Goddard, Hoy & Woolfolk Hoy, 2000), has one of the largest effects on student performance.

The number of students in need of support in general education is continually increasing, especially students in need of educational support in mathematics (OECD, 2016; Official Statistics of Finland, 2016). During secondary education, variations in students' mathematics performance tend to increase (Harju-Luukkainen & Nissinen, 2011; Metsämuuronen, 2011; Rautopuro, 2013; TIMMS, 2011/2015), especially in higher grades of compulsory education (Grades 7–9),<sup>1</sup> where the need for educational support is higher in mathematics than in any other subject (Official Statistics of Finland, 2011<sup>2</sup>).

Teaching mathematics to low-performing students can be challenging and typically requires deep subject knowledge and strong pedagogical skills (van Garderen, Thomas, Stormont & Lembke, 2013). The education and certification requirements for teachers in special education and learning support vary notably between countries (Meijer, Soriano & Watkins, 2003). As the teacher education programme for teachers in special education primarily focuses on the subject knowledge concerning lower grades (e.g. in Finland for Grade 1–6), this may result in a situation where special education teachers have to deal with a wide range of topics on a level with which they are not

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<sup>1</sup> In Finland, compulsory education is Grade 1–9 (age 7–15).

<sup>2</sup> 2011 was the last time that the reason for support was collected.



necessarily familiar (Johnson & Semmelroth, 2014). This situation seems to be particularly common in mathematics teaching (Faulker & Cain, 2013, Rosas & Campbell, 2010).

While Finnish students have performed among the top countries in international assessments (e.g. PISA, Trends in International Mathematics and Science Study [TIMSS]) during the last decade, a low share of low-performing students has also been recognised. These results have been connected to teacher quality, teacher education (Hautamäki, Kupiainen, Marjanen, Vainikainen & Hotulainen, 2013; Malinen, Väisänen & Savolainen, 2012) and to the educational support provided in schools (Hausstätter & Takala, 2011; Kivirauma & Ruoho, 2007; Sahlberg, 2011a). The aim of Finnish compulsory education is for all students to receive an equal education in a neighbourhood school (Finnish National Board of Education, 2011, 2015; Sahlberg, 2011a, 2012). However, to take into consideration the diversity of students in their classrooms, teachers need qualities and characteristics that support them to work efficiently in the diverse classroom (Pearce, Gray & Campbell Evans, 2010).

Despite researchers' increased interest in educational support in mathematics, there is still a lack of research concerning factors (e.g. settings, co-operation and instruction) affecting the educational support in mathematics in lower secondary education. To contribute to the research in the field of educational support in mathematics, this thesis examines the models that are used in Finland for providing educational support in mathematics and special education and for teaching low-performing students in mathematics. The key concepts used in this thesis and their relations are shown in Figure 1.

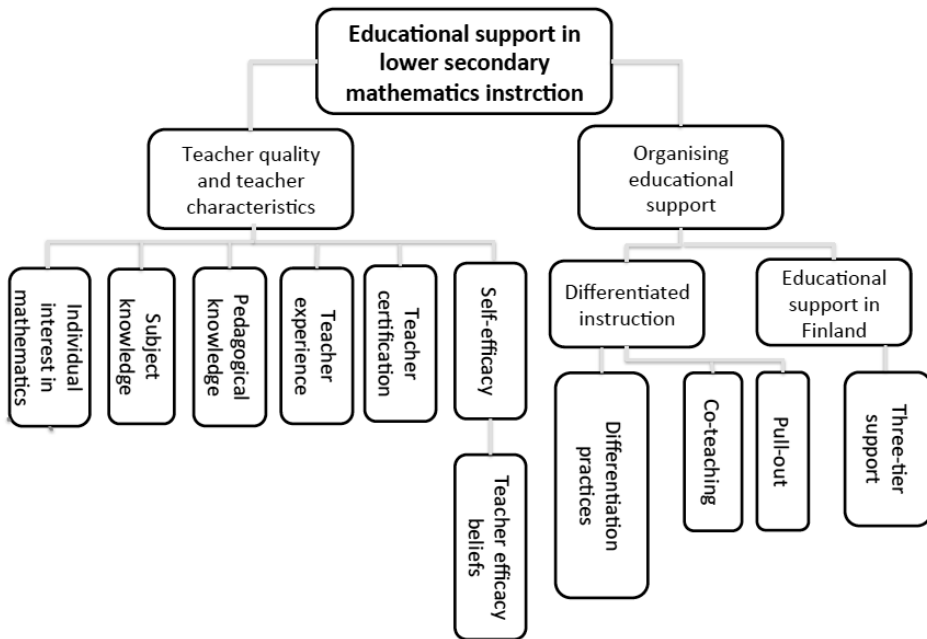


Figure 1. Overview of key concepts.

## 1.1. Low-performing students in mathematics

Low performance is reported to be a consequence and accumulation of several individual factors (e.g. cognitive, neuropsychological, genetic; Geary, 2010) and disadvantages (e.g. socio-economic status, immigrant background; Banerjee, 2016; OECD, 2016). While students in need of support in mathematics are found in almost every classroom, these students are not defined by one clear definition (Barnes, 2005; Mononen, 2014). Thus, several different terms are used in the literature to describe students in need of support in mathematics; for example, *low-achieving* (OECD, 2016), *low-attaining* (Koay, Kaur, Foong & Sudarshan, 2012), *low-performing* (OECD, 2013/2014), *students with mathematical difficulties* (Carnine, Jitendra & Silbert, 1997) and *at-risk* students (McCann & Austin, 1988). According to the literature, low-performing students can be defined as a heterogeneous group who underperform compared to their typically achieving peers in

mathematics and constitute approximately the lowest achieving 20% of an age group (Geary, 2013; Geary, Hoard, Nugent & Bailey, 2012; Mazzocco, Devlin & McKenney, 2008). This definition can be compared to the definition of students who fail to reach Level 2 of the Programme for International Student Assessment (PISA) (Education, Audiovisual and Culture Executive Agency [EACEA], 2011; OECD, 2013/2014), since Level 2 is the minimum level required to fully participate in society (OECD, 2013/2014). International and national evaluations have shown that mathematics has the highest number of low-performing students among all school subjects in Europe and in the United States (U.S.; National Center for Educational Statistics, 2014; OECD, 2013/2014). In this thesis, the terms *low-performing* and *students in need of support* are used for all students with undefined difficulties in mathematics and who do not meet the required standard of mathematics performance, without implying a cause.

## **1.2. Organising Educational Support in Mathematics**

In 1993, the United Nations (UN) declared that all children, youths and adults have the right to education in an integrated and general school setting (UN, 1993). Later, in 1994, the Salamanca Statement and Framework for Action (UNESCO, 1994) led most countries to state the policy of inclusion in their educational declarations. Inclusive education is a process of responding to diverse needs through increasing the participation of all students in learning and reducing exclusion from educational settings. To meet the requirements of inclusive education, schools often need to modify and adjust their current learning processes and environment. A change towards inclusive education requires economical recourses and a political will judged by the quality of basic education provided to all learners (UNESCO, 2005).

One of the key features of inclusive education is to provide diverse students with the support they need to gain successful learning experiences. There are several ways of organising the educational support, which varies across countries and cultures (Hausstätter & Takala, 2011; Anthony, Rotatori, Jeffrey, Bakken, Burkhardt, Obiakor, Sharma, 2014). The aspects of how to

organise the educational support depend on the people involved, such as the teachers, parents and peers, and these aspects should be implemented to ensure the best for the student in every situation. Such educational support can be provided in class by, for example, implementing differentiated instruction and co-teaching or by providing the student with support outside of the classroom, known as the pull-out model.

A common model for organising educational support is *Responsiveness to Intervention* (RtI; Fuchs, Fuchs & Compton, 2012; Fuchs & Vaughn, 2012). Johnson and Smith (2008) defined RtI as a school-wide process that integrates instruction, intervention and assessment, and that should be based on evidence-based research. RtI has been developed to support low-performing students through early identification and multitier (commonly three-tier) intensified instruction (Lembke, Hampton & Beyers, 2012). The first tier provides instruction for all students and includes differentiated instruction and flexible student grouping as common instructional practices; the second tier offers additional educational support in additional small groups or in-class support for those students not responding to instruction in tier one; and the third tier offers intensive instruction, usually one-to one, for students in need of more specialised support. Assessment is an important part of RtI to guarantee students' gains and performances (Riccomini & Smith, 2011). RtI, which is widely used in the U.S., has much in common with the three-tier educational support model used in Finland, although many differences exist according to both the theoretical and pedagogical frameworks (Björn, Aro, Koponen, Fuchs & Fuchs, 2015). As most of the research-based intervention programs focus on early grades, RtI has some challenges in secondary education (Johnson & Smith, 2008) caused by, for example, lack of school-wide processes and relevant assessment measures (Clarke, Lembke, Hampton, & Hendricker, 2011). Furthermore, the importance of teachers' professional skills for a successful implementation of RtI has been noted (Brownell, Sindelar, Kiely & Danielson, 2010; Hoover & Patton, 2008).

### 1.2.1. Differentiated instruction

Differentiation in instruction can be defined as ‘a systematic approach to planning curriculum and instruction for academically diverse learners’ (Tomlinson & Strickland, 2005, p. 6) and is based on teachers’ ability to adjust the work to the various needs of the student group (Konstantinou-Katzi, Tsolaki, Meletiou-Mavrotheris & Koutselini, 2013). While differentiated instruction is not new, it has gained a higher profile in recent years, and today, educational systems and parents expect teachers to be aware of the needs of each individual student – whether struggling, average or gifted – and to plan their instruction accordingly. Researchers such as Valiandes, Koutselini and Kyriakides (2011) and Pardini (2005) claimed that differentiated instruction has a positive impact on student achievement and that any increase in the differentiation of instruction in a classroom improves instructional effectiveness. Teachers can modify several elements, such as the content, process (methods of practice and performance), product (different way for student to show their progress), learning environment and learning profile, to assist students in the learning process based on their readiness and interest (Tomlinson & Strickland, 2005). Differentiation requires teachers to have experience in different teaching and learning methods and a strong knowledge of their students’ backgrounds, experiences, interests and learning profile (Kiley, 2011; Taylor, 2015; Tomlinson, 2008).

In 2015, Prast, Van der Weijer-Bergsma, Kroesbergen and Van Luit developed the process of differentiated instruction to create the *cycle of differentiation*, consisting of five steps: identification of educational needs, differentiated goals, differentiated instruction, differentiated practice and evaluation of progress and process. In this model, *instruction* refers to the teacher providing instruction to the whole class, subgroups of students or individual students, and *practice* refers to moments when students work on tasks, individually or in groups. The differences between the two above-mentioned models seems to be that the cycle of differentiation focuses more on identification and evaluation of progress than the previous differentiation in instruction model by Tomlinson and Strickland (2005). The later model is

also in line with the common support models used in schools today (Fuchs et al., 2012; Fuchs & Vaughn, 2012; Finnish National Board of Education, 2015).

As many students need support in their mathematics learning (Official Statistics of Finland, 2011), and the gap in mathematics performance continues to grow during compulsory education (Rautopuro, 2013; TIMMS, 2011/2015), differentiated instruction is of great importance in mathematics (NCTM, 2000). In this thesis, differentiation in mathematics instruction is measured using nine variables: differentiation of content, use of calculator, manipulative tools, flexible models for examinations, part-time special education, homework support, complementary oral examinations, co-teaching and remedial (supplementary) education (Roy, Guay & Valois, 2013; Tomlinson, 2008). However, differentiation in mathematics is found to be more challenging in Grades 6–12 than in earlier grades (Tomlinson & Strickland, 2005), mostly caused by the growing differences between students' mathematical levels during secondary education (Rautopuro, 2013; TIMMS, 2011/2015).

### ***1.2.1.1. Co-teaching***

As a consequence of the last decade's focus on high quality education for all students and the right for students in need of educational support to access the same instruction as their peers, the interest in co-teaching has intensified considerably (Friend, Cook, Hurley-Chamberlain & Shamberger, 2010). Co-teaching can be defined as a partnering of two educators who may or may not have the same area of expertise, delivering instruction together to a group of students (Dieker & Rodriguez, 2013; Friend et al., 2010; Walther-Thomas, Korinek, McLaughlin & Williams, 2000). A common model of co-teaching takes place in a classroom, with and without educational needs students, and a general education teacher and a special education teacher share responsibility for classroom management and instruction (Murawski & Dieker, 2004). The general teacher usually holds the critical and subject matter instructions, while the special education teacher provides the special expertise related to the process of learning and the need for individualised instruction

(Scruggs, Mastropieri & McDuffie, 2007). Friend (2015) defined six different types of organising co-teaching in the general classroom: *station teaching* (students are in two or more groups and both teachers instruct at their stations and students rotate), *parallel teaching* (students are divided into two groups and both teachers teach their groups the same content), *alternative teaching* (teachers teach their groups sometimes different content), *teaming* (teachers co-instruct the same group), *one teach-one assist* (one teacher leads instruction and the other interacts with students individually) and *one teach-one observe* (one teacher leads instruction and the other observes one student, a group of students or the whole class). Which model to use depends on the subject, the student group and the teacher. However, during co-teaching it is important that the students in need of educational support receive the type of instruction that is most suited to their needs (e.g. academic, context or behavioural; Friend, 2015).

The combination of the subject teacher's subject knowledge and the special education teacher's specialised instruction for low-performing students is a profitable educational setting (Mageira, Smith, Zigmund & Gebauer, 2005, Wilson & Michaels, 2006). Furthermore, a model in which the educational support is provided in classrooms by a co-teacher is considered an effective model for supporting students in mathematics, especially in secondary education (Hoover & Patton, 2008; Mageira et al., 2005; Saloviita & Takala 2010; Weiss & Lloyd; 2002). Additionally, general students in co-teaching classes felt supported by the co-teacher, and their level of understanding of the subject matter was enhanced by the different types of instruction and provided support (Wilson & Michael, 2006).

When examining studies of co-teaching, it is clear that for effective co-teaching to occur, several obstacles need to be overcome (Wilson & Michel, 2006). For example, Takala and Uusitalo-Malmivaara (2012) found that insufficient planning time was the highest barrier to effective co-teaching followed by a 'lack of functional models' and 'unclear roles'. Friend (2008) indicated the necessity for teacher classroom roles and administrative support for successful co-teaching, and Pancsofar and Petroff (2016) claimed that

personal experiences of co-teaching alongside pre- and in-service training in co-teaching are related to the successful implementation of co-teaching. Finally, for co-teaching to be effective, Murawski and Dieker (2004) stated that it has to be integrated with the school traditions and backed with the full support of the teachers and administrators.

#### ***1.2.1.2. The pull-out model***

The pull-out model refers to the removal of students from the classroom to administer small-group or one-to-one instruction in a separate (resource) room (Klinger, Vaughn, Schumm, Cohen & Forgan, 1998). While the content can be the same as that in the general classroom, additional focus might be placed on reviewing concepts learned earlier or special areas of weakness. Several studies have investigated the practical realisation of the inclusive education framework, with varying educational outcomes. For example, Lindsay (2007) reported marginally positive results, while Rea, McLaughlin and Walther-Thomas (2002) found moderate effects regarding mathematics, languages, science and humanities. Pull-out classes were found to be the most common model of special education in Finland during the first decade of the twenty-first century (Takala, Pirttimaa & Törmänen, 2009). However, the frequency of the pull-out sessions depends largely on the student's age, the subject to be learnt and the teacher group involved (Takala et al., 2009). For example, while special education teachers prefer a combination of inclusive and pull-out settings (Marston, 1996), subject teachers seem to prefer the pull-out model to providing in-class support (Rea et al., 2002; Saloviita & Takala, 2010; Takala et al., 2009). The pull-out model is considered intensive and educationally effective in a supportive environment, which also helps to improve some students' concentration levels (Marston, 1996; Takala et al., 2009). However, some negative aspects of the pull-out model are that children suffer from being separated from their class because they feel stigmatised (Hannes, Von Arx, Christiaens, Hevytaert & Petry, 2012; Klinger et al., 1998, Marston, 1996), and because special education teachers are required to



support students in various subjects at the secondary level, they might have insufficient subject knowledge (Dieker & Rodriguez, 2013).

In sum, as both models (in-class and pull-out) have their strengths and weaknesses, the students' individual needs should dictate which model to use. Thus, collaboration between special education and mathematics teachers is important for providing sufficient educational support.

### **1.2.2. Educational support in Finland**

In Finland, the education system has long been based on the policy of inclusion. Normalisation was a strong statement for the start of the comprehensive school system at the beginning of the seventies, and the new Basic Education Act (628) was launched in 1998 to guarantee educational equality for all, with a focus on equal rights to education, no matter the school or municipality. At that time, educational support was arranged in two forms, part-time and full-time special education. The more common support, *part-time special education* support was most often provided in pull-out settings by special education teachers. In addition, special education teachers also began to work as supervisors to develop general education teachers' skills for coping with the diverse classroom (Sundqvist, 2012). The aim of part-time special education was to remedy mild difficulties in reading, writing, mathematics and behaviour (Jahnukainen, 2011); thus, no official decision was needed to provide this type of support.

However, the process to receive full-time special education was somewhat laborious, involving a required consultation with a health care provider (e.g. a psychologist or physician) as well as an official decision made by the municipality educational administration. An individual education plan was then made based on observations, assessments and reports from teachers and the student welfare group (Finnish National Board of Education, 2004). In 2005, about 7% of the Finnish compulsory education students received full-time special education (Official Statistics of Finland, 2010), which followed the general education or an individualised curriculum (Finnish National Board of Education, 2004).

During the first decade of the twenty-first century, the number of students in need of support in Finland steadily increased from 5% to 8%. However, this 60% increase in students receiving full-time special education between 2001 and 2009 was considered economically intolerable (Official Statistics of Finland, 2010). In addition, a significant variation was noticed among the number of students receiving full-time special education between the municipalities, and as each municipality used different inclusion criteria for special education, inequalities were evident in the provision of special education (Thuneberg et al., 2013b).

In 2004, delegates from the ten biggest Finnish municipalities wanted to enact changes to the special education support system, and in 2006, a report concerning the special education system was handed to the Ministry of Education (Salo, 2010). In the following year, the Special Education Strategy (SPES) was launched (Ministry of Education, 2007). This strategy proposed to decrease the differences between the municipalities by (1) supporting the basic principles of Finnish education, (2) emphasising early identification and learning support in general classroom settings and (3) establishing common administrative procedures. To ensure that the learning support would be gradual, a new step known as 'intensified support' was included (Ministry of Education, 2007). Three years later, in 2010, the national core curriculum was updated to reflect the proposed changes, which are still in place today (Finnish National Board of Education, 2011, 2015).

#### ***1.2.2.1. The three-tier model for educational support***

The three-tier educational support model was a step towards inclusion, which required teachers to develop a new way of thinking and presented new models for organising the work in schools (Johnson & Smith, 2008; Thuneberg et al., 2013a). The three-tier support model (Figure 2) focuses on the identification of learning difficulties, early intervention, educational differentiation and collaboration between professionals in schools (Finnish National Board of Education, 2011, 2015).

The first tier, *general support*, is provided to all students in basic education as a part of everyday teaching. General support is offered by classroom or subject teachers through educational differentiation, which involves adjusting the content or instruction to suit students' readiness, interests or learning profile. If this support fails to help the student to keep up with their peers, the teachers and the student welfare group evaluate the student's need for support using a *pedagogical assessment document*. This document details the support that has been given and the additional support the student requires to succeed (i.e. a student plan). In the second tier, *intensified support*, teachers are required to provide intensified support for a limited period and evaluate the student's progress regularly to determine whether the support is sufficient. The special education teacher, the general or subject teachers, the student and the students' guardians collaborate to create a student plan, which includes what kind of support the student needs to progress. If the student does not progress as expected, it will then be determined whether he or she should receive special support. If the student requires *special support*, they move into the third tier.

To determine the type of special support required, the teachers collaborate with the school's student welfare group to create a pedagogical statement document. The education provider (usually the principal) makes the final decision about whether the student will receive special support. For each student receiving special support, an individual educational plan (IEP) is required, which is developed by the teachers, the student and the student's guardians. The plan details the role and responsibilities of each participant (school, student and home) in supporting the student's learning process. Special support allows the student to follow a general or individualised curriculum and ensures the student receives the support that he or she needs to complete the compulsory education.

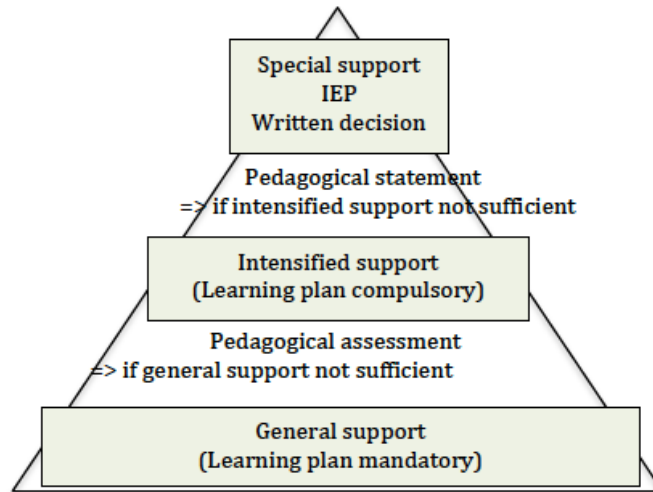


Figure 2. The Finnish three-tier model for educational support.

In 2015, 7.3% of the students in compulsory education in Finland received special support services, and about 22.7 % of all students received part-time special education at some point during the school year (general, intensified or special support; Official Statistics of Finland, 2016). Of the full-time special education (special support) students, 18.9% received all of their education in general education classes, 41.5% in both special and general special classes, and 39.7% in special classes or schools only (Official Statistics of Finland, 2016). In the Swedish-speaking schools in Finland, the number of integrated students in general education (i.e. students in third tier) is generally higher than in Finnish-speaking schools (National Institute for Health and Welfare, 2015). This difference is usually due to few Swedish-speaking special schools (long distances and few students) which has developed a tradition to include most students in general classes and schools. In the Swedish-speaking schools, almost 80% of students receiving special support (full-time special education) receive part or all of their education in general classes (compared to 60% in the Finnish-speaking schools; National Institute for Health and Welfare, 2015).

### 1.3. Teacher Quality and Teacher Characteristics

Teachers' work in school has changed over the last decade, and this change can be noticed at several levels. At the *individual* (student) *level*, teachers need to focus more on initiating and managing learning processes and responding effectively to the individual learning needs of students. At the *classroom level*, the teacher now works in multi-cultural classrooms, with a cross-curricula emphasis on including students with diverse needs. At the *school level*, teachers are expected to work in multi-professional teams, focus on systematic improvement planning and implement the use of information and communication technology (ICT) in education and administration. In addition, the importance of collaboration between parents and the society is increasing constantly, and as reports (e.g. OECD, 2013/2014, 2016) relate teacher quality to student performance, increased research on teacher quality has led to many national educational documents (e.g. U.S. Department of Education, 2002; Finnish National Board of Education, 2011, 2015).

During the last decade, several studies have highlighted the importance of ensuring highly qualified teachers for all students (see No Child Left Behind Act [NCLB], U.S. Department of Education, 2002), especially in mathematics (Bolyard & Moyer-Packenham, 2008; Brownell et al., 2010; Clotfelter et al., 2007; Flores, Patterson, Shippen, Hinton & Franklin, 2011; Rosas & Campbell, 2010; Tara, 2012). However, teacher quality can be defined from the viewpoint of the researcher, policymaker or the educator: (1) the researcher usually operationalises teacher quality and identifies variables in relation to student achievement, (2) the policymaker considers that teacher quality should meet a certain standard of quality and (3) the teacher views a qualified teacher as a measure of subject and pedagogy knowledge and of professional development (Bolyard & Moyer-Packenham, 2008). According to the NCLB, a highly qualified teacher holds at least a bachelor's degree and a full certification and demonstrates competence in subject knowledge and teaching skills. The National Council of Teachers of Mathematics defines a highly qualified teacher in mathematics as one who has a deep knowledge in mathematics and the capability to guide the students to understand and learn

mathematics. A highly qualified teacher also uses a wide range of learning strategies and knows their students well (how the students learn mathematics best; NCTM, 2005). Traditionally, teacher quality has been measured by characteristics that are easy to measure and control such as certification, experience and subject knowledge. However, more recent research has shown that many other characteristics such as self-belief, motivation and interest have an impact on student performance, but they are much harder to measure (Hattie, 2015; Bong & Skaalvik, 2003; Bursal, 2010; Evans, 2011; Gresham, 2008; Kim et al., 2014; Swars, 2015; Swars, Hart, Smith, Smith & Tolar, 2007; Swars, Smith, Smith & Hart, 2009; Tschannen-Moran et al., 1998; Woodcock & Reupert, 2016). In this thesis, teacher quality is analysed according to the following teacher characteristics: subject and pedagogical knowledge, certification status, experiences in instruction, teacher efficacy beliefs and individual interest in mathematics.

### **1.3.1. Subject and pedagogical knowledge in mathematics**

Several studies have reported that teachers' subject knowledge has a positive effect on student achievement, especially in mathematics and during secondary education (Bolyard & Moyer-Packenham, 2008; Clotfelter et al., 2007; Feng & Sass, 2013; Hill, 2007; Kukla-Acevedo, 2009; Telese, 2012). Additionally, low-performing students can develop their skills to succeed in mathematics through discussions about mathematical problems (Boyd & Bargerhuff, 2010; Mevarech & Kramarski, 2014; Neild, Farley-Ripple & Byrnes, 2009). However, to understand not only mathematical concepts and computations but also the processes required for mathematical reasoning and to communicate about mathematical problems, the teacher needs strong mathematical subject knowledge (Griffin, Jitendra & League, 2009; Jurik, Gröschner & Seidel, 2014). Strong mathematical subject knowledge also enables teachers to spend more time on questioning, discussing and reasoning about mathematical processes (Griffin et al., 2009). As low-performing students tend to have a more passive role in the classroom, teachers' awareness of valid questions and student engagement is important for

encouraging students to participate in mathematical discussions (Griffin et al., 2009). Communication in mathematics also means using ‘mathematical language’ for mathematical concepts as a natural part of the instructional practice (Seah, 2012). Furthermore, teachers’ familiarity with mathematical subject knowledge predicts the number of instructional practices that the teachers provide for low-performing students in mathematics (Maccini & Gagnon, 2006).

The teacher needs pedagogical knowledge to introduce, teach and make mathematical concepts understandable. In mathematics, pedagogical knowledge can be defined as the teachers’ mathematical knowledge for teaching (MKT; Hill, Rowan & Ball, 2005). MKT covers three categories related to teachers’ mathematical knowledge: (1) common subject knowledge (i.e. mathematical knowledge and skills used in settings other than teaching), (2) specialised subject knowledge (i.e. mathematical subject knowledge and skills especially for teaching mathematics), and (3) horizon subject knowledge (i.e. an awareness of how different mathematical areas are related; Ball, Thames & Phelps, 2008). A review by Depaepe, Verschaffel and Kelchtermans (2013) found a positive impact of MKT on teachers’ instructional practices and student performance, and Hill et al. (2005) found that mathematical knowledge for teaching is positively correlated with students’ mathematical gains during the first and third grades. This implies that for even the most basic elements of the mathematical content (including basic content in Grades 7–9), the teacher must be familiar with the subject and the underlying mathematical theories.

### **1.3.2. Teacher certification**

While some studies report that the teacher’s certification status has a positive impact on student performance (Clotfelter et al., 2007; Darling-Hammond & Youngs, 2002; Goldhaber, Brewer & Amer, 2000; Neild et al., 2009), other studies have conflicting results (Decker, Mayer & Glazerman, 2004; Kane, Rockoff & Staiger, 2006). Especially in secondary mathematics, certification is considered great importance for student achievement (Goldhaber et al., 2000).

The requirements for teacher certification also vary between countries for all teachers including subject teachers and those in special education (Ingersoll, 2007; Sahlberg, 2011b; Wang, Coleman, Coley & Phelps, 2003).

Existing research has also reported that teachers who major in mathematics or are certified to teach secondary-level mathematics have a greater positive correlation with students' mathematical achievement in middle school than do teachers with a primary school or Grade 4–9 certification (or other complementary certifications; Clotfelter et al., 2007; Neild et al., 2009; Hill, 2007). Teacher certification also seems to have a larger effect on student gain than the effect of a teacher degree in subject knowledge (Goldhaber & Brewer, 2000). However, many countries lack certified teachers in mathematics, especially in lower secondary education (Neild et al., 2009; Kumpulainen, 2014).

Evaluating the teacher effect for special education teachers is complicated because of the diverse and unique challenges associated with instruction in special education (Johnson & Semmelroth, 2014). However, Nougaret, Scruggs and Mastropieri (2005) found in their study of first-year special education teachers that certified teachers outperformed non-certified teachers in planning and preparation, classroom environment and instruction. Feng and Sass (2013) also reported a higher gain in achievement by students who received support from teachers certified in special education than by students who received support from teachers not certified in special education. These results underscore that, similar to subject teachers, special education teachers benefit from having a certification. In many countries, special education teachers are certified to teach grades K–12; however, as special education programmes primarily focus on the content for grades 1–6, teachers must deal with a wide range of topics on a level with which they are not necessarily familiar, especially in mathematics (Faulkner & Cain, 2013; Rosas & Campbell, 2010). In addition, Bouck (2005) reported that a very low percentage of special education teachers in middle and high school had proper training for instruction secondary education during their education despite being certified for both middle and high school.



To be certified to teach mathematics in secondary education (Grades 7–12) in Finland, a master’s degree is required with at least a minor (60 ECTS [European Credit Transfer and Accumulation System]) in mathematics and in education (including practice) as well as a major (120 ECTS) in another subject (if not in mathematics). Certification in special education (K-12) also requires a master’s degree with at least a minor in Special Education (including practice) and a major in another subject (if not special education). It takes approximately five years to obtain a teacher certification in Finland.

### **1.3.3. Teacher experience in instruction**

In this thesis, teacher experience is defined as the teacher’s cumulative experience of instruction. Excising research imply that teacher experience correlates differently to student achievement than other teacher characteristics. While the effect of teacher experience on student achievement is found to be positive, the correlation seems to be squared instead of linear (Clotfelter et al., 2007; Harris & Sass, 2011; Ladd, 2008). Evidence points to a strong positive development of impact on student performance at the beginning of teachers’ careers, which plateaus at 5–10 years’ experience and declines at around 20–25 years (Bolyard & Moyer-Packenham, 2008, Feng & Sass, 2013; Ladd, 2008). The effect of experience on student achievement in mathematics also increases by grade (Bolyard & Moyer-Packenham, 2008, Harris & Sass, 2011), and the effect of the first year’s experience is stronger in math (middle school) than in other subjects and is more consistent for elementary and middle school than for high school (Harris & Sass, 2007). Hill (2007) claimed that teachers with more experience in instruction performed better than novice teachers in mathematical knowledge, and middle school teachers with experience of teaching in high school performed better than teachers without such experience. In the U.S., teachers with less than three years’ experience are more likely to teach in schools in low-socioeconomic areas (Clotfelter et al., 2007); consequently, these teachers will probably teach a larger number of low-performing students than more experienced teachers in higher socio-economic area schools. Huang and Moon (2009) found that a

year's experience of a certain grade level had a stronger effect on student gain than total year of teacher experience. Teachers' experience with diverse learners is also reported to have a positive impact on teachers' attitudes and beliefs (Subban & Sharma, 2005; Ekins, Savolainen & Engelbrecht, 2016).

#### **1.3.4. Self-efficacy**

The origin of self-efficacy lies in social cognitive theory, which refers to a person's subjective perception of his or her capability to achieve a preferred outcome in a specific context (Bandura, 1977). Self-efficacy, which is formed through experiences, incorporates what individuals believe they can do with their existing skills rather than the actual skill itself (Bandura, 1977; Bong & Skaalvik, 2003). People's beliefs in their efficacy are developed through four main sources of influence: mastery experience, vicarious experiences, physiological factors and social persuasion (Bandura, 1994/1998). The most important factor contributing to an increase in self-efficacy is the experience of mastery: success raises self-efficacy, while failure lowers it. Vicarious experience is defined as experiences when people, similar to oneself, successfully manage tasks, while social persuasion generally manifests as direct encouragement or discouragement from another person. Physiological factors are more related to one's belief in implications for physiological responses (e.g. shakes, pains, fatigue and fear) in a specific situation rather than the physiological response itself (Bandura, 1994/1998). Self-efficacy beliefs are also affected by processes and emotions that affect an individuals' motivation which are skill-, task- and domain-specific (Bandura, 1997). People with high beliefs in their capabilities usually approach difficult tasks as challenges to be mastered rather than threats to be avoided; such an efficacious approach fosters deep interest and involvement in activities (Bandura, 1994/1998).

##### **1.3.4.1. Teacher efficacy beliefs**

Teacher efficacy beliefs (i.e. teacher self-efficacy) are defined as a teacher's beliefs and perceptions about his or her ability to teach students with varying

needs and qualifications (Tschannen-Moran et al., 1998) and to bring about desired student engagement and learning outcomes (Bandura, 1977, 1997; Skaalvik & Skaalvik, 2007). Teacher efficacy beliefs are also connected to a teacher's capability to organise and execute teaching tasks in specific contexts (Skaalvik & Skaalvik, 2007). Tschannen-Moran et al. (1998) introduced a conceptual foundation in which teacher efficacy beliefs are based on a two-dimensional model, which includes the teaching task and its context and the self-perception of teaching competence. However, teacher efficacy beliefs were later noticed to be more complex, and thus measurements have to be adapted to today's standards, which have a focus on the more inclusive and student-centred context (Skaalvik & Skaalvik, 2007). Teacher efficacy beliefs also vary between contexts and over time (Tschannen-Moran et al., 1998). Thus, it is important for pre-service teachers and novice teachers to establish high teacher efficacy beliefs at an early stage because evidence shows that, once established, teacher efficacy beliefs can be hard to change (Bandura, 1997).

Teacher efficacy beliefs are related to teaching strategies, instruction, student motivation (Midgley, Feldlaufer & Eccles, 1989; Thoonen, Slegers, Peetsma & Oort, 2011) and student achievement (Austin, 2013). Teachers with high efficacy beliefs tend to provide a more student-centred instruction; invest more effort into implementing new teaching methods, strategies and personalised learning support (Holzberger et al., 2013); and demonstrate greater flexibility in classroom engagement and lesson design (Temiz & Topeu, 2013). Teachers working with low-achieving students benefit from having high self-beliefs, which helps to maintain teachers' interest, motivation and belief towards their work (King-Sears & Baker, 2014). In addition, Malmberg, Hagger and Webster (2014) found that teacher efficacy beliefs are positively correlated with higher task- and situation-specific mastery experiences.

*Mathematics teaching efficacy*, which is defined as a teacher's belief in his or her ability to teach mathematics effectively (Enochs, Smith & Huinker, 2000), is considered a significant predictor of teachers' instructional strategies

for mathematics, and teachers with high mathematics teaching efficacy have been shown to be more effective in teaching the subject (Enochs et al., 2000; Gresham, 2008; Swars, 2005). Teachers' mathematics performance and their mathematics self-efficacy are also positively correlated with mathematics teaching efficacy (Bates, Lathan & Kim, 2011; Newton, Evans, Leonard & Eastburn, 2012; Swackhamer, Koeller, Basile & Kimbrough, 2009). In addition, efficacy beliefs in teaching mathematics are formed through one's mathematics experiences and subject knowledge (Phlippou & Christou, 2002), and through teachers' experience in instruction (mastery experience in mathematics instruction has a positive effect on teacher efficacy, while the perception of failing in instruction has a negative effect on his or her mathematics teacher efficacy beliefs; Kim et al., 2014). A teacher with high mathematics teaching efficacy is likely to be more deeply involved in student instruction and classroom engagement and in implementing new teaching methods and strategies (Bates et al., 2011; Swackhamer et al., 2009; Takahashi, 2011; Temiz & Topeu, 2013). Since student achievement is affected by teachers' instruction and motivation (Hattie, 2009), high teaching efficacy in mathematics might have an indirect positive effect on students' achievement in mathematics. Furthermore, mathematics teaching efficacy has been found to negatively correlate with teachers' mathematics anxiety (Bursal & Pazonkas, 2006; Gresham, 2008).

### **1.3.5. Individual interest in mathematics**

The concept of interest has been defined as a psychological state that occurs during interactions between persons and their objects of interest (Hidi, 2006). A distinction is also made between situational and individual interest (Hidi & Renninger, 2006; Renninger, 2009; Renninger, Ewen & Lasher, 2002; Renninger & Hidi, 2011). Situational interest is environmentally triggered and described as a transient state involving affective reactions and focused attention (Hidi, 2006; Renninger & Hidi, 2002). Conversely, individual interest is a more stable relationship between the person and certain subject or domain (e.g. mathematics) and can be described as the attitudes,

expectations and values with which he or she identifies (Krapp, 2002). While it is well known that interest has an effect on student learning and motivation (Krapp, 2002; Long & Woolfolk Hoy, 2006), interest as a single factor is not enough to succeed – at least a basic level of subject knowledge is necessary to make progress (Linnenbrink-Garcia, Pugh, Koskey & Stewart, 2012). As interest is a cognitive and affective motivational variable, learners' experience with an object or subject can start developing interest in both positive and negative ways (Renninger, 2009; Renninger & Su, 2012). The deepening of individual interest is said to be linked with the desire to increase one's knowledge in and engage with objects of interest as well as feelings of enjoyment, competence and personal value (Renninger & Hidi, 2011; Renninger et al., 2002).

Despite the importance of the impact of teachers' interest in and beliefs towards mathematics in terms of their instruction, and subsequently, the formation of their students' beliefs, interests and attitudes towards learning mathematics, the literature contains limited research on the topic (Charalambos, Philippou & Kryiakides, 2002; Karp, 1992; Kunter et al., 2008; Long & Woolfolk Hoy, 2006). Teachers' individual interest in mathematics is also said to be associated with teachers' self-concept, self-efficacy and subject knowledge (Long & Woolfolk Hoy, 2006).

#### **1.4. Present Study**

The aim for an equal education for all students has entailed several organisational and pedagogical reconstructions in the classrooms during the last decade. Implementing these new strategies requires teachers and administration to adapt to new situations and regulations (Thuneberg et al., 2013a). Special and general education teachers are expected to cooperate to ensure high quality education for all students, and the importance of mathematical skills has increased the focus on research in educational support in mathematics. Despite this growth in interest in educational support in mathematics, there is still a lack of research on the field of instructional and

organisational factors affecting the educational support in mathematics in lower secondary education.

### **1.4.1. Aims of the study**

The aim of this thesis is to investigate organisation- and teacher-related factors for teaching students in need of educational support in lower secondary mathematics instruction.

The following are the specific aims of this study:

1. Examine organisational and instructional practices for educational support in lower secondary mathematics.
2. Investigate special education and mathematics teachers' perceptions of their readiness for teaching students in need of educational support mathematics in lower secondary education.
3. Examine the impact of teacher efficacy beliefs on differentiated instruction practices in lower secondary mathematics education.
4. Explore the effect of pre-teachers' interest and subject knowledge in mathematics on teacher efficacy beliefs.

More specifically, Study I examines the organisation of the educational support in mathematics used in Grades 7–9 of the Swedish-speaking schools in Finland and focuses on how the teachers perceived the changes in work following the reform for educational support. Study II focuses on special education and mathematics teachers' perceptions of their teacher efficacy beliefs for teaching students in need of educational support in mathematics in relation to certification, experience and teacher group. Study III focuses on the special education and mathematics teachers' teacher efficacy beliefs in relation to differentiation practices and investigates the impact of certification and experience of differentiation practices. Study IV examines the factors affecting teacher efficacy beliefs, particularly the interrelations between interest, subject knowledge and teacher efficacy. Figure 3 presents an overview of variable relations for the four studies.

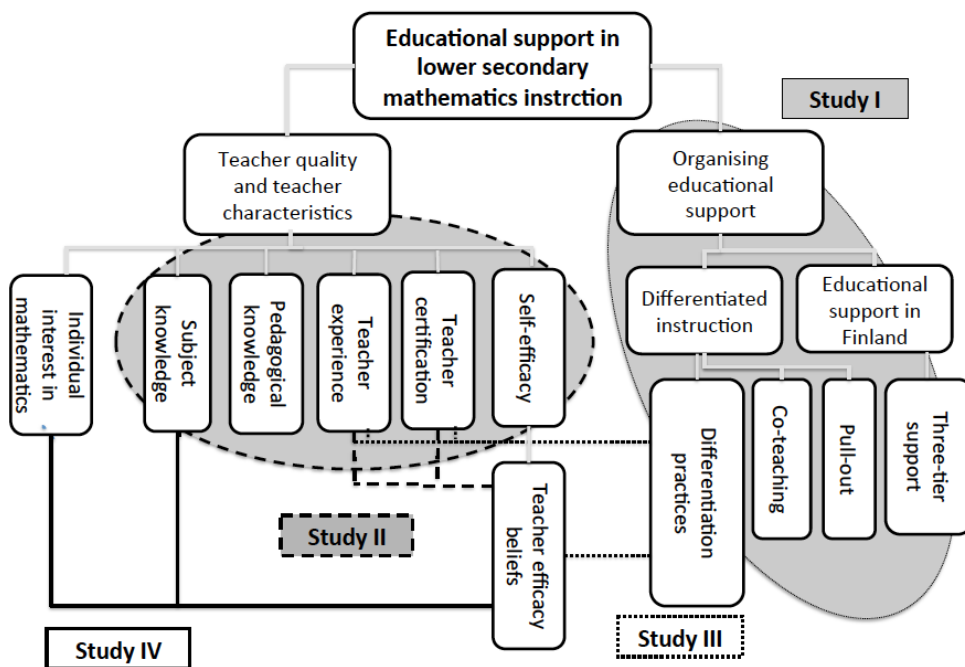


Figure 3. An overview of variable relations for the original studies.

## **2. Overview of the Original Studies**

### **2.1. Study I**

#### **2.1.1. Aims**

The purpose of Study I is to investigate and clarify practices used in lower secondary schools for students in need of mathematics support. Study I also examines whether special education and mathematics teachers' perceive any differences in their work before and after the change in legislation regarding educational support (Finnish National Board of Education, 2011).

#### **2.1.2. Participants, procedure and measures**

The participants in Study I were 69 special education (26 women and one man) and mathematics (21 women and 21 men) teachers teaching students in Grades 7–9 in Swedish-speaking schools in Finland. Of the special education teachers, 78% had worked for five years or more and 72% were certified teachers in special education. Of the mathematics teachers, 71% had worked for five years or more and 73.5% were certified mathematics teachers.

The teachers answered an electronic questionnaire covering which models (e.g. in-class support or pull-out) and practices (differentiation in content, flexible student grouping, extra time during assessments, use of manipulative tools, calculator etc.) they use in their educational support for mathematics. The questionnaire also examined the teachers' perceptions of the efficiency of the educational support in mathematics and the perceived change in work practices after the legislation reform regarding educational support. The questionnaire comprised multiple choice and open-ended questions.

#### **2.1.3. Analysis**

Descriptive statistics and analyses were conducted for all variables used in the study. Nine differentiation practices (flexible models during assessment, differentiation in content, use of calculator, manipulative tools, part-time



special education, remedial education, homework support, complementary oral examinations and co-teaching) were judged on a five-point Likert-type scale ranging from 1 (*not at all*) to 5 (*often*). To analyse the differences between teacher groups and differentiation practices, a *t*-test was conducted, and the reliability of the study was tested using Cronbach's alpha (0.71).

#### **2.1.4. Results**

The results indicate that the special education teachers spent most of their (instruction) time with students in need of support in mathematics, followed by language support (mother tongue and foreign languages). In addition, more than one third of the special education teachers reported spending the majority of their time teaching in pull-out settings; however, not all the special education teachers preferred this model, even if they argued that this model offers more time for learning, to review content and hold discussions. However, co-teaching was mentioned as an efficient use of (teacher) resources and that cooperation and information flow was easier with co-teaching. Of the mathematics teachers, two thirds preferred the pull-out model because students tend to concentrate better and because this model allows more teacher time per student than in-class support.

Regarding differentiation in instruction, the models most used by both teacher groups were flexibility according to assessment situations, followed by use of the calculator and differentiation in content. However, the special education teachers used 'part-time special education' and 'co-teaching' at significantly higher frequencies than did the mathematics teachers. Flexible student grouping was used in Grade 9 by 91% of the mathematics teachers; however, none of the teachers used it in Grade 7.

Special education and mathematics teachers both perceived the efficiency of educational support in mathematics to be moderate, and two thirds of the mathematics teachers perceived that they had sufficient resources for effective educational support in mathematics. However, there was a wide range in the amount of extra resources (e.g. an extra teacher in class) from 0%–100% of the lessons (some teachers had access to an extra

resource all lessons and some teachers had never access to an extra resource). On average teachers had access to an extra recourse about one third of the lessons.

Almost two thirds of the special education teachers perceived a change in their work after the legislation reform compared to 43% of the mathematics teachers. Most of the changes in work were associated with the documentation requirements of pedagogical assessments and statements; few teachers mentioned changes to instructional practices, collaboration or educational settings.

### **2.1.5. Discussion**

The main aims of Study I were to investigate the models and practices used in the educational support in mathematics for lower secondary students and to examine how the teachers perceived the effects of the change in legislation on their practical work. The results from this study indicated that the pull-out model was most commonly used for students in need of mathematics support in lower secondary education. Additionally, both teacher groups (special education and mathematics) used the differentiation practices mostly with the same frequency, except for part-time special education and co-teaching, which were used more by the special education teachers than by the mathematics teachers. Furthermore, the flexible student grouping was used by most of the mathematics teachers in Grade 9. Regarding the change in their practical work after the legislation reform, the majority of special education teachers perceived an increased amount of administrative work rather than changes to their instructional practices or support models. In addition, both teachers' groups considered the educational support in mathematics to have moderate efficiency.

The results of Study I, which found that the pull-out model was the most used educational setting for students in need of educational support in mathematics, are in line with the results of Takala et al. (2009), who found that subject teachers at subject teachers preferred to use the educational support outside the classroom instead of in class, especially for mathematics. These

similar findings indicate a lack of notable changes in the settings for the educational support following the legislation reform. Lempinen (2016) also indicated that the progress in Finland towards an inclusive education is slow. As research has shown that inclusive education for students in need of support has a positive impact on student performance (Hoover & Patton, 2008; Saloviita & Takala 2010; Weiss & Lloyd; 2002), this is something that teachers, school leaders and teacher education need to focus on in the future. Especially in secondary education, where not all special education teachers are necessary familiar with the subject knowledge, co-operation between special education and mathematics teachers is important (Mageira et al., 2005; Rimpola, 2011).

Study I found that special education teachers noticed a greater change in their work practices after the legislation reform than did the mathematics teachers. However, most changes were related to their administrative work rather than their teaching models. This finding supported that of Pesonen et al.'s (2015) study. Pesonen et al. (2015) also reported increased collaboration among teachers for students in need of support; however, these findings were not supported in the present study.

In terms of the frequency of using differentiation practices, few differences were found between the special education and mathematics teachers. These findings are in line with the study by Maccini and Gagnon (2006), who also found that the mathematics and special education teachers used instructional practices with the same frequency. Furthermore, in the present study, 'flexible arrangements' was the most frequently used differentiation practice and the least used was co-teaching. In this study, both teacher groups reported that differentiation was difficult to implement in general secondary education, which mathematics teachers mentioned as a reason for preferring the pull-out model. These findings can be compared to a study by Kiley (2011), who found that secondary teachers used differentiation practices to a moderate extent and had difficulties conceptualising differentiation. Kiley (2011) also reported that the only teacher characteristic that had an impact on the use of differentiation practices

was if the teacher valued differentiation as important for student performance. As differentiation is an important component in the Finnish National Core Curriculum (Finnish National Board of Education, 2011, 2015) for supporting students in need of educational support, teachers need to be encouraged and supported to collaborate and to benefit from both teacher groups specialised knowledge (Maccini & Gagnon, 2006). Rimpola (2011) found that both special education and mathematics teachers perceived some benefits from co-teaching including shifts in instruction, classroom management and support. However, some negative aspects were also reported in Rimpola's study. Special education teachers reported feeling uncomfortable in class with limited authority and sometimes even felt unwelcome in the classroom. In Finland, as well as in other countries (e.g. Brownell, Ross, Colón & McCallum, 2005), teacher education for subject teachers and special education teachers is often kept separate, with little teacher practice in common. However, if cooperation between the pre-service special education teachers and general teachers started at the early stages of teacher education, obstacles to collaboration would likely be lower, and positive experiences of cooperation would encourage such practices to continue when pre-service teachers become in-service teachers (Cochran-Smith & Dudley-Marling, 2012).

## **2.2. Study II**

### **2.2.1. Aims**

The purpose of Study II was to examine special education and mathematics teachers' readiness to teach lower secondary students in need of mathematics support and to analyse the effect of teacher characteristics (certification, experience and gender [mathematics teachers]) on teacher efficacy beliefs. This study also investigated the mathematics teachers' perceived pedagogical knowledge and the special education teachers' perceived subject knowledge in mathematics.

### 2.2.2. Participants, procedure and measures

The participants in Study II were 27 special (26 women and one man) and 42 mathematics (21 women and 21 men) teachers, teaching students in Grade 7–9 in Swedish-speaking schools in Finland. Of the special education teachers, 78% had worked for five years or more and 72% were certified teachers in special education. Of the mathematics teachers, 71% had worked for five years or more and 73.5% were certified mathematics teachers.

An electronic questionnaire for special education teachers and mathematics teachers was sent to all principals of Swedish-speaking schools in Finland with Grades 7 to 9 ( $N=55$ ) to forward to the special education and mathematics teachers in the schools. The questionnaires comprised items regarding the teachers' self-perceived efficacy beliefs and their subject and pedagogical knowledge for teaching mathematics to low-performing students in Grades 7–9. Eight items addressed teacher efficacy beliefs, for which teachers rated their confidence in teaching students in need of mathematics support. All items were judged on a four-point Likert-type scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). There was also one item to measure special education teachers' self-perceived level of mathematical subject knowledge and one item regarding the subject teachers' self-perceived pedagogical knowledge for teaching low-performing students in mathematics, both judged on a four-point Likert-type scale ranging from 1 (*low*) to 4 (*high*).

### 2.2.3. Analysis

The analyses were conducted in stages. First, the quality and dimensionality of the measures were investigated using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). An examination of the factor loadings revealed that three items did not load strongly on the factor, which were thus discarded from subsequent analyses. Second, a series of CFAs with covariates were run to analyse the effect of teacher characteristics on teacher efficacy beliefs. Finally, *t*-tests were conducted to analyse subject teachers' self-perceived pedagogical knowledge and special education teachers' subject

knowledge. Furthermore, Cronbach's alpha was calculated, with an acceptable result ( $\alpha=.82$ ).

#### **2.2.4. Results**

The results of the analyses showed that teacher group, certification status and gender all *individually* predicted teacher efficacy beliefs. Special education teachers, female teachers and certified teachers reported higher teacher efficacy beliefs compared to subject teachers, male teachers and noncertified teachers. The only covariate that did not predict teacher efficacy beliefs was teacher experience. The full model, was then fitted with all significant covariates from the previous models (with single covariates). In the full model, the only significant predictor of teacher efficacy beliefs was the teacher group. This model explained 52% of the variance in teacher efficacy beliefs.

Special education teachers were asked to rate their mathematical knowledge. The results indicated that the special education teachers perceived their mathematical knowledge as moderate (3.3), and this was not related to teacher experience or certification status. As there was only one male respondent in the special education group, gender differences were not tested.

The mathematics teachers answered a question about their pedagogical knowledge for teaching low-performing students in mathematics. The results showed that the mathematics teachers self-reported a high (3.8) level of pedagogical knowledge for teaching low-performing students in mathematics. The results indicated no significant differences in gender, experience or certification status.

#### **2.2.5. Discussion**

The aim of Study II was to investigate how special education and mathematics teachers' efficacy beliefs to teach mathematics to low-performing students in the lower secondary general classroom were predicted by teacher group, certification, experience and gender. This study also investigated how the special education teachers perceived their subject knowledge in mathematics

and how the mathematics teachers' perceived their pedagogical knowledge for teaching low-performing students.

The only difference in teacher efficacy found in this study was for teacher group, with higher efficacy beliefs noted for special education teachers; no significant differences in teacher efficacy beliefs were found for gender, teacher experience or certification status. Existing research has reported varied results for the impact of teacher characteristics on teacher efficacy beliefs. For example, Voris (2011) did not find any differences in teacher efficacy between alternatively and traditionally certified special education teachers, while others noted positive relations between certification and teachers' mathematics efficacy beliefs (Kim et al., 2014). For gender differences, a variety of results have also been reported. Klassen and Chiu (2010) observed efficacy beliefs to be less positive for women, while Yeo, Ang, Chong, Huan and Quek (2008) and Tejeda-Delgado (2009) found no differences between men's and women's efficacy beliefs for teaching low-performing students. However, in this study, when the variables were analysed separately, gender and certification status predicted significantly higher teacher efficacy beliefs with a positive effect for special education teachers, certified teachers and female teachers. The small sample used in the study may be a reason for this difference in teacher efficacy beliefs, as also the effect sizes for these variables were moderate.

Existing research reported the relationship between teacher experience and teacher efficacy beliefs as nonlinear and complex (Kim et al., 2014; Klassen and Chiu, 2010), and influenced by the psychological context of the work environment (Bandura, 1994/1998; Klassen and Chiu, 2010). Additionally, the most important factor contributing to an increase in self-efficacy is the experience of mastery: success raises self-efficacy, while failure lowers it (Bandura, 1994/1998). This suggests that if a teacher has a positive experience of teaching students in need of support, their teacher efficacy will rise, while less positive experiences will lower their teacher efficacy. As teacher efficacy is usually formed in the early stage of a teacher's career and can be hard to change (Bandura, 1997), it is important to strengthen novice

teachers' efficacy beliefs during their teaching education so that they can teach students in need of support effectively.

In this study (Study II), the mathematics teachers reported having a high level of pedagogical knowledge for teaching low-performing students in mathematics. In the Swedish-speaking schools in Finland, the majority of students in need of support are included in the general classroom (Svedlin et al., 2013, National Institute for Health and Welfare, 2015). As a consequence, (Swedish-speaking) mathematics teachers in Finland are usually experienced at teaching diverse learners in their classrooms. This experience might have a positive effect on the mathematics teachers' perceptions of their level of pedagogical knowledge for teaching students in need of support. The special education teachers perceived their mathematical knowledge as moderate. As several studies have reported that teachers' subject knowledge is important for student achievement, especially in mathematics and in secondary education (Bolyard & Moyer-Packenham, 2008; Clotfelter et al., 2007; Feng & Sass, 2013; Hill, 2007; Kukla-Acevedo, 2009; Telese, 2012), it is important that the special education teachers have sufficient basic mathematical skills to cover the compulsory education curriculum.

## **2.3. Study III**

### **2.3.1. Aims**

The aims of Study III were to investigate how teacher efficacy beliefs for teaching lower secondary mathematics to students in need of support, certification status and teacher experience were related to the frequency of use of differentiation practices in mathematics teaching.

### **2.3.2. Participants, procedure and measures**

In this study, the participants were 27 special education (26 women and one man) and 42 mathematics (21 women and 21 men) teachers teaching students in Grades 7–9 (aged 13–15) in Swedish-speaking schools in Finland. Of the special education teachers, 78% had worked for five years or more and 72%



were certified teachers in special education. Of the mathematics teachers, 71% had worked for five years or more and 73.5% were certified mathematics teachers.

The study was conducted using an electronic questionnaire for special education teachers and mathematics teachers, which was sent to the principals of all Swedish-speaking schools in Finland with Grades 7 to 9 ( $N=55$ ). To measure the differentiation practices, the teachers rated the frequency of use of flexible examination models, differentiation in content, use of calculators, manipulative tools, flexible assessment models, part-time special education, homework support, complementary oral examinations, co-teaching and remedial instruction. All practices were judged on a five-point Likert-type scale ranging from 1 (*not at all*) to 5 (*often*). The questionnaire included eight items regarding teacher efficacy beliefs for which the teachers rated their confidence in teaching students with difficulties in mathematics. These items were judged on a four-point Likert-type scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). Teacher experience was controlled for the alternatives: 0–2 y, 3–5 y, 6–10 y, and >10 y.

### **2.3.3. Analysis**

The data analyses were conducted in stages. For teacher efficacy beliefs, the EFA and CFA conducted during Study II and the five items used in Study II were used again in Study III. The scores from the five items were recoded and summed to obtain a sum variable of teacher efficacy beliefs. Based on the sum score, teachers were divided into three groups for the level of teacher efficacy: low (13 teachers), moderate (25 teachers) and high (22 teachers). MANOVA and post-hoc tests were used to analyse the impact of teacher efficacy beliefs, experience and certification on differentiation practices.

### **2.3.4. Results**

First, the effect of teacher efficacy beliefs, experience and certification were tested separately. The preliminary results showed no significant differences; however, the  $p$ -value for teacher efficacy beliefs was close to .05, and a

between-subject test showed that significant differences existed between the levels of teacher efficacy beliefs for two of the differentiation practices: differentiation in content and co-teaching. As the variable manipulative tools had a *p*-value close to .050, a pairwise comparison was conducted. The results indicated that a significant difference exists between high and moderate levels of teacher efficacy beliefs on the frequency of use of manipulative tools.

The distribution for different levels (low, moderate and high) of teacher efficacy beliefs on teacher certification (certified and non-certified) and teacher experience in instruction (0-2y, 3-5y, 6-10y and >10y) were also controlled. Six out of eleven (55%) of the non-certified teachers were included in the low level teacher efficacy group, four (36%) in the moderate level group and one (9%) in the high level group. The distribution of the certified teachers to the low, moderate and high level groups was 14%, 43% and 43%, respectively. For the four different groups teacher experience (0-2y, 3-5y, 6-10y and >10y), the distributions between the levels of teacher efficacy were all approximately the same with 20% in the low level group, 45% in the moderate level group and 35% in the high level group.

### **2.3.5. Discussion**

Study III examined the impact of teacher efficacy beliefs, teacher experience and teacher certification on the frequency of use of differentiation practices in lower secondary mathematics instruction. The results indicated that level of teacher efficacy beliefs was related to the frequency of using differentiation in content, manipulative tools (used more frequently in the high level group than the moderate level group) and co-teaching (used more frequently in the high and moderate levels than the low level). Existing studies have also found that teachers with high efficacy beliefs use more student-centred instruction and make more effort to implement new strategies (Bates et al., 2011; Swackhamer et al., 2009; Takahashi, 2011; Temiz & Topeu, 2013) and methods to manage educational support (Holzberger et al., 2013).

The significant differentiation practices (differentiation in content, use of manipulative tools and co-teaching) require high subject knowledge in

mathematics, confidence and interest in teaching low-performing students. These practices have also been shown to have an impact on teacher efficacy beliefs (Clotfelter et al., 2007; Holzberger et al., 2013; Kleinsasser, 2014). The non-significant practices (use of calculator, flexible assessment models, part-time special education, homework support, complementary oral examinations and remedial instruction) can be linked to differentiation in product (evaluation and assessment) and learning environment. These practices are more easily implemented and therefore more commonly used than practices connected to content and process (McLeskey & Waldron, 2011). The results from this study can be compared to a study by Skaalvik and Skaalvik (2007), which reported that teachers with high teacher efficacy beliefs are more capable of organising and executing teaching tasks for specific contexts. As co-teaching is considered an effective model for educational support in secondary mathematics (Magiera et al., 2005), the result from this study reinforces the importance of teacher efficacy beliefs.

The present study did not find a relation between certification status or experience on the frequency of use of differentiation practices. However, when analysing the frequency of teachers in the different levels of teacher efficacy beliefs, 50% of the non-certified teachers were included in the low level group of teacher efficacy beliefs. Of the certified teachers, only 14% were included in the lowest level. Existing studies have reported that certification has a positive effect on student learning in mathematics on all educational levels (Clotfelter et al., 2007; Neild et al., 2009) and that the effect of teacher experience on student performance (Clotfelter et al., 2007; Harris & Sass, 2011; Ladd, 2008) and teacher efficacy beliefs (Kim et al., 2014; Klassen & Chiu, 2010) is complex and non-linear. However, as this study indicated that teacher efficacy beliefs have an effect on differentiation practices, and a majority of non-certified teachers were included in the low teacher efficacy group, these findings indicate that certification status might have an indirect effect on the differentiation practices (via teacher efficacy). As Bandura (1997) noted that teacher efficacy beliefs are established during the early stages of teacher

education, it is recommended to start building a foundation for these qualities during teacher education.

## **2.4. Study IV**

### **2.4.1. Aims**

This study aimed to investigate how special education pre-service teachers' efficacy beliefs for teaching mathematics are predicted by their individual interest and subject knowledge in mathematics. In addition, we compared the level of the three sub-domains of teacher efficacy beliefs.

### **2.4.2. Participants and procedure**

The participants in Study III were 57 special education pre-service teachers in years one to five (years 1–5: 26.3%, 14.0%, 22.8%, 24.6%, 12.3%, respectively) of a Swedish-speaking university in Finland (52 female). These special education pre-service teachers covered about 81% of all Swedish-speaking active (present and non-working) special education pre-service teachers for the semester. The pre-service teachers participated voluntarily and were supervised by the authors of this research study.

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<sup>3</sup> In Finland, approximately 5.5% (290 000) of the population speaks Swedish as their native language. This segment of the population is mostly people living in the west and southwest coastal areas. Parents can choose whether their child will start in a Swedish- or Finnish-speaking school, and the school systems are equal. About 6.2% of an age group go to a Swedish-speaking school, and this number has increased over the last few years. A few universities offer all educational programs in Swedish and others provide a selection of programs.

### 2.4.3. Measures

To measure individual interest and self-efficacy, the pre-service teachers answered an online questionnaire comprising seven items that measured their individual interest in mathematics and 12 items addressing teacher efficacy beliefs toward mathematics. *Individual interest* in mathematics was measured with seven items (e.g. 'I am interested in mathematics') using a 7-point Likert-type scale ranging from 1 (*not at all*) to 7 (*very much*). *Teacher efficacy beliefs* were measured using the Norwegian Teacher Self-Efficacy Scale (NTSES; Skaalvik & Skaalvik, 2007). The original scale consists of 24 items concerning teacher self-efficacy (six sub-domains), estimated on a seven-point Likert-type scale ranging from 1 (*not certain at all*) to 7 (*absolutely certain*). From the original scale, three sub-domains were translated and modified to explicitly measure teaching efficacy beliefs in mathematics: (1) *instruction* (how certain they are about instructing and answering student questions that help them to understand mathematical problems), (2) *adapting instruction to individual needs* (how certain they are about organising classwork so that both low and high achievers can perform mathematical tasks at their own level) and (3) *motivating* students (how certain they are that they can get students to do their best, even with more challenging math tasks).

A Finnish standardised assessment test, KTLT (Räsänen, Linnanmäki, Korhonen, Kronberg & Uppgård, 2013), was used to measure *subject knowledge* in mathematics. KTLT is based on the basic mathematical skills for grades 7–9 (13–15 years). In this study, the digital Swedish version was used, normed for Grade 9, which is the last year of compulsory education in Finland. The KTLT consists of adaptive multiple-choice questions and open questions on basic arithmetic, applied problem solving and algebra.

### 2.4.4. Analysis

To assess the quality and dimensionality of the measurements, internal consistency analyses (Cronbach's alpha) and CFAs were conducted. To test whether a three-factor or one-factor model was most effective for testing the dimensionality of teacher efficacy, the chi-square difference test with the

Satorra-Bentler scaled chi-square was used to compare these competing models (a one or a three factor model). The analysis indicated that the three-factor model fitted the data better than the one-factor model. To investigate the effects of pre-service teachers' individual interest and subject knowledge in mathematics on efficacy beliefs, a path model was specified in which efficacy beliefs were regressed on interest and subject knowledge. Because of the small sample size, composite scores instead of latent variables were used in the path model.

#### **2.4.5. Results**

The three teacher efficacy beliefs sub-domains were first regressed on individual interest and subject knowledge in mathematics. The results indicated that individual interest had a positive effect on all three teacher efficacy beliefs sub-domains and explained 26.8% of the variance in instruction, 11.1% of the variance in adapting instruction for individual needs and 11.6% of the variance in motivating students, whereas subject knowledge was not found to have any impact on teacher efficacy beliefs. However, the preliminary correlations between the variables subject knowledge and teacher efficacy beliefs and prior research indicated that a relation might exist between subject knowledge and efficacy beliefs regarding instruction. Consequently, it could be hypothesised that subject knowledge might have an indirect effect (via individual interest) on the sub-domain instruction. The results showed that the indirect effect from subject knowledge via individual interest was statistically significant, thus confirming the hypothesis. These results indicate that individual interest fully mediates the relationship between subject knowledge and teacher efficacy beliefs concerning instruction in mathematics.

To compare the mean levels between the three sub-domains of teacher efficacy beliefs, a repeated measure ANOVA was conducted. The analysis revealed a moderate main effect on the teacher efficacy sub-domains. Furthermore, post-hoc tests indicated that teacher efficacy beliefs for instruction and adapting instructions to individual needs had higher mean

scores (18.7 and 19.0, respectively) than for motivating students (17.7). However, the small overall effect size indicates that the observed differences are small in magnitude.

#### **2.4.6. Discussion**

Study IV investigated the interrelations between mathematics subject knowledge, individual interest and teacher efficacy beliefs in teaching mathematics for special education pre-service teachers. The results indicate that individual interest plays an important role in pre-service teachers' efficacy beliefs in mathematics, while subject knowledge must be coupled with individual interest to have an effect on teacher efficacy beliefs. However, the influence of subject knowledge is restricted to teacher efficacy beliefs concerning instruction in mathematics. The findings from Study IV also indicate that pre-service teachers showed significantly less teacher efficacy in mathematics for motivating students than in instruction and adapting instructions to students' individual needs.

In this study, individual interest in mathematics was found to be a strong predictor of teaching efficacy beliefs in mathematics. The relation between individual interest and efficacy beliefs has not been analysed in many studies. However, the findings from this study are in line with the findings of Schiefele, Streblov and Retelsdorf (2013), which indicated a significant relation between the teachers' subject and didactical interests and the teachers' self-efficacy. However, Tella (2008) found no correlation between teacher efficacy beliefs and interest in teaching mathematics, even if both factors were reported to have an effect on student achievement. As teacher efficacy beliefs are established during the early stages of teacher education, the importance of teacher interest on efficacy beliefs should be made known for all working with teacher education.

In Study IV, pre-service teacher efficacy beliefs for motivating students were significantly lower than for instruction and adapting instruction to individual needs. This finding relates to the PISA 2012 results (OECD, 2016), which reported that low-performing students have lower motivation for

mathematics than do higher achieving students. These findings highlight the importance of teacher impact on student motivation for mathematics.

In this study, subject knowledge in mathematics was found to have an effect on teacher efficacy only via individual interest, and only for the sub-domain, instruction. This means that, without interest in mathematics, the subject knowledge will not have a direct impact on teacher efficacy beliefs for instruction in mathematics. As this is the connection between subject knowledge and teacher efficacy beliefs, it is worth highlighting the importance of special education teachers' subject knowledge for student performance. Several studies have discussed the importance of special education teachers' subject knowledge in mathematics, given its key role in student achievement, especially of those needing additional support (Flores et al., 2011; Griffin et al., 2009; Rosas & Campbell, 2010). Since interest develops through several phases and may need help to grow (Hidi & Renninger, 2006; Renninger, 2009), teacher education must account for strengthening pre-service teachers' interest in mathematics. As developing individual interest warrants at least a basic knowledge in the subject (Linnenbrink-Garcia et al., 2012), pre-service teachers' mathematical level is also important.



### **3. General Discussion**

The aim of this thesis was to examine educational support in mathematics in lower secondary education, teacher quality, teacher characteristics, and their interrelations. A data collection (Study I, II and III) was conducted to investigate mathematics and special education teachers' use of differentiation practices and learning environments for educational support in Grades 7–9. Furthermore, the teachers' self-perceived teacher efficacy beliefs were investigated in relation to certification, experience in instruction and differentiation practices. As teacher efficacy beliefs are context specific and established in the early stages of teacher education, the second data collection (Study IV) was conducted to investigate whether subject knowledge and individual interest in mathematics can predict teacher efficacy beliefs for special education pre-service teachers.

#### **3.1. Main Findings of the Studies**

The study (Study I), examining the models and practices used in the educational support in mathematics indicated that the pull-out model (one-to-one or in small groups) was the most commonly used educational setting for students in need of educational support in mathematics in lower secondary education. Nine out of ten mathematics teachers also reported using flexible student grouping in Grade 9 based on differences in the tempo and/or depth of instructional content. Regarding the use of differentiation practices, there was almost no difference between the teacher groups. The most often used differentiation practice was the flexible examination model and the least frequently used model was co-teaching. Overall, the teachers perceived that the educational support in mathematics had a moderate efficiency. Fifty-nine per cent of the special education teachers reported a change in work practices after the legislation reform compared with 43% of mathematics teachers. Most of the changes in work practices related to the documentation process rather than pedagogical teaching models.

For teacher efficacy beliefs, special education teachers were found to have higher teacher efficacy beliefs for teaching students in need of support than were mathematics teachers. None of the other factors (certification, experience or gender) had any effect on teacher efficacy beliefs. The mathematics teachers perceived their pedagogical knowledge as effective for teaching low-performing students, whereas the special education teachers self-reported a moderate level of subject knowledge in mathematics. Teacher efficacy beliefs were found to have an effect on the use of differentiated instructional practices. Regarding the use of differentiation in content, the use of manipulative tools and co-teaching with teachers with high teacher efficacy beliefs reported a more frequent use than teachers with moderate and/or low teacher efficacy beliefs. A majority (55%) of the non-certified teachers were included in the low level of teacher efficacy beliefs.

When examining the interrelations between subject knowledge, individual interest and teacher efficacy beliefs, the findings indicated that individual interest in mathematics was important for all three sub-domains of teacher efficacy beliefs (instruction, adapting instruction to individual needs and motivating students). However, subject knowledge only predicted teacher efficacy beliefs for one of the sub-domains (instruction) and only via individual interest. Differences were also found between the three sub-domains; teacher efficacy beliefs for motivating students were significantly lower than the other two sub-domains.

### **3.2. Theoretical Implications**

Researchers have investigated teacher characteristics and their impact on elements such as instruction and student performance for many years. However, recent research has focused also on characteristics such as motivation, interest and teacher efficacy beliefs (e.g. Hattie, 2015). The results of this thesis indicate that special education teachers have higher teacher efficacy beliefs for teaching students in need of educational support in mathematics than do mathematics teachers, which also was noted by Paju, Rätty, Pirttimaa, and Kontu (2015). In their study, special education teachers'

had higher perceptions of their ability to teach students in need of support than did classroom and subject teachers (Paju et al., 2015). This thesis also showed that teacher experience, certification status and gender did not predict teacher efficacy beliefs for teaching mathematics to low-performing students, when accounting for the effects of all the other covariates. However, when studied separately, gender and certification status significantly predicted higher teacher efficacy beliefs with a positive effect for special education teachers, certified teachers and female teachers. The small sample used in the study might be a reason for this difference in teacher efficacy beliefs. With more participants, variables with moderate and high effect sizes would have been significant.

Existing studies have reported the relationship between teacher efficacy beliefs and teachers' experience as nonlinear and complex (Kim et al., 2014) because of the psychological context of the work environment (Klassen & Chiu, 2010). However, the lack of relation found in this study between experience and teacher efficacy beliefs supports other studies findings, thus suggesting that teacher experience negatively affects teachers' self-efficacy for teaching low-performing students (Foss & Kleinsasser, 1996). In their study, pre-service teachers reported more readiness for teaching mathematics than in-service teachers (Foss & Kleinsasser, 1996). The negative effect of teacher experience on teacher efficacy beliefs has been described in the literature to have its origins in the theory of behavioural change in which positive or negative experiences affect a person's self-efficacy (Bandura, 1977).

Regarding certification, a variety of results are reported in existing studies. For example, Voris (2011) did not find any differences in teacher efficacy between alternatively and traditionally certified special education teachers, while Kim et al. (2014) observed positive relations between certification and teachers' mathematics efficacy beliefs. The same inconsistent results can be found for gender differences. For example, Klassen and Chiu (2010) observed efficacy beliefs to be less positive for women, while Yeo et al. (2008) and Tejada-Delgado (2009) found no differences between men's and women's efficacy beliefs for teaching low-performing students. In the present

thesis, certification and gender only had an effect (positive effect for certificated and female teachers) on teacher efficacy beliefs if they were tested separately, while the full model (with all covariates) did not indicate any effect of gender or certification on teacher efficacy beliefs. These inconsistent results require further investigation.

In this study, the effects of subject knowledge and interest on teacher efficacy beliefs for teaching mathematics to students in need of support were also examined. Interest was found to have a direct impact on teacher efficacy beliefs, whereas subject knowledge only predicted teacher efficacy beliefs via interest. These results differ from existing research in which subject knowledge was found to have an effect on teacher efficacy beliefs (Austin, 2013; Bates et al., 2011; Newton et al., 2012; Swackhamer et al., 2009). As subject knowledge and individual interest in mathematics have not been predicted based on teacher efficacy beliefs in the same model in earlier studies, this may be one reason for the different results.

Differentiated instruction is based on the teacher's ability to adjust the teaching methods to meet learners' individual needs and the teacher's knowledge of the subject and pedagogy (Tomlinson, 2008); in other words, they need to be a highly qualified teacher. In addition, as this study supports, teacher efficacy beliefs are related to teaching strategies, instructions and motivation (Holzberger et al., 2013; Midgley et al., 1989; Thoonen et al., 2011) and student achievement (Austin, 2013). Teachers with high level of efficacy beliefs used differentiation in content, manipulative tools and co-teaching more often than teachers with lower level of teacher efficacy beliefs. Teacher efficacy beliefs are an important teacher characteristic for successful differentiated instruction and should therefore be a focus of teacher education; for example, pre-service teachers should be exposed to positive experiences of teaching mathematics to students in need of support. As individual interest in mathematics was found to strongly relate to teacher efficacy beliefs, the methods of gaining pre-service students interest should be investigated.

### 3.3. Pedagogical Implications

Lower secondary education typically sees a greater variation in student performance and an increased need for educational support in mathematics (Harju-Luukkainen & Nissinen, 2011; Metsämuuronen, 2011; Rautopuro, 2013, TIMMS, 2011/ 2015). Special education teachers in lower secondary education spend most of their (teaching) time supporting students in mathematics (Official Statistics of Finland, 2011; Takala et al., 2009), a finding which this thesis echoed. However, studies investigating educational support models for lower secondary mathematics education are scarce. This thesis therefore examined Finnish models of educational support in lower secondary education mathematics, teacher quality, teachers' characteristics and their interrelations.

In the Finnish National Core Curriculum, differentiation is an important component in educational support (Finnish National Board of Education, 2011, 2015). This thesis demonstrated that the models and practices used for students in need of educational support in mathematics were almost the same for special education and subject teachers. These findings indicate that both teacher groups have adapted differentiation practices to the same extent. As differentiation not only has an impact on student performance but also on student motivation and attitudes for mathematics (Konstatinou-Katzi et al., 2013, Tomlinson, 2008), differentiation has to be a part of teachers' every day work, and teachers should be encouraged to practice implementing different models and trying new ways of integrating differentiation for the most effective instruction.

Differentiation also includes different educational environments. Before the reform in legislation, the pull-out model was the most common educational setting for students in need of educational support in mathematics in Finland (Takala et al., 2009), and the findings from the present study consolidate previous findings that the pull-out model remained the most used model after the reform. These findings were also noted by Lempinen (2016), who indicated that Finland is progressing relatively slowly towards an inclusive education. In addition, mathematics teachers use the

pull-out model for students in need of support more than other subject teachers (Hallam & Ireson, 2006), most likely because the teachers in the present thesis pointed out that differentiation was easier to implement in pull-out settings. However, during secondary education, the social setting in the classroom is becoming more important for the student, and segregation has been found to sometimes cause a decrease students' motivation and performance (Alatupa, Karppinen, Keltikangas-Järvinen & Savioja, 2007). These contradictions in learning environments for students in need of support highlights the importance of listening to the student and finding the best educational setting with respect to student motivation and learning.

Existing research showed that educational support in the classroom from a special education teacher or a co-teacher is an effective model to support students in mathematics, especially in secondary education (Hoover & Patton, 2008; Mageira et al., 2005; Saloviita & Takala 2010; Weiss & Lloyd; 2002). However, as echoed in this study, for co-teaching to work in practice, school leaders need to offer their support by, for example, providing sufficient planning time (Murawski & Dieker, 2004; Takala & Uusitalo-Malmivaara, 2012). In this study, co-teaching was found to be used significantly more by the special education teachers than by mathematics teachers, but not as frequently as the pull-out model. Teachers with high level of teacher efficacy beliefs and certified teachers were found to use co-teaching more frequently than teachers with lower levels of teacher efficacy beliefs and without certification. In addition, co-teaching was reported as an effective use of resources and facilitated the communication between special education and mathematics teachers. Even if studies have reported that low-performing students do not always perform better within co-teaching settings (Murawski, 2006; Idol, 2006), there are other aspects (e.g. greater self-confidence and self-esteem, improvement in social skills and more positive peer relationships) which students in need of support can benefit from in the co-teaching environment (Walter-Thomas, 1997). Consequently, the results in this study indicate that secondary mathematics education would develop and extend the use of co-teaching models.

As a part of differentiation, flexible student grouping is commonly used in mathematics education (Metsämuuronen, 2013). In this thesis, flexible student grouping, based on interest or content level, was reported to be used by almost every mathematics teacher in Grade 9. This can be compared to the study from Hannula and Oksanen (2013) in which almost 50% of the Swedish-speaking schools in Finland reported that they used flexible student grouping, mainly in Grade 9. As some of the teachers in Study I argued that flexible student grouping was not a legal model for differentiation, discussions about what flexible student grouping includes and how it best can be implemented are necessary.

The importance of mathematical subject knowledge in secondary educational support has been discussed in several studies (e.g. Clotfelter et al., 2007; Maccini & Gagnon, 2006). In this study, special education teachers self-reported a moderate level of mathematical knowledge. While special education teachers in Finland are certified for Grades K-12, they only need to be familiar with the subject matter up to Grade 6 to be certified. During secondary education, this lack of familiarity with the subject knowledge may cause situations where the special education teacher does not necessary feel confident enough to teach mathematics. By introducing educational support models during teacher education, where the subject and special education teachers cooperate and contribute with their specialised skills, these situations can be avoided. The findings from this study also indicate that the mathematics teachers perceived their pedagogical knowledge as effective for teaching students in need of support, whereas existing research has reported a lack of mathematics teachers' pedagogical knowledge for teaching students in need of support (DeSimone & Parmar 2006). As the majority of low-performing students in the Swedish-speaking schools in Finland are included in the general education classroom, the teachers are experienced in teaching low-performing students, which has likely affected the result (Subban & Sharma, 2005; Ekins et al., 2016). In addition, the high academic level of teachers in Finland might also affect their high level of self-perceived readiness (Sahlberg, 2010). For the most efficient educational support, both

teacher groups' specialised knowledge need to be combined in an effective way, such as through co-teaching.

Teacher efficacy beliefs are developed through different kind of experiences (good or bad) and mainly during an early stage of teacher education, mostly affected by mastery experiences (Bandura, 1997). Offering opportunities to develop teachers' interest and facilitate opportunities to experience successful teaching situations could strengthen teachers' efficacy beliefs. Other ways to strengthen teacher efficacy beliefs are through vicarious experiences (Bandura, 1997). That is, experiencing other teachers' mastery experience will create the feeling of being able to do it oneself. Additionally, collaboration between special and mathematics pre- or in-service teachers through co-teaching can enable them to learn from each other's special knowledge and develop positive teacher efficacy beliefs. However, for this to be a reality in the classrooms, it has to start during teacher education.

This thesis has highlighted several factors that affect the education for students in need of educational support in mathematics. An awareness of these factors and understanding the importance of teacher effect on student performance will promote support for all students in the diverse classroom.

### **3.4. Limitations**

These original studies contained some limitations which concern methodological (measure) and practical issues. In Studies I, II and III, the number of participants was small. While an electronic questionnaire was sent to all principals in the Swedish-speaking schools in Finland with Grades 7–9, it was not possible to know which teachers actually received the questionnaire. If it had been possible to send the questionnaire individually to every teacher, the number of participants would likely have been higher, and the percentage of participating teachers could have been calculated and reported. The instruments, statistics and analyses performed in Study I were simple, more sophisticated analyses and multilevel models about for prediction of differentiation practices could have given deeper knowledge about teachers use of differentiation practices in instruction.



Study II focused on factors predicting teacher efficacy beliefs. As gender and certification predicted teacher efficacy beliefs as single variables, we can assume that the findings would have remained the same with a greater number of participants. However, as only one item was used to measure the level of the teachers' mathematical (special education teachers) and pedagogical knowledge (mathematics teachers), more items would have strengthened the statistical analysis and results for these variables.

In Study IV, subject knowledge was evaluated using the KTLT mathematics test, (Räsänen et al., 2013), which was developed and normed for testing basic mathematical knowledge at the end of Grade 9. As no mathematics test exists for adults in Swedish (in Finland), this was the only alternative that could be used. However, statistics from KTLT showed that the test is also suitable for a university population. As in all studies based on voluntary participation, a selection of participants decide not to participate for various reasons. In this case, it is possible that pre-service teachers who are weak in mathematics or feel some kind of anxiety about test situations might not be represented in this study.

While studies I, II and III were somewhat dependent on whether the principal gave the teachers the questionnaire, it can also be assumed that only those teachers who find these kinds of studies important chose to participate. As a consequence, it is difficult to get a sample of participants representing a whole teacher group (Wright, 2005). Because of the small sample, additional important information could have been collected by for example interviews and group discussions. Related to self-reported data validity, there are two issues to consider: First, the cognitive factor, which relates to whether the respondents understood the question and whether they had the knowledge and/or memory to answer it accurately, and second, the situational factor, which refers to the influence of the setting of the survey (Brener, Billy & Grady, 2003). In this study, both the cognitive and situational factors' validity was assured. (1) as the items in Studies I, II and III were part of a survey about educational support in mathematics for students aged 13–15, the context and meaning of the questions should have been clear to all respondents. Study IV

was supervised by the authors of the study, and participants were able to ask questions if something was unclear. (2) In terms of the situational factors, the surveys were electronic questionnaires, which enabled the respondents to answer anonymously and without risk of being judged.

### **3.5. Conclusions**

Differentiation in instruction, as a main component of inclusive education, requires the teachers to possess various skills and abilities for example teacher efficacy beliefs, interest and subject knowledge, and the results of this thesis indicate that implementing new teaching strategies and models takes time to be accomplished in practice. Even after the legislation reform, the pull-out model remained the most commonly used educational setting for students in need of educational support mathematics in lower secondary education, and the greatest changes in work practices were associated with the documentation processes rather than the teaching models used. The findings from this study indicate that special education teachers have higher teacher efficacy beliefs for teaching students in need of educational support in mathematics than do mathematics teachers, and the level of teacher efficacy beliefs are related to the use of differentiation practices. It was also found that individual interest in mathematics is a strong predictor of teacher efficacy beliefs. In sum, teacher efficacy beliefs are an important and complex teacher characteristic that require further investigation in future studies, especially with a focus on how different factors are interrelated and what effect they have on teacher efficacy beliefs. The findings from this thesis should encourage teacher education to focus on how to strengthen teachers' efficacy beliefs for teaching mathematics to low-performing students and to support a fruitful cooperation between mathematics and special education teachers.

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