Teaching High-Ability Pupils in Early Primary School

Citation for published version (APA):

Document status and date:
Published: 19/10/2015

Document Version:
Publisher's PDF, also known as Version of record

Please check the document version of this publication:
• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:
https://www.ou.nl/taverne-agreement

Take down policy
If you believe that this document breaches copyright please contact us at:
pure-support@ou.nl
providing details and we will investigate your claim.

Downloaded from https://research.ou.nl/ on date: 09 Oct. 2020
Teaching High-Ability Pupils in Early Primary School
The research reported here was carried out at the

Open Universiteit
www.ou.nl

and at

ITS
Instituut voor Toegepaste Sociale Wetenschappen (ITS), Radboud Universiteit

In the context of the research school

ICO
Interuniversity Centre for Educational Research

and funded by

Dienst Uitvoering Onderwijs
Ministerie van Onderwijs, Cultuur en Wetenschap

ISBN: 978 94 922 3118 5
© Elma Dijkstra, Utrecht, the Netherlands, 2015
Cover design & layout: Janine Cranshof, Open Universiteit
Printed by Datawyse, Maastricht, The Netherlands
All rights reserved
Teaching High-Ability Pupils in Early Primary School

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Open Universiteit
op gezag van de rector magnificus
prof. mr. A. Oskamp
ten overstaan van een door het
College voor promoties ingestelde commissie
in het openbaar te verdedigen

op vrijdag 13 november 2015 te Heerlen
om 13.30 uur precies

door

Eline Marike Dijkstra
Geboren op 2 mei 1987 te Groningen
Promotores
Prof. dr. P. A. Kirschner, Open Universiteit
Prof. dr. A.J. Mooij, Open Universiteit en Radboud Universiteit, Nijmegen

Co-promotor
Dr. A. Walraven, Radboud Universiteit, Nijmegen

Overige leden beoordelingscommissie
Prof. dr. R. J. Bosker, Rijksuniversiteit Groningen
Prof. dr. J. van Braak, Universiteit Gent, België
Prof. dr. F. L. J. M. Brand-Gruwel, Open Universiteit
Prof. dr. M. Vermeulen, Open Universiteit
Dr. A. J. M. Hoogeveen, Radboud Universiteit, Nijmegen
Contents

Introduction ................................. 7

Chapter 1  Teaching High-Ability Pupils in Dutch Primary Schools: Reflections and New Directions  15

Chapter 2  Towards Optimal Education Including Self-Regulated Learning in Technology-Enhanced Primary Schools  29

Chapter 3  Factors Affecting Intervention Fidelity of Differentiated Instruction in Early Primary School  49

Chapter 4  Improving Teachers’ Differentiation Practices to Better Anticipate Pupil Differences in Early Primary School  67

Chapter 5  Effects of a Teacher Intervention for Differentiation on Academic Achievement of Early Primary School Pupils  83

Chapter 6  General Discussion ................................. 99

Appendix .................................. 111

References ................................ 113

Summary .................................. 125

Samenvatting ............................... 129

Dankwoord ................................ 135

ICO Dissertation Series ......................... 137
Introduction
“Education will be organised in such a way that pupils are able to proceed through an uninterrupted developmental process. It will be geared to the progress in the development of pupils”. This quote is from the Dutch Act for Primary Education (Wet op het primair onderwijs, 1981, art. 8.1) and acknowledges that pupils may have different developmental pathways for which the teaching practices need to be adapted. Pupils in the same class may differ, for example, in gender, age, cognitive abilities, socioeconomic background, motivation for learning, self-regulatory capabilities, and so on. All of these differences can be relevant for their learning in school. It is therefore important that teaching is adapted – as much as possible – to the unique needs and skills of each pupil in the classroom and school. Only then are pupils able to learn at a pace and through a type of activity that match their learning needs, which is required for learning new knowledge and acquiring new skills (Vygotsky, 1978).

Unfortunately, there is often a mismatch between pupils’ needs and the learning activities offered. In primary schools in the Netherlands, for example, learning activities are mainly organised in age-based mixed-ability classrooms. In teaching the core curriculum (e.g. reading, arithmetic), teachers usually divide their pupils in three groups with different instructional needs: pupils who need either little, regular, or extended instruction. According to the Dutch Inspectorate of Education (Inspectie van het Onderwijs, 2014), however, this instructional differentiation is insufficient to adequately adapt learning activities to the needs of each individual pupil in the class. As a consequence, the suboptimal learning processes of those pupils who deviate the most from the mean class development may result in academic underachievement and other problems (Onderwijsraad, 2007).

While traditionally much research and policy attention is paid to how teaching could be better differentiated for those pupils who lag behind others, the more advanced or high-ability pupils in the Netherlands have been neglected for a long time. In the seventies and eighties of the twentieth century, Dutch differentiation policy was primarily aimed at pupils who were academically at-risk, due to, for example, learning problems or characteristics of their social background and/or ethnicity. The main task of education was to bring all pupils, including those at-risk pupils, to a minimum achievement level. To this end, extracurricular activities were made available for those pupils who lagged behind their classmates. No attention was paid to those pupils who were advanced, and most teachers did not feel the urge or need to do something for this group of pupils, as was reflected in the Dutch mentality of on the one hand ‘don’t stick out’ and ‘good is good enough’ and on the other hand ‘they’re so good, they’ll manage it themselves’. The overall impression at that time was that these pupils did not need extra educational care and that there was no need to adapt their education (De Boer, Minnaert, & Kamphof, 2013; Doolaard & Harms, 2013).
Since about the year 1985, Dutch society has seen a growing discontent among teachers and parents about gifted pupils being kept home because the situation in school was dissatisfying. Also, since about 2000, a number of international comparative studies of pupil achievement (for example the Progress in International Reading Literacy Study and the Trends in International Mathematics and Science Study) showed that Dutch pupils were disappearing from the top of those lists. Although Dutch pupils generally scored well, only few pupils excelled according to international standards. Dutch education seemed to do very well with bringing lower performing pupils to a basic achievement level, but struggled with excelling high-ability pupils (Meelissen et al., 2012).

The Dutch government realised, thus, that the schools were not successfully dealing with the needs of pupils who were advanced compared to their class peers. Several small-scale initiatives to improve school practice were employed for this group of pupils, but the overall results produced no consistent information about what works for these pupils in schools (Mooij, Hoogeveen, Driessen, Van Hell, & Verhoeven, 2007). When teaching adaptations were available, they generally only started halfway through primary education, which was considered by Mooij et al. (2007a) to be too late to prevent academic, social, and motivational problems of gifted pupils. Furthermore, the activities that were provided were generally offered on an ad hoc basis, and, thus, lacked a structural basis in a school-wide curriculum.

The lack of appropriate learning opportunities was also reflected in a study by the Educational Council concerning the underachievement rates of primary school pupils, that reported that 10-18% of the pupils underachieved. This rate, however, was much larger for high-ability or gifted pupils (Onderwijsraad, 2007) where of the pupils with an IQ of 130, 30% underachieved, which increased to 60% for pupils with an IQ ≥150. According to the Council, the causes could be found in the lack of an intellectual context in the schools, little flexibility in the regular curriculum, and few opportunities to do extra activities.

In 2008, the Dutch Ministry of Education, Culture and Science acknowledged that schools, despite some attempts, still had a problem recognising cognitively advanced pupils, and offering them appropriate learning activities. To counteract this situation, the Ministry launched new measures for stimulating the learning of these pupils (Ministerie van Onderwijs, Cultuur en Wetenschap, 2007). According to the Ministry, early identification and offering appropriate learning activities in regular education are important to fully realise the learning potential and prevent later problems. To gain more knowledge on how to do this, a number of research initiatives were stimulated.

One research initiative to increase evidence-based knowledge for teaching high-ability pupils is the research programme Onderwijs Bewijs (Education Evidence). The programme aimed to promote the development of evidence-based innovations in education. In two rounds (2009 and 2010), schools and research institutes could form consortiums to apply for funding of a research project. A total of 37 projects were launched. In addition to topics such as citizenship education and prevention of bullying, education for gifted or excellent pupils were among the core themes of the subsequent funding rounds. For this last topic, projects needed to focus on improving excellent pupils performances, which could be manifested in academics, arts, or
sports. In the research programme, excellence referred to the top 10% performing pupils. By making this funding available, the government hoped to gain more knowledge about what works in early identification and realising the potential of excellent pupils.

**Aim of the Dissertation**

In this dissertation, one of the funded research projects on cognitively excellent pupils is studied. Central to this project was the development and implementation of an intervention called *Excel Kwadraat* (Excel Square) in regular primary schools, which aims at improving teachers’ differentiation practices in order to better anticipate pupil differences, including excellent or high-ability pupils. In the end, the intervention aims at enhancing the academic achievement of both high-ability and non-high-ability early primary school pupils, that is, grade 1 and 2 for pupils aged 4–6. The intervention includes screening pupils’ school-entry characteristics, matching their needs with curricular activity levels, and implementing a school-wide approach to differentiation and high-ability. During the school years 2011/2012 and 2012/2013, the intervention was implemented in phases in 37 primary schools in the Netherlands. The central question in this thesis is: does Excel Kwadraat, compared with regular education, positively affect high-ability pupils’ academic achievement? To answer this question, a number of studies were set up that focus on current teaching practices for high-ability pupils, and the design, development, implementation, and effects of *Excel Kwadraat* in early primary school.

**Chapter Overview**

First, it is important to study the current teaching practices for high-ability pupils in primary school. Chapter 1 explores whether these practices either allow or support these pupils in achieving according to their potential. It focuses on regular primary education as underachievement of high-ability pupils generally seems to start in this early educational context (see Mooij & Driessen, 2008). The chapter presents a simplified version of the 3-level model originally developed by Mooij (2013), containing relevant home and school variables which may influence a pupil’s development. Variables from the school context are then used to make a number of shortcomings visible in the current practices of teaching high-ability pupils. The information used is based on recent representative reports from the Dutch Inspectorate of Education and others. Following this discussion, new directions for better (integrating the) teaching of high-ability pupils in regular education are given. These directions include, among others, improving the determination of the level of high-ability pupils, matching appropriate learning activities to these levels in the everyday curriculum, and improvement of teachers’ differentiation skills.

How these directions can be integrated in educational practice is presented in Chapter 2. In primary education, educational processes and corresponding ICT-based pupil-monitoring systems are generally adapted to the mean age of the pupils in class. This norm-based factor seems
to undermine the potential of ICT to support the educational differentiation needed for pupils, including those of high-ability. In this chapter, a theoretical framework is sketched in which pedagogic-didactic, organisational, and ICT guidelines enhance differentiated, self-regulated playing and learning for each pupil – including the high-ability pupil – within primary school. To develop and check such differentiated education in practice, a pilot and a randomised intervention study were carried out in Dutch primary schools. The pilot study concerns the use of screening the developmental levels of pupils entering primary school. In the randomised intervention study Excel Kwadraat, which is the central research project in this dissertation, two components are added to the screening: curricular differentiation in the arithmetic and language curricula, and a school-wide protocol for differentiation. Teachers are supported by the researchers in implementing these components. Some first results of how teachers and school implement these two research projects are presented.

Chapter 3 focuses on the implementation process of Excel Kwadraat in the schools and investigates which factors influence the intervention fidelity; that is, the extent to which the components of the intervention are implemented. This chapter starts with the question of how pupil differences can be anticipated in teaching and what factors may be of influence when teachers try to do this. Hereafter, Fullan's (2007) framework of nine implementation factors (i.e., characteristics of the intervention, local and external factors) for educational change is used as a theoretical basis for the analyses. The data collection includes observations, field notes, log books, and self-report questionnaires measuring participants' perceptions of the intervention. Both qualitative and quantitative methods are employed to provide a comprehensive view of the intervention fidelity and implementation processes. Following a design-based research approach (Anderson & Shattuck, 2012), lessons learned for future interventions for high-ability pupils are uncovered and discussed.

In Chapter 4, the lessons learned from Chapter 3 are used to design an improved intervention for the second year of the intervention study Excel Kwadraat. Before studying pupil outcomes, it is important to assess the intervention fidelity and actual changes in teacher differentiation practices (O’Donnell, 2008). This chapter specifically focuses on the effects on teachers’ differentiation practices (DP), including diagnostics and assessment methods, instruction and grouping arrangements, and the offering of activities for high-ability pupils. A pretest posttest cluster randomised design was used with three conditions: control ($n = 34$), intervention in the first year ($n = 32$), and improved intervention ($n = 34$). The intervention fidelity is hypothesised to be higher in the improved intervention than in the first year intervention, which in turn has to result in more improved teacher-reported DP. In the control condition, no improvement of teacher-reported DP was expected. Qualitative and nonparametric quantitative analyses were carried out. Limitations and implications of this specific study are discussed.

Finally, Chapter 5 examines the main research question of this dissertation. The effects of the intervention on the academic achievement of primary school pupils, especially high-ability pupils, are studied. In this chapter, the pupils in the intervention condition ($n = 147$) are compared to the pupils in the control condition ($n = 208$) in their achievement on standardised arithmetic and language tests for early primary school pupils. Variance analyses are carried out including
pretest achievement measures as well as background characteristics as covariates. Effects are presented for two groups of pupils: high-ability pupils and non-high-ability pupils. By doing this, intervention effects can be compared for pupils with different initial abilities. The chapter concludes with discussions of the effectiveness of the study for specific pupils, and discusses limitations of the study and possible further research steps.

In the General Discussion (Chapter 6), the results from the different chapters in the dissertation are integrated and new directions are presented for policy and further research.
Chapter 1
Teaching High-Ability Pupils in Dutch Primary Schools: Reflections and New Directions

Abstract
Research shows that many Dutch high-ability pupils in primary schools do not academically achieve according to their potential. This study explores whether the current teaching practices in the Netherlands support high-ability pupils in achieving according to their potential. It focuses on primary education, as underachievement of high-ability pupils generally seems to start in this early educational context. A simplified version of a 3-level model originally developed by Mooij (2013) is presented as theoretical framework, containing relevant home and school variables which influence a pupil’s development. The school context variables are used to make a number of shortcomings visible in the current teaching practices, based on recent reports from the Dutch Inspectorate of Education and others. These shortcomings include, among others, the strong teacher-dependence in offering appropriate learning activities and the lack of educational goals for enrichment or extracurricular learning activities. Furthermore, the activities for high-ability pupils are not integrated in a curriculum, and are only offered at an ad hoc basis. Following this discussion, new directions for better and better integrated teaching of high-ability pupils in primary education are given.
The learning processes of high-ability or gifted pupils, compared with those of low and average ability, are characterised by larger learning steps, more abstract thinking, more self-structuring, longer periods of concentration, less repetition and a greater willingness and ability to work independently, resulting in, for example, the acquisition of strong verbal and arithmetic skills at a young age (Colangelo, Assouline, & Gross, 2004; Gagné, 2004; Mooij, 1992). By using their advanced self-regulatory capacities (Zimmerman, 2000), these children can use environmental hints and cues to learn to read and write even before entering primary school. In principle, these children are academically at an advantage.

However, research shows that the achievement level of many high-ability pupils in school does not reach the level that might be predicted based on their abilities. Research in the Netherlands, for example, found that 30–40% of high-ability pupils in grades 4, 6 and 8 academically underachieve (Onderwijsraad, 2007); that is, their achievement scores are more than one standard deviation below the expected achievement scores based on their IQ. This is twice the rate of pupils from all other ability levels combined.

Underachievement is suggested to start as early as in primary school and continues throughout the pupil’s schooling career. Mooij and Driessen (2008), for example, used a national cohort study on Dutch pupils in primary school to show that pupils with the highest language and arithmetic scores progressed the least in two years compared to the other pupils, and that this effect was stronger in lower grades compared to the higher grades of primary school. This underachievement can have severe consequences for high-ability pupils’ educational careers as a whole. The level of secondary education, for example, which is based on advice from the primary school, is shown to be too low for one third of high-ability pupils in the Netherlands (Guldemond, Bosker, Kuyper, & Van der Werf, 2007). Moreover, in secondary education, one quarter to one third of high-ability pupils completed their education at a lower level than would be expected (Kuyper & Van der Werf, 2012).

International achievement comparison studies such as the Progress in International Reading Literacy Study (PIRLS) and the Trends in International Mathematics and Science Study (TIMSS) show similar trends, in which Dutch secondary school pupils generally score relatively well, but very few excel according to international standards (Meelissen et al., 2012). Dutch education seems to show significant achievements in bringing low-performing pupils to a standard level, but struggles in working with advanced or high-ability pupils. In the egalitarian Dutch educational system, despite some first attempts in the last decade, there are still “insufficient opportunities for pupils to excel” (De Boer, Minnaert, & Kamphof, 2013, p. 146), which may threaten the ongoing development of the knowledge-based economy (Ministerie van Onderwijs, Cultuur en Wetenschap, 2011a, 2011b; Van Eijl, Wientjes, Wolfensberger, & Pilot, 2005).
What is clear, is that the learning potential of high-ability pupils is not fully realised in school. According to Mooij (2013), this is the result of an interactional process between personal identity dimensions, and home and school variables. He developed a 3-level model (see Figure 1.1 for a simplified version) containing relevant variables from the home and school context for pupils’ development during primary school. In this model, the genetic base of a child is expressed in personal identity dimensions characterised by individual behavioural, psychological and developmental potentials, abilities and performances referring to e.g. cognitive, social, emotional, and sensory-motor areas. From a very young age, variables from the home environment are thought to influence the development of a child’s identity dimensions and self-regulation potentials which is expressed in respective developmental processes and performance levels. Also, in early primary school and successive school situations, various environmental characteristics at individual, class, and school level continuously influence the personal identity dimensions and self-regulation. The combination of the specific school characteristics for a pupil define the instructional and learning situations for this pupil which, by interacting with personal identity and self-regulation characteristics, influence their long-term development and performance (see Figure 1.1). Moreover, in the course of primary school, the within-school experiences and interactions lead to the development of school subject-specific variables such as feelings of

![Figure 1.1](image-url)
orientation towards and competence in the subject, specific (learning) behaviour during lessons, and achievement in the subject. In the case of high-ability pupils in particular, the level of school subject achievement may indicate either an adequate level or reflect a process of underachievement.

In this chapter, we explore whether the variables from the school context (see Figure 1.1) support high-ability pupils in regular Dutch primary education to achieve according to their potential. We focus on primary education for children aged 4–12, as underachievement of high-ability pupils generally seems to start in this early educational context (see Mooij & Driessen, 2008). First, we describe the theoretical framework of the 3-level model in more detail. Hereafter, the variables from the school context are used to evaluate the current practices of teaching high-ability pupils in Dutch primary schools. To this end, we use the outcomes from recent reports by the Dutch Inspectorate of Education and others concerning the teaching of high-ability pupils. A number of shortcomings are identified in schooling opportunities for these pupils. Finally, the chapter concludes with new directions for better (integrating the) teaching of high-ability pupils in primary education, which are discussed in more detail in Chapter 2 and onwards.

Theoretical Framework

Terms such as high-ability, giftedness, excellence, and talent each refer to a small subgroup of people, distinct from others by their exceptional aptitudes, abilities, developments, skills, or performances (Dai, Swanson, & Cheng, 2011). Here, ‘exceptional’ can refer to the best 2.5 to 20%, depending on the particular operationalisation (Segers & Hoogeveen, 2012). Over the years, researchers identified various domains in which persons can show giftedness or high-ability. Gardner (1983), for example, distinguished eight intelligences or domains, such as linguistic, logico-mathematical, spatial, and musical intelligences, in which a person can be strong in some and weak in others. Building on Gardner’s multiple intelligences model, Gagné (2004, 2011) included several competence domains in his Differentiated Model of Giftedness and Talent (DMGT) in which persons could manifest high performances, including the sports, the arts and the academics. He considered talent development to be an active process of formal and informal learning, in which innate abilities are catalysed by environmental and personality factors, resulting in certain competencies or performances. Being ‘gifted’ refers to exceptional natural abilities, and ‘talent’ is considered to represent the best 10% of the general population with respect to performance concerning specific abilities at some time (Gagné, 2011; Segers & Hoogeveen, 2012).

In the case of early primary school pupils, Mooij (2000) concentrated on seven competence domains reflecting the child’s personal identity dimensions at the start of primary school. Based on his quantitative research involving the parents and teachers of 966 4-year-old children just starting primary school, he identified the following domains: social interaction/communication, general cognition, language proficiency, (preliminary) arithmetic level, sensory-motor level,
level of emotional expressiveness, and the child’s expected academic motivation. They interact
with the genetic base of the child and could be assessed upon entering primary school: see
Figure 1.1. In terms of Gagné (2011), assessment of the performance levels of these identity
dimensions by parents and/or teachers may indicate giftedness or high-ability of a child.

Furthermore, a high-ability pupil usually exerts more control over his or her own develop-
ment or learning processes in the various identity dimensions than other pupils do. Corres-
ponding positive outcomes will stimulate both next development and learning processes and
the degree of his or her self-regulated learning competence, which will motivate him or her to
select and carry out more complex learning tasks. Thus, self-regulation is, along with the identity
dimensions, a key concept for high-ability pupils’ development (Mooij, 2013): see Figure 1.1.

Home Variables
Children develop through everyday interactions with the environment and high performance
can be seen as the positive result of these interactions (Bronfenbrenner & Morris, 2006; Gagné,
2004; Heller, 1999; Magnusson & Allen, 1983; Reis & McCoach, 2000). Socio-cognitive theorists
such as Vygotsky (1978) assign a crucial role to support from the social environment, such as
the home and the school context. At the earliest age, the home environment is among the
most influential immediate surroundings of the child. Important for the child’s development is
the degree to which the parents stimulate and enable her or him to express herself or himself
in her or his abilities (Mooij, 2013). The level of educational attainment at home is important
in this respect. Having parents who have achieved a higher level of education makes it more
likely that a child will get the intellectual and social conditions that it needs. According to Mooij
(2013), these home variables influence the development of the child’s identity dimensions and
self-regulation potentials and performance levels: see Figure 1.1.

Primary School Variables
At about the age of 4, when the child begins formal schooling, it not only interacts with the
home environment, but also with the school environment (i.e., teachers, classmates). In primary
school, variables at the individual, class, and school level are relevant for the child’s development:
see Figure 1.1.

Pupil level. Research shows that at the chronologic age of 4, which is when most children
begin primary school, they differ by about 5 years (range: 2–7 years) in their levels of cognitive
abilities or identity dimensions (Mooij, 2000). At the beginning of a pupil’s school career, his or
her entry-level characteristics on the identity dimensions are thus most relevant as initial foci of
the interactions with the environmental variables at school: see Figure 1.1.

The role of education, particularly of the teachers therein, is to allow pupils to have experi-
ences that are in their zone of proximal development (ZPD; Vygotsky, 1978). ZPD constitutes the
difference between what the pupil is able to achieve without help and with help. Experiences
in this zone are essential for learning (cf. Cesar & Santos, 2006). As shown in the model, teachers
need to adapt instruction and content complexity to the pupils’ unique needs. High-ability pu-
pils, for example, may have the capacity to grasp and understand essential information much
more quickly and effectively than other pupils. A deep approach to learning, that is, meaningful learning by means of pupil-centred methods intended to foster understanding, may fit the needs of high-ability pupils better than surface learning which aims at reproducing learning materials. Assignments or projects that stimulate the use of higher-order skills in the cognitive domain of Bloom’s taxonomy of learning objectives, such as evaluating, synthesising, analysing, and creating, are therefore more appropriate than lower-order skills, such as knowledge reproduction or comprehension (Doolaard & Harms, 2013). In addition, when tasks interest pupils more, they become more engaged with the tasks; they are more creative, productive, and autonomous; they express more positive feelings about learning; and they exhibit a stronger self-concept and a higher level of intrinsic motivation (Lou, Abrami, Spence, & Poulsen, 1996; Ryan & Deci, 2000; Simpkins, Mastropieri, & Scruggs, 2009; Tomlinson et al., 2003).

In this respect, teachers or schools can promote differentiation in instruction and content complexity when using learning cycles consisting of the following stages: (1) estimation of the level of difficulty of one or more learning tasks, followed by selection of tasks to be performed; (2) offering various types of support or coaching for learning or carrying out the learning tasks (see class level); and (3) assessment or evaluation of the learning results according to specific criteria or norms, followed by selection of follow-up or other types of tasks, going back to stage (1) in the cycle (Mooij, 2013).

Adapting instruction and content complexity is particularly important as the effects of particular instructional strategies will also vary according to pupils’ abilities (Al Otaiba et al., 2011; Connor, Morrison, Fishman, et al., 2011; Connor, Morrison, Schatschneider, et al., 2011; Tomlinson, 2005). In this respect, Kalyuga, Ayres, Chandler, and Sweller (2003) refer to the expertise reversal shift, meaning that instructional designs which are effective with inexperienced or less knowledgeable learners have negative effects when used with experienced or more knowledgeable learners and vice versa. For example, 4-year-old pupils who start in early primary school with larger vocabularies and more developed phonological awareness are at a relative advantage when they are exposed to written language in school, which in turn further expands their vocabulary, phonological skills, and automaticity in reading. In contrast, pupils who are poorly equipped in vocabulary and phonological awareness require systematic teaching in these basic skills (National Institute of Child Health and Human Development, 2000). Thus, adequately differentiated levels of play and instruction, including deep-level differentiation in the content of activities, are necessary according to Mooij (2013) to continue promoting the pupil’s development and learning in the identity dimensions.

Class level. At the class level, the teachers’ differentiation skills and management skills are most relevant, and these are in turn reflected in the achievement and behaviour of the pupils in the class: see Figure 1.1. When a teacher has better classroom management skills, more time is available to work with individual pupils or a small group of pupils. Differentiation in instruction and content complexity cannot be achieved when the teacher does not have good classroom management skills, gives inadequate instruction, and does hardly or not allow pupils to work independently (Doolaard & Harms, 2013; Van de Grift, 2010).
In addition, teachers' differentiation skills come into play when teachers continually need to adapt learning activities, processes, products and/or learning environments to the differences in pupils' ability levels, needs and interests. According to Mooij (2013), teachers' child sensitivity and with-it-ness are relevant for recognising the changing needs of all pupils in class, and providing them simultaneously with appropriate learning activities. By doing this, teachers are assumed to “maximize the potential of all learners by proactively designing learning experiences in response to individual needs” (Santangelo & Tomlinson, 2012, p. 310). To this end, teachers need adequate knowledge of pupils' ability levels and of the cognitive levels required for various learning activities (see pupil level). Ability grouping, combined with adaptations in instruction and curricula, could potentially improve all pupils' learning, including high-ability learners (Adelson & Carpenter, 2011). Compared to classroom management skills, however, differentiating in instruction and assignments are teaching skills of a higher complexity order (Van de Grift, 2010). According to Van de Grift, these higher order skills can only be learned when the basic skills such as providing clear and structured instruction, are acquired by teachers.

In addition to teachers' skills, the mean academic achievement and behaviour in the class are important when the high-ability pupil relates his or her own efforts, performances and behaviour to the other pupils. When the outcome of the comparison is evaluated positively, this may enhance the pupil's self-concept and motivate more learning, and increase self-regulation in learning. When the outcome of the comparison is negative, this may decrease the pupil's self-concept and lead to withdrawal or a shift to other activities (see Marsh, Chessor, Craven, & Roche, 1995). However, according to Mooij (2013), initially positive comparison outcomes may turn into negative outcomes when a high-ability pupil functions at a level much higher than his or her peers. In regular age-based primary school, a high-ability pupil may encounter social isolation, forced underachievement, and/or inattentive and disruptive behaviour due to its cognitive and metacognitive or self-regulative distance to the other pupils (see also Mooij, 1992). The adequate perception and prevention of these problems may – partly – depend on the teacher's differentiation and classroom management skills.

**School level.** At the school level, Mooij (2013) identifies the direct and integrated availability of curricular resources and materials suitable for the full spectrum of development and learning levels of all pupils, and corresponding enrichment opportunities that stimulate interest, self-regulation and deep learning. The flexibly structured integration of educational materials across grades is necessary for all pupils. Such a systematic approach, in which schools evaluate and guarantee the quality of the teaching arrangements for high-ability pupils, is required for optimal education. In this respect, schools need a school policy for designing and controlling high-ability pupils' teaching arrangements including achievement goals. Only when schools formulate and execute goals for high-ability pupils in practice, will it be possible to instruct and evaluate pupils' progress along these goals (cf. Doolaard & Harms, 2013).

To summarise, in regular school practice all pupils, including those of high-ability, need accurate differentiation of curricula by achievement level and – in the case of high-ability pupils – deep learning, and adequate variations in individual and group instruction and learning from their very first day in primary school.
Present Teaching of High-Ability Pupils in the Netherlands

Teaching of high-ability pupils (best 2.5–20%) in the Netherlands happens primarily in the inclusive context of regular education. There are some full-time classes or schools for gifted pupils, but these select only the best 2–3% of pupils and are not very common (Doolaard & Oudbier, 2010), also because of high costs for parents and larger travel distances. In the following discussion, we will concentrate on the present teaching practices for high-ability pupils in regular education. To this end, recent reports from the Dutch Inspectorate of Education and others are used, which will be shortly described.

Commissioned by the Dutch Inspectorate of Education, Doolaard and Oudbier (2010) surveyed 450 primary schools to study the teaching for high-ability and gifted pupils. They specifically focussed on the selection of these pupils, offered learning activities, financing, and quality control issues. Results were weighted to present a national representative image. In another study, in-depth views were used in a multiple case study of nine primary schools (Doolaard & Harms, 2013), that were visited by the researchers five times in one year to observe and guide teachers in their teaching of high-ability pupils.

In 2015, the Dutch Inspectorate of Education studied how schools provided teaching for high-ability pupils (best 20%) in primary and secondary education (Inspectie van het Onderwijs, 2015b). In this study, 200 primary schools and 125 secondary schools were surveyed. Additionally, inspectors visited 48 primary schools and 49 secondary schools in which they observed lessons and interviewed pupils, teachers, and school administrators.

Further, the most recent report of the Dutch Inspectorate of Education concerning the status of Dutch education was used (Inspectie van het Onderwijs, 2015a). Here, the use of a representative sample of schools allowed statements about the system as a whole. The inspectors surveyed primary schools and visited them for class observations.

These four studies are complemented by other studies and form the basis for discussing the present practices concerning the school context variables as given in the simplified 3-level model of Mooij (2013).

Pupil Level: Differentiation in Instruction and Content Complexity

Dutch primary schools primarily group pupils in class contexts according to age. Most learning activities and corresponding learning methods and assessment instruments are organised and adapted to the mean chronologic age of the pupils (Mooij, Roeleveld, Fettelaar, & Ledoux, 2012). To anticipate the higher educational needs of high-ability pupils, schools may use a number of differentiation strategies, such as curriculum compacting, enrichment activities, and acceleration (Hoogeveen, Van Hell, Mooij, & Verhoeven, 2004). Curriculum compacting involves modifying the instruction and/or content by eliminating already-mastered curriculum. Schools often combine curriculum compacting with enrichment opportunities that include richer and more varied learning activities than the regular curricula offer, with more deep and broad content and methodology. Enrichment may be offered in the regular classroom or in a pull-out
classroom for a few hours a week. Acceleration involves offering advanced content from higher grades, or skipping grades.

In 2010, 40% of primary schools offered differentiated learning activities such as curriculum compacting and/or enrichment activities in the regular classroom, and 32% offered enrichment activities in a pull-out class context (Doolaard & Oudbier, 2010). Most teachers preferred the regular classroom context to offer learning activities for high-ability pupils (Inspectie van het Onderwijs, 2015b). This is called internal differentiation, in contrast to external differentiation such as pull-out classes, which takes place outside the pupil’s regular classroom (Bosker, 2005).

The current teaching of high-ability pupils in regular classes, however, seems to be suboptimal (Doolaard & Harms, 2013; Doolaard & Oudbier, 2010; Inspectie van het Onderwijs, 2015b). In general, teachers divide their pupils in three groups with different instructional needs: short, regular, and extended instruction. This instructional differentiation, however, is not sufficient to fully adapt activities to the needs of individual pupils, the Dutch Inspectorate of Education concludes (Inspectie van het Onderwijs, 2014, 2015a).

Further, differentiation in instruction and content complexity is largely dependent on the available learning methods/textbooks and extracurricular enrichment materials (Inspectie van het Onderwijs, 2015b). When methods offer clear curricular enrichment arrangements for high-ability pupils, schools apply these arrangements in practice. But when the methods do not offer these arrangements, schools hardly make any adaptations in the instruction and content complexity for the high-ability pupils. Large differences occur between domains. Most arithmetic methods, for example, offer differentiated learning activities for high-ability pupils, while this is not the case for orthography or English. This availability issue is also found for enrichment materials, usually characterised by more complex and open-ended activities. Thus, not the learning needs of the high-ability pupils guide the offering of activities, but the available learning materials do.

There are some more weaknesses in the offering of enrichment activities. When these activities are available, they are often only given after the pupil finished the regular tasks, while the pupil may already possess the skills being taught in the regular tasks. In 2010, this was the case in 75% of primary schools (Doolaard & Oudbier, 2010). Also, enrichment activities in learning methods are often too easy for high-ability pupils and contain more of the same level of activities (Doolaard & Harms, 2013), and, thus, may not stimulate the required deep-level learning of high-ability pupils. This is compounded by teachers skipping the more complex enrichment activities, because the teachers lack the time (Inspectie van het Onderwijs, 2015b) and/or the knowledge to offer these activities (Doolaard & Harms, 2013). Teachers seem to be unaware of the cognitive levels required for successfully carrying out specific learning activities. Further, it seems that schools offer enrichment activities, but deciding what regular activities can be skipped (curriculum compacting) is more difficult for teachers and, therefore, can be lacking. Differentiation in content complexity in the regular curriculum is then not achieved.

Teachers usually do not provide instruction for enrichment activities that are carried out in the regular classroom (Inspectie van het Onderwijs, 2015b). This finding is supported by the preference of primary school teachers to offer materials that do not require instruction from the
teachers (Doolaard & Harms, 2013). Also, teacher guidance often lacks while pupils carry out the enrichment activities (Doolaard & Harms, 2013). As enrichment activities should be as difficult for the high-ability pupils as is the regular work for the non-high-ability pupils, teachers should also provide adequate support for scaffolding the learning of these pupils.

Most worrying possibly is that teachers and schools hardly set any requirements for the high-ability pupils’ performances on the enrichment activities (Inspectie van het Onderwijs, 2015b). Also, in 25% of the schools, pupils receive no feedback or evaluation for these activities (Doolaard & Oudbier, 2010), while this is essential for optimal learning according to stage three of Mooij’s learning cycle. In this respect, Mooij (2013) specifies that adequate requirements and evaluations need to be based on double diagnostics which include both individual, long-term estimation or assessment of learning, and assessment of the level of learning compared to age-mates. Instruction and learning, and their organisation in school and class, should be based on both types of diagnostics, for all pupils. At present, however, the evaluation of learning is complicated when learning objectives for high-ability pupils relate vaguely to motivation and ‘learning how to learn’, which is often the case in extracurricular enrichment activities in pull-out classes (Inspectie van het Onderwijs, 2015b). It is therefore self-evident but also striking that the effects of existing enrichment material for the learning and development of high-ability pupils are not clear. Finally, the coherence with the regular curriculum usually lacks or is suboptimally developed (Doolaard & Oudbier, 2010; Mooij & Fettelaar, 2010).

Compared to higher grades in primary school, the intellectual context for high-ability pupils in early primary school is even less challenging, as the emphasis here is traditionally on socialisation and play and not ‘learning’ (Oberon, 2013). In 2010, only 29% of the schools compacted learning activities in early primary school (Doolaard & Oudbier, 2010). This may have to do with the fact that in early primary school, teaching methods, with indications for curriculum compacting, are not very common; the curriculum usually consists of diverse play- and learning material.

In sum, Dutch primary schools suboptimally integrate differentiation in instruction and content complexity in their teaching, and, in cases, this differentiation is completely lacking. Most high-ability pupils are primarily taught in regular classes and may be provided with curriculum compacting and/or enrichment activities, but these arrangements have some weaknesses concerning content, instruction, and evaluation.

**Class Level: Differentiation and Classroom Management Skills of Teachers**

The Dutch Inspectorate of Education observed to what extent the instruction, assignments, and learning pace were differentiated according to developmental differences between pupils in a class. They found that teachers in nearly 40% of the schools had insufficiently developed differentiation skills (Inspectie van het Onderwijs, 2015a). This may involve, for example, sub-optimal use of the different performance levels at which pupils function in varying subsequent assignments at adequate learning levels (Deunk & Doolaard, 2013). Doolaard and Harms (2013) found a similar result, and wondered whether teachers could be expected to optimally differentiate, while teacher education only teaches the basic skills to pre-service teachers, and teachers only learn the more complex skills by doing over the years.
The teachers in early primary school possessed the differentiation skills to a lesser extent than higher grade teachers (Inspectie van het Onderwijs, 2015a). According to the Dutch Inspectorate of Education, this may have to do with the fact that in higher grades more learning material is available that can be used for differentiation (see pupil level). In the same study, the classroom management skills were observed, and they were generally well developed. In over 90% of the observed lessons, teachers took care of a task-oriented work atmosphere and pupils were actively involved in the learning activities.

More specifically, the Dutch Inspectorate of Education found that Dutch teachers generally were willing to stimulate their best pupils towards high achievements, but the knowledge and time for adequate instruction and feedback was lacking (Inspectie van het Onderwijs, 2015b). Determining the levels of the pupils was strongly dependent on the assessment skills of teachers. Underachievers, in particular, were difficult for teachers to recognise. Also, teachers usually only determined that a pupil needed more academic challenge, but did not deliberately think about what particular activities would fit this specific pupil. Doolaard and Harms (2013) found that teachers often lack a clear picture of the levels at which high-ability pupils function, and although assessment data is widely present in schools, teachers often lack the knowledge of how to acquire and use the assessment data for initial level determination and monitoring learner progress for high-ability pupils. Also, some teachers were reluctant to provide pupils with more academic challenge, as the pupils already showed good performance and teachers felt that “good is good enough” (De Boer et al., 2013, p. 134). This noncompetitive mentality has traditionally been present in Dutch society, and could function as a barrier for teachers’ offering of appropriate learning activities to high-ability pupils.

In sum, teachers’ classroom management skills are generally sufficiently developed, but required teaching materials or methods including adequate diagnostics hardly or do not exist; moreover, teachers’ differentiation skills and corresponding beliefs that are required to offer the required variation in instruction and content complexity for high-ability pupils, are in need of improvement.

School Level: Integration of Curricula and Enrichment

According to the Dutch Inspectorate of Education (2015b), the offering of appropriate learning activities such as enrichment activities in Dutch primary education is still too much dependent on the individual teacher. Usually, no integrated curricula of learning activities for high-ability pupils are present in schools. As a consequence, high-ability pupils can be stimulated at their own level in one grade, and in the next grade this offering of appropriate learning activities is completely lacking.

In some schools, teachers collaboratively discuss what to teach to the high-ability pupils. In the majority of schools, however, the offered activities totally depend on the available learning materials, not on the learning needs or learning goals of the high-ability pupils (see pupil level). In only a few schools, there is a clear policy about what, how and when to offer extra learning activities, but usually this is not developed systemically. In this respect, the school-wide goals for teaching high-ability pupils are largely missing. Doing ‘something’ for the high-ability pupils seems to be more important than defining and pursuing clear goals and adequate outcomes
of this teaching. The lack of goals makes evaluation of the learning processes difficult or even impossible. The quality of this teaching cannot be guaranteed when clear goals are lacking (Doolaard & Harms, 2013).

Conclusions

When applying the 3-level model of Mooij (2013) to the Dutch education for high-ability pupils in regular primary education, some points of improvement come up. Although most teachers are willing to provide their high-ability pupils with some improved learning possibilities, it is striking that most enrichment activities are provided by the learning methods or the extracurricular activities that are available in the schools. Not the educational potentials or needs of the high-ability pupil guide the teaching, but the available learning activities determine what is done. Moreover, the objectives and effects of these activities are often not clear. Also, teachers may lack the differentiation skills that are required to optimally base and differentiate instruction and content complexity for these pupils. The situation may be worse in early primary school, as the curricula may be less compacted and the teachers are less skilled in differentiation for high-ability pupils who may function at cognitive levels of one or more grades higher.

In addition, schools lack educational goals for the teaching of high-ability pupils. The activities for these pupils are not integrated in a curriculum, and are only offered at an ad hoc basis. The offering of these activities is very much teacher-dependent. Thus, systematic support for high-ability pupils in primary school seems to be lacking since their first day in this educational institution.

New Directions

The offering of appropriate learning activities for high-ability pupils should be less teacher-dependent and more structurally integrated in the school curriculum during primary school and higher. Also, the educational needs of the high-ability pupils should guide the provision of learning activities; the available materials should not do this. In this respect, differentiation of the core curricula seems to be a relevant starting point for research, as it provides a way to adequately adapt learning activities to the needs of high-ability pupils (e.g. Chapter 2; Tomlinson, 2005). Starting in early primary school and continuing in secondary education, pupils can be challenged continuously in order to learn in their zone of proximal development. Relevant research areas are, then, how early primary school teachers can assess the (initial) performance levels of the pupils and determine which development and learning activities match with these levels (see Chapter 2). Also, it is important to clarify how the teaching of high-ability pupils could be integrated in a school-wide structure of differentiated curricula; and how teachers can be supported to improve differentiation within and between classrooms in order to challenge all pupils (see Chapters 2, 3 and 4). For each research area, suggestions for further research and policy recommendations are given.
Pupil Assessment and Progress Monitoring

From the perspective of educational psychology, the entry-level characteristics of each pupil should be used as the initial criteria for giving the pupil proper, ability adequate instructional support in the early primary school environment. To determine the levels at which pupils function, including those of high-ability, the use of multiple assessment instruments are recommended (e.g. Brown et al., 2005). These can include, among others, observation and screening by parents and teachers, assessment games, higher level testing, and, in higher grades, portfolio assessment. Research may focus on the best way to support teachers in assessing initial levels of pupils at the start in primary school, and on monitoring their progress. In this respect, Chapter 2 presents a method in which teachers collaborate with parents in the screening of school-entry characteristics of 4-year-old pupils.

School-Wide Differentiated Curricula

To make appropriate decisions about instruction for each pupil in a class, teachers need to know which cognitive levels are required of learners for the various core curricular and extracurricular enrichment learning activities (cf. Tomlinson et al., 2003). To make the offering of these activities less teacher-dependent, both types of learning activities need to be part of learning cycles. Each learning cycle could be integrated into the instructional organisation aspects of the learning processes at the school. By evaluating pupils’ learning according to learning goals in a differentiated curriculum, further steps in learning may be determined. A clear school policy concerning differentiation for high-ability pupils could be helpful. Research into the development and teachers’ use of such learning cycles in school-wide differentiated curricula could be helpful in realising the differentiated learning for all pupils in the classroom. In this respect, Chapter 2, 3, and 4 focus respectively on how early primary schools could develop and implement these differentiated curricula, which factors play a role herein, and what the effects are of differentiated curricula on teacher-reported differentiation practices. In the end, Chapter 5 concerns the effects of these curricula on high-ability and non-high-ability pupils’ academic outcomes in early primary school.

Differentiation Skills of Teachers

A number of researchers have shown that the willingness and skills needed for offering differentiated instruction and curricula to pupils, including those of high-ability, are not in the repertoire of all teachers (Deunk & Doolaard, 2013; Doolaard & Harms, 2013; Hertberg-Davis, 2009; Tomlinson et al., 2003; Van de Grift, 2010). Thus, an important area for research is how to improve teachers’ differentiation practices in order to provide all pupils in the classroom, including the high-ability pupils, with adequate learning activities. It seems plausible that the ordering of activities in learning cycles that are integrated in the instructional organisation aspects in school can be helpful in applying differentiation in instruction and content complexity, which is the focus of Chapter 4. Further research into the support for teachers in improving their differentiation skills, in particular in how to support high-ability pupils, is therefore encouraged.
Chapter 2
Towards Optimal Education Including Self-Regulated Learning in Technology-Enhanced Primary Schools

Abstract
At the start of primary school, 4-year-old pupils differ in their development, including the capacity to self-regulate their playing and learning. In primary school, educational processes and (digital) pupil-monitoring systems are generally adapted to the mean age of the pupils in class. This norm-based factor undermines the educational differentiation needed for pupils and increases the amount of daily work for teachers. A theoretical framework is sketched in which pedagogic-didactic, organisational, and ICT guidelines enhance differentiated, self-regulated playing and learning for each pupil within primary school. To develop and check such optimal education in practice, a pilot and a randomised intervention study entitled Excel Kwadraat are carried out in Dutch primary schools for pupils aged 4–12. The results support the use of a procedure to screen each pupil’s characteristics at the start of primary school by parents and teachers, and also the immediate relevance of criterion-based and norm-based ordering (double diagnostics) of playing and learning materials. Finally, a case study is presented and attention is given to further development of optimal education.

This chapter is based upon:
Human learning is characterised by continuous interactions between innate potential and abilities on the one hand and different types of environments on the other; each side may contribute to the learner’s growth (Magnusson & Allen, 1983). The learning of a young child is influenced, then, by the home situation, which also reflects the level of educational attainment of the parents or caregivers, in particular the mother (Moss & Strayer, 1990; Pino-Pasternak & Whitebread, 2010; Robinson, Burns, & Winder Davis, 2009). Opportunities for relative autonomy or self-regulation in playing, and parental support for educational achievement are generally more evident in homes characterised by relatively high levels of parental educational attainment. Parents also vary in their regulation of their children’s media use, trying to maximise the advantages and to minimise the disadvantages and potential dangers (Livingstone, 2003; Livingstone & Helsper, 2008). In addition, children with high potential in cognitive and meta-cognitive competencies profit more from possibilities to develop autonomously than their peers without these competencies (Baroody, 1993; Byrne, 1998; Kalyuga, 2007; Mooij, 1994; Overtoom, 1991).

Both personal and environmental characteristics contribute to the fact that, at the chronologic age of about 4, children differ in their levels of psychological development and performance, ranging between about two to seven years of age (Hermanns, Öry, & Schrijvers, 2005; Mooij, 2000). This psychological diversity includes cognitive and emotional or expressive abilities and performance, and also meta-cognitive capacities to self-regulate playing and learning processes. The differentiation of personal and environmental characteristics and the interactions between them makes the exact specification or identification of personal characteristics a difficult task.

Brown, Renzulli, Gubbins, Siegle, Zhang, and Chen (2005) conclude that various screenings or assessments based on various sources and points in time should be included to enable specification of personal characteristics to be promoted by home and education conditions.

In many European and other countries, developmental and educational processes in preschool or kindergarten and primary school are organised according to age and the corresponding tasks or activities are generally adapted to the mean age level of the pupils. This situation for example exists in Germany (Arbeitsgruppe Schulforschung, 1980; Händel, Vialle, & Ziegler, 2013), the United Kingdom (Norwich, Ylonen, & Gwernan-Jones, 2014; Tymms, Merrel, & Henderson, 2000; Wheaton, 2013), the USA (Colangelo, Assouline, & Gross, 2004; Earle, 2001; Lillard, 2012), and the Netherlands (Hermanns, 1979, 1980; Mooij, Roeleveld, Fettelaar, & Ledoux, 2012). Generally, this implies that most of the tasks or activities fit most of the pupils in a group or class. For less-developed and highly-developed young pupils, however, the playing and learning activities that are offered do not fit their level of psychological development. Gagné (2011) interprets age-based education and grouping as the age/grade lockstep of educational systems around the world, causing many problems with learners.
This nonfit is responsible for many cognitive, social, emotional, behavioural, and motivational problems of pupils who function either clearly below or at a higher level than their age mates (Bennett, Gordon, & Edelmann, 2012; Hermanns, 1979, 1980; International Panel of Experts for Gifted Education (iPEGE), 2009; Leseman, 2002). The more a pupil deviates from the group in, for example, cognitive and metacognitive respects, the more problems the pupil usually encounters in early primary school (Kemp, 2000; Meijer, 2003; Mooij & Driessen, 2008). This nonfit also implies that these marginal pupils are less able to self-regulate their activities in an appropriate way.

Education, including ICT facilities, should be adapted to and stimulate the development and learning of each pupil or learner (Beirn, Kinsey, & McGinn, 1972; Durkin, 1966; Kemp, 2000; Kohnstamm, 1928; Lubinski, 2004; Parkhurst, 1922). Yet (ICT-based) pupil-monitoring systems for primary school in the Netherlands are organised according to pupils’ age and class (Meijer, Ledoux, & Elshof, 2011; Nieveen & Kuiper, 2012; Slinger, Van Trijp, Verheijden, & Van Empelen, 2011). Teachers not only have to carry out the bureaucratic operations required by the monitoring systems, but also create developmentally adequate learning situations for the marginal pupils. This involves working out separate, and more detailed, arrangements for each pupil who does not fit the mean level. Moreover, as the monitoring systems generally do not integrate learning content and their evaluations in one system, teachers have to discover, or guess, which content is evaluated by which aspects of the monitoring system (Meijer et al., 2011; Mooij, 2008, 2009). Comparable problems exist in the other countries as mentioned above (Betebenner, 2009; Earle, 2001; Händel et al., 2013; Wheadon, 2013).

 Appropriately differentiated education therefore requires the identification and structuring of pedagogic-didactic, organisational, and ICT characteristics that, in combination, can be expected to promote diagnostically adequate, flexible playing and learning processes for each pupil; moreover, pupils who are able to self-regulate their learning to some degree should be enabled and stimulated to do so, whereas pupils who need more teacher assistance should receive this support. We will first sketch a theoretical framework in which specific education and ICT conditions are hypothesised to optimally support playing and learning processes as well as differing degrees of self-regulation for pupils in primary school. We will furthermore provide results of a pilot study to screen the school-entry characteristics of pupils and sketch some main aspects of a randomised intervention study conducted in Dutch primary schools for pupils aged 4–12.

**Theoretical Framework**

**Learning Differences, Class Organisation, and Self-Regulation of Pupils’ Learning**

A primary goal in early primary school is to socially integrate pupils by forming groups and involving them in enjoyable educational activities. To realise this goal, pupils are typically grouped according to age. Whether or not some of the pupils are under-challenged cognitively, for example, while others are over-challenged, depends on the degree to which curricula and
the related level of self-regulation are differentiated (Jewett, Tertell, King-Taylor, Parker, Tertell, & Orr, 1998; Lillard, 2012; Lubinski, 2004; Mooij, 1992; Skinner, Bryant, Coffman, & Campbell, 1998).

Adequate differentiation including self-regulation at the beginning of primary school does not seem to be self-evident, however (Bennathan & Boxall, 1996; Colangelo et al., 2004; Lems, 1996; Purcell, Burns, Tomlinson, Imbeau, & Martin, 2002; the Scottish Government, 2009). In age-based schooling, cognitive and metacognitive development and stimulation are important in the playing processes and the curriculum, next to attention for pupils’ social, emotional, and sensory-motor functioning. The degree of educational differentiation of a school is then conditional on the adequate stimulation and motivation of pupils who are marginal when compared to the mean of their age group. Both cognitive underchallenge and overchallenge will reduce the adequate growth of the pupils in various domains and their capacities to learn how to manage or self-regulate their own development and learning (Bowerman, 1978; Parkhurst, 1922; Zimmerman, 2000, 2002). This is also demonstrated in research concentrating on scaffolding in teacher-pupil interaction (Van de Pol, Volman, & Beishuizen, 2010) and in effects of school-based programs for increasing pupils' connectedness and reducing their risk behaviour (Chapman, Buckley, Sheehan, & Shochet, 2013).

According to Zimmerman (1990), self-regulated learning (SRL) is characterised by pupils’ use of specific learning strategies, responsiveness to self-oriented feedback about learning effectiveness, and interdependence of motivational processes and SRL. SRL theories concentrate on how learners select, organise, or create challenging learning environments for themselves and on how these learners plan and control the form and amount of instruction. Compared to other learners, “self-regulated students are distinguished by their systematic use of metacognitive, motivational, and behavioural strategies; by their responsiveness to feedback regarding the effectiveness of their learning; and by their self-perceptions of academic accomplishment” (Zimmerman, 1990, p. 14). Moreover, Zimmerman (1990) emphasises that metacognitive, motivational, and behavioural strategies should be integrated in school instruction to affect long-term effects (see also Heckhausen, 1980).

Therefore, to support the growth of SRL and increase motivation, identifying the actual learning level of each pupil is essential at the start of primary school. Based on this diagnosis, instruction and (digital) support should differentiate playing and learning tasks and classroom organisation structures, to accommodate diverse ability levels and learning strategies. Teachers should also focus on ways to differentiate plenary classroom activities to further develop self-regulation (Perels, Gürtler, & Schmitz, 2005). It is expected that development and learning will increase as pupils are allowed to take more initiative and responsibility within a coherent instructional structure (see also Lillard, 2012; Parkhurst, 1922; Rozendaal, Minnaert, & Boekaerts, 2005; Zimmerman, 2002).

**Adequately Differentiated Curricula**

At the pupil’s level, differentiated SRL can be expressed in learning cycles characterised by (1) estimating the difficulty level of learning tasks in a specific domain, followed by selection of the tasks to be performed; (2) selecting types or intensity of support for carrying out the learning
tasks; and (3) assessing the effectiveness of the learning followed by applying the results in the follow-up tasks (Bowerman, 1978; Mooij, 2007a). Increasing a pupil’s self-regulation or ‘learner control’ by providing fitting support is a necessary condition for increasing motivation on subsequent learning tasks (Brush & Saye, 2001; Mooij, 2007b; Parkhurst, 1922).

A learning cycle consists of integrated diagnostic, instructional, managerial, and systemic aspects of the learning processes in a school. A structured set of play or learning tasks forms an ‘instructional line’, which may be one of many sets of instructional lines. Combining these lines results in ‘learning arrangements’ which build a specific curriculum or curriculum part. An instructional line, for example, starts with one or more diagnostic tasks, that help indicate the level of curricular activities to be performed. A criterion-referenced task concerns the evaluation based on a learner’s progress with respect to a specific set of learning activities. A norm-based diagnostic task results in a score representing a standardised or nationally representative value (Betebenner, 2009; Earle, 2001; Kemp, 2000; Mooij, Haverkort, & de Kleijne, 2013; Wheadon, 2013). A diagnostic task which is used simultaneously as a criterion indicator and normed assessment refers to double diagnostics (Mooij, 2007a, 2007b, 2013). The combination of the curricular concepts and their assessments specifies an instructional ‘pedagogic-didactic kernel structure’ (PDKS) of competence domains in the national educational system (Mooij, 2007b, 2013).

Furthermore, the diagnostic and instructional aspects of the learning processes must be managed adequately to organise the evaluation of the learning (Kreijns, Kirschner, & Jochems, 2003; Van den Boom, Paas, Van Merriënboer, & Van Gog, 2004). Here ICT can give support by integrating diagnostic and instructional characteristics on the one hand, and information about individual, small group, and class learning progress on the other.

The systemic aspect of learning indicates that a pupil not only belongs to small groups or classes in primary school where he or she spends many hours every week, but also to a family and peer groups outside school. Moreover, a pupil at risk may also have contacts with youth health-care professionals, for example. ICT can be designed to integrate information across these different environments (Black, McCormick, James, & Pedder, 2006; Hermanns et al., 2005; James, Black, McCormick, Pedder, & William, 2006; Mooij, 2009).

Differentiation of learning materials and procedures, integration of ICT support, and strategies to improve development and learning, can therefore act as conditional dimensions referring to diagnostic, instructional, managerial, and systemic aspects of learning. This theoretical framework is sketched in Table 2.1. The table illustrates that the combination of the 3 dimensions and the 4 aspects results in a pattern of 15 guidelines, to realise conditions for optimal development and learning.

The first dimension in Table 2.1 concerns differentiation of curricular materials and procedures. The curricular materials form learning blocks and a compilation of blocks across levels of attainment represents a school career. Guidelines 1.1–1.5 specify the pedagogic-didactic kernel structure (PDKS) referring to competence domains, curricular concepts, and assessment from a double diagnostic point of view. The domains may, for example, include socioemotional performance; general intelligence; language; arithmetic; physical-medical aspects; general psychological characteristics; or motor activities (Byrne, 1998; Gallagher, 1975).
Web-based ICT can assist in registering, evaluating, and reporting learning processes across various organisational levels (Blumenfeld, Fishman, Kraycik, Marx, & Soloway, 2000; Clark & Estes, 1999; Crook, 1998; Meijer, 2003; Walsh, Hodge, Bowes, & Kemp, 2010; Watkins, 2001). Guidelines 2.1–2.5 of Table 2.1 therefore require the development of web-based ICT to support guidelines 1.1–1.5. If this ICT supports the various learning aspects referred to in the theoretical framework, ICT is the second conditional dimension for optimal education and optimal learning (Earle, 2001; Kemp, 2000; Mooij, 2002, 2009; Sinko & Lehtinen, 1999).

In school practice, the first and second dimension can be empowered by a third dimension with a focus on strategies to improve development and learning, including self-regulation. Guidelines 3.1–3.5 in Table 2.1 concern the screening of a pupil’s school-entry characteristics in primary school (see also Colangelo et al., 2004; Durkin, 1966; Mooij, 2000). The results could refer to level-adequate play materials as a starting place for an individual pupil (Bennathan & Boxall, 1996; Lems, 1996; Lillard, 2012; Reynolds, 2005; Tymms et al., 2000). Instructional support should differ among pupils in accordance with their ability levels, magnitude of learning steps, use of metacognitive strategies, and level of self-regulation during learning. Managerially, collaborative self-regulation of pupils in small groups enables the teacher to concentrate more on those pupils most in need of coaching.

### Table 2.1 Educational conditional dimensions, learning aspects, and guidelines for designing education for optimal learning

<table>
<thead>
<tr>
<th>Learning aspects</th>
<th>Educational conditional dimensions</th>
<th>Strategies to improve development and learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differentiation of learning materials and procedures</td>
<td>Integration and use of ICT support</td>
<td></td>
</tr>
<tr>
<td>Diagnostic 1.1. Identify a pedagogic-didactic kernel structure for different domains and subdomains</td>
<td>2.1. Facilitate construction and use of a pedagogic-didactic kernel structure instructional lines</td>
<td>3.1. Use a learner’s entry-level characteristics to start</td>
</tr>
<tr>
<td>Instructional 1.2. Structure domains of competence in terms of skills, subskills and instructional lines</td>
<td>2.2. Enhance structuring and flexible use of instructional lines and learning arrangements</td>
<td>3.2. Create and control prosocial relationships in and around school</td>
</tr>
<tr>
<td>1.3. Include criterion-based and normed indicators to evaluate learning progress</td>
<td>2.3. Facilitate differential instruction, collaborative learning, and self-regulation</td>
<td>3.3. Use collaborative didactic procedures to stimulate self-regulation across grades</td>
</tr>
<tr>
<td>Managerial 1.4. Organise and match flexible groups of learners and teachers/coaches</td>
<td>2.4. Encourage differentiated and multilevel evaluation of learning progress</td>
<td>3.4. Concentrate teacher coaching on those pupils most in need of this</td>
</tr>
<tr>
<td>Systemic 1.5. Use integrated systems for monitoring, evaluation, and administration</td>
<td>2.5. Integrate instruction and learning across different contexts and points in time</td>
<td>3.5. Apply multilevel indicators to improve instruction and learning throughout school</td>
</tr>
</tbody>
</table>
The theoretical framework in Table 2.1 emphasises adequate differentiation and appropriate placement concerning play and learning processes, beginning with a pupil’s very first day in primary school. This means, for example, that 4-year-old pupils, who function at language or arithmetic levels of 6- or 7-year-old pupils, are enabled to function at or above their actual performance level, even if these pupils are placed in their age group. Such cognitively high-ability pupils are marginal pupils (about 10% of their age group) who score relatively highest as diagnosed with cognitive screening results; as identified with a personality test; or with national pupil monitoring tests in academic achievement (see also Brown et al., 2005; Gagné, 2011). Their appropriate placement in the curriculum and consequent stimulation will have positive effects on their cognitive, social, emotional, and motivational performances (Bailey et al., 2012; Durkin, 1966; Heckhausen, 1980; Mooij, 1999; Sontag, Stoeger, & Harder, 2012). Comparable but different curricular content and procedures are necessary for pupils who lag behind in one way or another (Bennathan & Boxall, 1996; Bennett et al., 2012; Mooij, 2000, 2013).

Hypothesis
If relatively advanced pupils have access to PDKS-differentiated curricula and instruction at levels appropriate to their ability, they can effectively engage in instructionally supported and self-regulated learning processes at their own levels. Analogously, the same is true for pupils developing relatively more slowly than their age mates. Once this type of educational differentiation becomes school practice, the traditional, age-based primary school system transforms into an instructionally supportive system which meets the needs of different pupils in a relatively optimal manner. The transformation will improve the learning processes of both relatively high- and relatively low-ability pupils (Mooij, 2013).

Method
Preliminary Information on the Dutch Education System
As the research was conducted in the Netherlands, we will first provide some information about the Dutch education system. Between 0 and 4 years, children may attend an infant day-care centre, in particular when both parents/caregivers have a job. Next, almost all children attend a primary school from when they turn 4 onwards. In primary school, pupils are usually organised according to age, with only minimal exceptions (Doolaard & Oudbier, 2010; Driessen, 2013; Mooij, Hoogeveen, Driessen, Van Hell, & Verhoeven, 2007). Primary school consists of eight years: two preparatory grades (cf. preschool or kindergarten) and six grades of basic education (or ‘special education’ for pupils characterised by specific psychological or physical disabilities). Standard national or regional curricula or learning requirements do not exist, however, because this would be in conflict with the legally defined responsibility (or freedom) of schools in the Netherlands. Yet schools are legally obliged to provide educational services characterised by continuous individual progress for all pupils. When pupils are about 12 years old they attend secondary education, which has 4 regular tracks that are differentiated with respect to educational
attainment. The situation concerning the lack of a standard national curricula is comparable to that in primary education. This is also true for higher levels of education. This system leaves much responsibility for schools.

The main Dutch national pupil-monitoring system for primary school is characterised by age- and class-based organisation of pupils (Meijer et al., 2011; Nieveen & Kuiper, 2012). This ICT-based system provides various achievement tests. Schools are not obliged to use this system, but most of them do. The system can provide the pupil’s norm-based scores based on the age of peers; in addition, the monitor provides individual information about the degree to which the pupil deviates from his or her peers. Teachers can use both types of information to structure their teaching, but only the norm based scores match the school curricular methods. Adaptation to individual pupil score profiles requires extra work for teachers.

It should be added that general formulations exist for desirable learning goals to be realised for specific ages. However, there is no clear relationship among the general learning goals, the curricular methods, and the attainment levels in the pupil monitoring system. This lack of transparency has legal and political roots, but from pedagogic and psychological points of view it is a main problem in Dutch schools and also presents challenges to the work of the Dutch Inspectorate of Education, which is the official body that looks after school quality and oversees school achievement (Mooij et al., 2012). To bring more clarity in the organisation of learning processes, and to reduce the related problems of teachers and marginal pupils in particular, we can use the guidelines of Table 2.1 including the concept of double diagnostics (see the theoretical framework).

Two Research Steps

The framework in Table 2.1 can be used as a tentative design for researchers to collaborate with teachers in schools in order to improve schooling for pupils who are identified as functioning relatively marginally compared to other pupils in class. In line with Cobb, Confrey, diSessa, Lehrer, and Schaubule (2003), this method is considered a ‘design experiment’ (see also Van den Akker, Maribe Branch, Gustafson, Nieveen, & Plomp, 1999). An important advantage of this in-service development is the opportunity to evaluate the school relevance, or ecological validity, of the guidelines in Table 2.1. Preliminary experiences in the schools have clarified that teachers and principals need much support to realise the necessary transformation of their school (Mooij, 2007a, 2009). Usually, focusing on marginal pupils and their problems in early primary school offers a starting point for teachers to analyse the causes and take the consequences seriously in their own practice. A first research step, then, concerns the estimation of the school-entry characteristics of each incoming pupil in primary school (guideline 3.1 in Table 2.1). A second, more comprehensive research issue is to use the school-entry characteristics as a starting point to realise appropriate placement of the pupil in the differentiated curricula. Teachers first need to develop adequate differentiated curricula, including activities in small groups and classes, and also include free play or other types of self-chosen stimulating and challenging activities. In addition, at the school level, differentiated curricula can be integrated across classes in primary school; opportunities for even the youngest pupils to self-regulate their playing and
learning can be stimulated (see Table 2.1). This second research step is included in a randomised intervention study entitled *Excel Kwadraat* (Excel Squared) in early primary school to assist the development of differentiated optimal education as outlined above and to check the effects on the pupils.

Step 1: Pilot Study on Screening of School-Entry Characteristics

The first research step was to pilot the screening of pupils’ school-entry characteristics. This took place between 2008 and 2010. The goal was to develop, implement, and review the whole procedure in practice in the context of the guidelines in Table 2.1. The pilot school is a primary school that was selected because of its collaboration with infant day-care teachers. The school building is located in the eastern part of the Netherlands (‘school East’).

A psychometrically controlled screening instrument was developed for this research (Mooij, 2000). To implement the use of this instrument, an infant day-care teacher, the parents/caregivers, and the teacher first complete a questionnaire to estimate a pupil’s level of competence in seven domains by comparing the pupil’s behaviour with the behaviour of same-age peers. The seven scales refer to social interaction/communication, general cognition, language proficiency, preliminary arithmetic, sensory-motor level, emotional-expressive level, and expected educational behaviour/motivation of the pupil in primary school (Alpha scale reliabilities for parents vary between .65 and .92; for teachers between .75 and .91). The questionnaire can be administered by an infant day-care teacher and by the parents when a child is about to go to primary school; the teacher can complete the questionnaire after the pupil’s first month in school.

Furthermore, approximately 6 weeks after a pupil has entered primary school, the teacher and the parent(s) meet to discuss each other’s screening results and reflect about the next educational steps. Parent(s) or care-giver(s) and the teacher may differ in their screening of specific characteristics of the same pupil, but here it may also be relevant that the home situation and class situation differ. The aim of the screening procedure is to bring parent(s) and teacher together and combine their expertise about the pupil to construct a mutually trusted way to promote the school experiences of the pupil. The common goal is to realise appropriate placement for the pupil in differentiated curricula within two months of admission. Screening results are only one type of indicator and should not be taken as absolute (see also Brown et al., 2005).

In the results section, we will present some qualitative and quantitative information about the screening procedure. The quantitative information consists of descriptive statistics, reliability coefficients (Alpha), and paired *t*-tests.

Step 2: Randomised Intervention Study in Early Primary School

According to Table 2.1, the necessary differentiation of education first of all requires the development of a pedagogicDidactic kernel structure (PDKS). An initial inventory of Dutch youth health tests and pupil-monitoring instruments resulted in a set of hierarchically structured competence domains concerning language, arithmetic, general cognition, socioemotional performance, physical-medical aspects, general psychological characteristics, and motor activities
The concepts and subconcepts per domain tap curricula for pupils aged 2–12 and can aid diagnosing criterion and norm indicators.

The next activity was to develop ICT to assist the development and use of the differentiated curricula in primary school. ICT development started by designing web-based support for the PDKS, according to guidelines 2.1–2.5 in Table 2.1 (Mooij, 2007b, 2009). Teachers can consult the normed basis of the PDKS and attribute learning information to this basis. For example, a teacher can select a concept from a specific pupil monitoring test and connect curricular tasks to this test, and create instructional lines. Specific learning arrangements can be made for specific types of pupils. Learning arrangements can also be stored by the software and be assigned to any pupil or small group of pupils, or be changed whenever desired. Moreover, schools can decide to collaborate with any other school and exchange learning arrangements. Finally, a digital procedure to estimate the school-entry characteristics of a pupil by parents and teacher was created (Dijkstra & Mooij, 2012).

A randomised field experiment was chosen to implement the screening and the differentiated curricula in early primary school and to check the hypothesised effects with pupils. The research focus is to intervene in schools in order to start the comprehensive innovation by schools of the educational dimensions outlined in Table 2.1. The whole-school intervention starts with the implementation of the screening procedure, which is followed by in-service training and development of differentiated curricula according to the PDKS with the teachers of grades 1 and 2. Given the urgency to improve Dutch education, the focus is on curricular development for cognitively high-ability pupils (see the definition in the theoretical section). In-service training is conducted per school or small group of schools, about four times a year. The ‘critical components’ (cf. O’Donnell, 2008) to be implemented are: 1) screening procedure to identify school-entry characteristics; 2a) development of PDKS-based differentiation in (preliminary) arithmetic; 2b) development of PDKS-based differentiation in language; and 3) development of a school policy for differentiated instruction and handling high-ability pupils. The researchers evaluate the implementation process characteristics per school by making field notes and assessing the intervention fidelity per year. Moreover, school principals and teachers complete evaluation questionnaires. The degree of implementation per school is conditional on financial compensation; participating schools get a maximum of €3,300 for their collaboration.

Results

Pilot Study: Screening of School-Entry Characteristics

Introduction. School East can be characterised as child-friendly and development-oriented (N pupils about 400). The school was initiated in 2001, in a region where a new suburb was planned. The mean education level of the parents is quite high. The school differentiates instruction of playing and learning processes into a variation of levels such as the individual pupil, a small group, a class, and a unit; a unit is a specific part of the school building where about 100 pupils reside who are all in grades 1–8. Several meetings among the first author, the most involved
teachers, and the principal were organised to clarify use of the procedure. The school decided to use the complete procedure with all new 4-year-olds and those who were almost 4. Whenever a new child had attended an infant day-care centre, the teacher from this centre was also asked to complete the screening questionnaire.

**Implementation.** During each of the implementation years from 2008–2010, the first author had about three communication sessions with the principal or one or more of the teachers to discuss experiences and coach the desired usage with respect to the screening procedure and the various results. Parents and teachers in particular exchanged particularities of each new pupil and the potential consequences were integrated in various playing and curriculum situations, or included in activities for a small group of pupils. If deemed necessary, teachers contacted the infant day-care centre for more information, applied further diagnostics, or integrated the support of for example youth health care professionals. Teachers discussed the information with the pupil’s parents to integrate new insights or to implement additional teaching approaches or materials.

**Evaluation.** On the whole, the teachers and principal evaluated the screening procedure and the related collaboration with care-givers or parents very positively and decided to continue the use of the procedure. However, the teachers were reluctant to implement follow-up differentiation in teaching. Generally, each unit’s playing and learning materials are ordered and made available on shelves so that even the youngest pupils can easily access and return them, which is a positive factor for self-regulation. But for individual pupils the range of across-grade or extra activities remained restricted, mainly because teachers did not feel comfortable about allowing pupils to use them. If they should do so, they would surpass or change the existing organisation of the school; moreover, the very good pupils would progress quickly and be ready for secondary school earlier than they should.

**Quantitative results of the screening.** Table 2.2 presents the reliability coefficients (Cronbach’s Alpha coefficients) and the number of items used per scale, separately for three respondent

<table>
<thead>
<tr>
<th>Scales (number of items)</th>
<th>Day-care</th>
<th>Parents</th>
<th>Teachers</th>
<th>Pilot school East</th>
<th>National studya</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n  a</td>
<td>n  a</td>
<td>n  a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social-communicative level (2)</td>
<td>52 .97</td>
<td>134 .97</td>
<td>118 .91</td>
<td>752 .92</td>
<td>749 .88</td>
</tr>
<tr>
<td>General cognitive level (4)</td>
<td>51 .87</td>
<td>133 .62</td>
<td>117 .82</td>
<td>736 .65</td>
<td>745 .80</td>
</tr>
<tr>
<td>Language proficiency level (5)</td>
<td>34 .97</td>
<td>113 .82</td>
<td>106 .86</td>
<td>703 .80</td>
<td>686 .87</td>
</tr>
<tr>
<td>Pre-arithmetic level (4)</td>
<td>30 .89</td>
<td>119 .84</td>
<td>109 .92</td>
<td>697 .76</td>
<td>680 .90</td>
</tr>
<tr>
<td>Emotional-expressive level (5)</td>
<td>45 .87</td>
<td>131 .87</td>
<td>116 .82</td>
<td>737 .68</td>
<td>714 .78</td>
</tr>
<tr>
<td>Sensory-motor level (4)</td>
<td>50 .88</td>
<td>124 .77</td>
<td>109 .81</td>
<td>739 .65</td>
<td>733 .75</td>
</tr>
<tr>
<td>Expected educ. beh./motiv. (4)</td>
<td>48 .93</td>
<td>131 .83</td>
<td>116 .85</td>
<td>733 .84</td>
<td>711 .91</td>
</tr>
</tbody>
</table>

* Normative study (Mooij, 2000).

* Based on listwise deletion of missing values.
The results in Table 2.4 indicate that the mean scale scores of day-care teachers and the parents generally agree; the means differ only with respect to sensory-motor level. In this respect, day-care teachers score young children higher than do the parents of these children. In comparing day-care centres and teachers, day-care centres score the children higher on sensory-motor level.
level, and lower on pre-arithmetic level. Most differences occur between the scoring of the parents and the teachers. Teachers score the pupils higher than the parents do on social-communicative level, pre-arithmetic level, sensory-motor level, and expected educational behaviour or motivation for school. As indicated above, these results should not be interpreted in an absolute way, but as indicators to support each pupil in starting a relatively optimal school career.

**Randomised Experiment Excel Kwadraat**

*Development and implementation.* Like school East, most Dutch primary schools keep most of the pupils’ playing and learning materials on shelves distributed throughout the classroom, along the walls, or in the corridors. Pupils may get these materials on their own initiative, at specific times, or because of an assignment by the teacher who may want to promote some instructional criterion. In regular primary schools, the ordering of these materials is generally not according to the specific domain or level of development. Conform the second intervention component, the materials should be ordered with respect to content such as arithmetic, language, sensory-motor development, and so on. Moreover, within each domain, the level of difficulty should be transparent in practice, and for pupils. Relevant materials have to be specified with respect to concepts, instructional lines, and ability levels or tests used for the first half of the first grade according to the national pupil-monitoring system, the second half of the first grade, the first half of the second grade, and so on. Such prepared playing-learning situations enable small groups of pupils or individual pupils to use the materials and instructions independent of their age.

![Figure 2.1 PDKS-related ordering of playing and learning materials for primary school grades 1–3.](image)
In addition to the use of the screening procedure (i.e., the first component), then, the experimental primary schools had the task of developing and using differentiated curricula of their playing and learning materials in grades 1–2. Researchers coached this development by meeting about four times a year with each school team or small group of teams; introducing a newsletter for all schools; and communicating on demand by e-mail or telephone. An example of an intervention result is a set of shelves with materials ordered by an experimental school in the course of the first intervention year: see Figure 2.1. The picture also illustrates that teachers use different colours and icons or other symbols on each of the shelves to indicate the ordering of contents and levels, thus representing ordering and integration of playing and learning materials for primary school grades 1 and 2.

Within a vertical shelf compartment for a particular domain, materials can be organised according to level of difficulty into easy (upper shelf), medium (middle), and challenging (lower shelf): see Figure 2.1. The registration system used to indicate the materials and the individual progress of pupils usually differs among schools. The reason is that Dutch schools generally can, and want, to integrate various playing and learning materials based on their own preferences and priorities in school. In the context of the intervention this differentiation is acceptable as long as the principle of double diagnostics is used as the underlying structure for the ordering. The resulting differentiated educational system in school has to be clear for both teachers and pupils to allow prepared instruction and stimulate the pupils’ self-regulation and self-management.
Continuation of the differentiated curricula across subsequent school grades enables unlocking of the age/grade lockstep (cf. Gagné, 2011): see the picture of pupils of different ages working on the same task in Figure 2.2.

Two Montessori schools were included in the study. In these Montessori schools, the intervention revealed that criterion-based concepts and the corresponding instructional lines are quite clear beforehand. However, the schools do not know the relationships of their educational system with the attainment level of the national pupil-monitoring system. The relevance is that, from a criterion point of view, pupils in Montessori schools can function at much higher or lower levels than required from a normed pupil-monitoring point of view. One result from coaching these Montessori teachers is that they are surprised to find that some of their pupils in grade 1 actually function at grade 4 normed level, or pupils in grade 5 are functioning at the highest level of grade 8 in primary school. This diversity is explained by the fact that, according to Montessori pedagogy and teachers’ supervision strategy, pupils can self-regulate their playing and learning activities to a very high degree (see also Lillard, 2012). An example is presented in the picture in Figure 2.3 where pupils in Montessori schools grades 1 and 2 collaborate successfully in doing arithmetic tasks for grade 6 in primary school. This example illustrates the considerable pupil differences in one classroom that teachers have to take into account, and stresses the importance of double diagnostics as stimulated in the differentiated curricula of Excel Kwadraat.

Of course, pupils will always need the teacher, but for different pupils this support is needed for different types of activities and to varying degrees. Pupils with special educational needs usually require much more attention at lower levels than pupils who achieve highly from cognitive and metacognitive points of view. An illustration of free activities by this last category of pupils, featuring posters they made to present to their class, is given in Figure 2.4.
The role of ICT. Initially, the ICT prototype was introduced in experimental schools in combination with the three intervention components. The aim was to facilitate the development and implementation of the differentiated school programme, but soon it became clear that this did not work as hoped. Teachers and principals needed much clarification and examples of the new concepts and work procedures in their own schools, which had to occur while their traditional programme was also functioning. In this respect, huge school-specific differences in innovation capacity and flexibility were noticed among experimental schools. Moreover, schools became more sensitive to the issue of diagnostically based curricula and their efficient organisation, but instead of the new ICT prototype they preferred the traditional ICT-based pupil monitoring system because of its wide distribution, national applicability, the Dutch Inspectorate of Education’s use of it to evaluate school achievement in a national oversight process, and its reputation. To eliminate such discussions, and to better concentrate on the essence of the school innovation, it was therefore decided to reduce the attention on ICT and focus instead on the pedagogic, didactic, and organisational features of the intervention.

Case study. One example concerning one pupil in an intervention school illustrates what may happen when ‘optimal education’ is underway. Lorette (pseudonym) is a new 4-year-old girl in an experimental school. Before entering primary school, the parents screened the school-entry characteristics of their daughter. The parents perceived their child as being average on social and sensory-motor behaviour; expressive behaviour and expectations about school behaviour are above average; and general cognitive, language, and arithmetic abilities are scored at the highest level (compared to age mates). After 4 weeks in primary school, the teacher is of the opinion that the social and sensory-motor behaviour of Lorette are at an average level; language and expressive behaviour are above average; and general cognitive level, arithmetic level, and expectations about school behaviour are at the highest level.
After 6 weeks in grade 1, parents and teacher meet to discuss their estimates. A summary of the meeting results made by the teacher illustrates that Lorette is perceived to be very sensitive, with pertinent ideas about how things should go, and very eager to know and learn. The first weeks in school were not easy for her, however, because she wanted to know beforehand what would happen. Emotionally, things went better after she found a friend in class. She is perceived to be smart and to function cognitively at high levels, but is not yet demonstrating her full capacity because in primary school specific sensory-motor facilities are required. In particular, her motor capacities are not developed sufficiently to enable paper-and-pencil testing as required now and then. Observation by her teacher, and oral checks by using nationwide pupil monitoring tests, verify that Lorette functions cognitively at levels of grade 2 or higher. Lorette knows how to count and knows numbers and letters. At home she demonstrates still greater and higher cognitive advancement; at school the understanding and getting along with the complex social situation still requires much of her. Results of norm-based pupil monitor tests demonstrate her functioning in language at the highest level (A) of grade 2 (for pupils who are one year older); in arithmetic she functions at a high level (B), grade 2. Parents and teacher agree that Lorette will carry out activities and materials at these levels by using the newly developed shelves with PDKS ordered learning materials. An appointment is made between teacher and parents to continue the observations and checks at school and the observations at home. The next meeting will be held before the summer holidays.

After these holidays, the teacher indicates that Lorette’s functioning has much improved both socially and cognitively. She now uses learning materials at grade 3 level, usually works with one or more other advanced pupils in a small group, and is motivated to apply self-regulation behaviours in free activities. Moreover, the primary school discusses continuing the preparation of the shelves with ordered learning materials to integrate the advanced pupils into higher grades of primary school.

Discussion

Learning, and in particular SRL, should be based on differentiated instruction at or above the actual level of development of each learner, whereas ICT should enhance the self-regulation and administration of learning progress. To realise such a situation, a theoretical framework was sketched in which pedagogic-didactic, organisational, and ICT conditions were hypothesised to support learning processes for each learner (see Table 2.1). To check the theoretical approach in practice, design-based development was planned in Dutch primary schools.

The first research step was a pilot study focused on the estimation of school-entry characteristics of all new 4-year old pupils in primary school East. Implementation of the screening procedure was realised as proposed. After getting used to the procedure, the teachers and the principal evaluated the screening procedure as positive. However, for pupils functioning above age level the range of across-grade or extra activities was restricted because teachers did not feel comfortable enabling pupils to do more, as this would change the school organisation and the pupils would leave school earlier than usual.
Chapter 2

The second research step therefore concentrated on the use of the screening procedure in the context of diagnostically-based differentiated curricula of playing and learning activities across grades, that were to be developed by means of specific intervention in early primary schools. More research with respect to this randomised experiment is presented in the following chapters. Chapter 3 focuses on teachers’ implementation of differentiated instruction for high-ability pupils, in particular on their perceptions of factors affecting the success or blocking of this educational innovation. Chapter 4 investigates the longitudinal, quantitative effects of the intervention. Does the intervention, as hypothesised, improve the educational differentiation as perceived and handled by the teachers in their practice? Final attention is given to the effectiveness of the integrated in-school intervention with respect to the pupils. It is expected that, by affecting teachers’ differentiation practices, the intervention also affects the academic development of high-ability and non-high-ability pupils (see Chapter 5). Taken together, these studies will provide a first comprehensive, empirical check of the theorising in this chapter.
Chapter 3
Factors Affecting Intervention Fidelity of Differentiated Instruction in Early Primary School

Abstract
This chapter reports on the findings in the first phase of a design-based research project as part of a large-scale intervention study in Dutch primary schools. The project aims at enhancing differentiated instruction and evaluating its effects on pupils’ development, in particular high-ability pupils. This study investigates relevant intervention fidelity factors based on Fullan (2007). A 1-year intervention in 18 primary schools was conducted to implement the screening of pupils’ school-entry characteristics, differentiation of arithmetic and language curricula, and a policy for the differentiation and teaching of high-ability pupils. The intervention fidelity and implementation process were scored for each school using data from observations, field notes and log books. Self-report questionnaires measured participants’ perceptions of the intervention (n = 35 teachers, 18 principals). Quantitative results showed that intervention fidelity differed between schools. Qualitative analyses of perceptions and cross-case analyses of three schools showed that a strong need, pressure from parents, an involved principal, and teacher time and motivation contributed to successful implementation. Implementation barriers were the innovation’s complexity, teacher beliefs, an absent principal and low teacher motivation, which was partly due to communication problems. Implications for interventions in general and differentiated instruction for high-ability pupils in particular are discussed.

This chapter is submitted for publication as:
Early primary school, and its classroom quality in particular, is assumed to positively affect pupils’ future academic and social behaviours (Cabell, DeCoster, LoCasale-Crouch, Hamre, & Pianta, 2013; Weiland, Ulvestad, Sachs, & Yoshikawa, 2013). Recent research indicates, however, that instructional quality may be suboptimal (e.g. instructional interactions are insufficiently adapted to pupils’ needs; Cabell et al., 2013). Many initiatives for improving teacher practice, usually during in-service training, are being undertaken to improve the instructional quality (Pianta et al., 2014). However, it has been shown that in-service training often does not achieve a change in teachers’ practices (Bitan-Friedlander, Dreyfus, & Milgrom, 2004), thus the quality remains suboptimal.

Changing teachers’ practices requires urgent attention since, of all school factors influencing learner outcomes, the teacher is possibly the most important (Hattie, 2009). According to Fullan (2007), the effects of interventions are to a large extent determined by the degree to which schools and teachers both accept the proposed changes and implement them. In this respect, intervention fidelity refers to the implementation of an intervention as intended or designed (O’Donnell, 2008). It is important to elucidate the degree of intervention fidelity and which factors affect it (Bywater & Sharples, 2012; McKenna, Flower, & Ciullo, 2014; O’Donnell, 2008; Swanson, Wanzek, Haring, Ciullo, & McCulley, 2013); only then can the relative strength of an intervention for outcomes be assessed and the information used – if necessary – to create a more successful intervention and, finally, to upscale the intervention (Darrow, 2013; Swanson et al., 2013). Further, as evidence-based interventions that “can be implemented with fidelity” (Swanson et al., 2013, p. 3) gain attention (Onderwijsraad, 2006), it is important that intervention fidelity and factors affecting it are investigated.

One of the areas in which evidence-informed interventions are top priority is the teaching of high-ability or gifted pupils (e.g. Callahan, Moon, Oh, Azano, & Hailey, 2015; Koshy, Pinheiro-Torres, & Portman-Smith, 2012; Robinson, Shore, & Enersen, 2007; Segers & Hoogeveen, 2012). In mainstream education, teaching is often not adapted to the specific learning processes of these pupils, which involve larger learning steps, longer periods of concentration, less repetition, and the willingness and ability to work rather independently (Colangelo, Assouline, & Gross, 2004; Mooij, 1992). Two problems teachers face are that they often do not have a clear picture of (a) the levels at which the pupils function, especially high-ability pupils (cf. Al Otaiba et al., 2011; Doolaard & Harms, 2013; Mooij, 2000) and (b) the cognitive levels required for carrying out specific curricular learning activities (cf. Chapter 2; Tomlinson et al., 2003). The resulting lack of fit between pupils’ needs and learning activities may have negative consequences for high-ability pupils’ achievement and behaviour (cf. Colangelo et al., 2004; Gross, 1999; Mulder, Roeleveld, & Vierke, 2007).
With the above in mind, an intervention was designed to improve the match between levels and activities, particularly for high-ability pupils. The ultimate goal was to enhance the learning and development of all pupils, including those of high-ability. Implementing this intervention includes changes in teachers’ behaviour, such as providing high-ability pupils with different instruction and/or materials than their classmates. This study focuses on the implementation process of the intervention in Dutch early primary school classrooms and hopes to provide insight into crucial success factors and barriers for its implementation. This research uses Fullan’s (2007) framework of nine implementation factors for educational change. The research questions guiding this study are: (a) What is the intervention fidelity of the intervention?; and (b) Which factors (i.e., characteristics of the intervention, local and external factors) influence the intervention fidelity? Following a design-based research approach (Anderson & Shattuck, 2012), lessons learned for future interventions for high-ability pupils are uncovered and discussed.

First, the question of how pupil differences can be anticipated in teaching and what factors may be of influence when teachers try to do this are discussed. For more information about the theoretical assumptions underlying the intervention, see Chapter 2.

**Anticipating Pupil Differences**

Teachers can improve the match between learner levels and learning activities by differentiating their instruction according to the relevant characteristics of pupils in the classroom. This may involve differentiation in content (i.e., curricula), process, product, and/or learning environments, based, for example, on pupils’ ability levels and interests (Tomlinson, 2005; Tomlinson et al., 2003). By doing so, teachers “maximize the potential of all learners by proactively designing learning experiences in response to individual needs” (Santangelo & Tomlinson, 2012, p. 310).

For successful differentiation practices, several organisational aspects are required.

First, learning must start with some type of diagnostics with respect to the level of competence of the individual pupil within a specific subject area. Regular monitoring of levels and progress is necessary so that teachers may continually modify free play and instruction and vary grouping patterns to meet changing characteristics and needs (Deunk, Doolaard, Smale-Jacobse, & Bosker, 2015; Purcell, Burns, Tomlinson, Imbeau, & Martin, 2002).

Second, to make appropriate decisions about each pupil’s instruction, primary school teachers need to become comfortable with and gain proficiency in the necessary differentiation characteristics of the curriculum. A solid understanding of the learning goals and developmental progression in each subject or skill is required, as are methods for achieving and using a differentially implemented curriculum including learning materials (Deunk et al., 2015; Mooij et al., 2014; Tomlinson et al., 2003).

Third, beliefs and practices related to systemic issues in early primary school need to fit differentiated instruction in a flexible system, as several systemic factors (e.g. school climate, resources) and teacher attitudes can impede the use of differentiated instruction (Kingore, 2004; Maier, Greenfield, & Bulotsky-Shearer, 2013; Roy, Guay, & Valois, 2013; Tomlinson et al., 2003).
Implementation Factors for Differentiated Instruction

Adequate implementation of differentiated instruction in early primary school is not self-evident (Darrow, 2013; Fullan, 2007; O’Donnell, 2008). The problem may be that the typical situation of teachers is one of perseverance with many factors, tending to keep things they always have been. There is often little room nor inclination for change, especially when it is imposed from the outside. The result may be that teachers adjust to proposed changes by doing as little as possible. According to Fullan (2007), characteristics of the intervention, local characteristics and external factors collectively influence an intervention’s implementation.

Characteristics of an intervention include the need for change, clarity of goals, complexity of the change, and quality and practicality of the program. The need for an intervention to improve the teacher’s ability to differentiate instruction is clear. A number of researchers have shown that the skills needed for differentiated instruction are not in the repertoire of all teachers (Deunk & Doolaard, 2013; Doolaard & Harms, 2013; Van de Grift, 2010). Though assessment data is widely present in schools, teachers often lack knowledge of how to acquire and use that data for monitoring progress, and may feel uncertain about how to differentiate in the curriculum (i.e., what to teach, such as more advanced content for high-ability pupils) (Doolaard & Harms, 2013; Santangelo & Tomlinson, 2012). Thus, in practice, there is a need to improve the differentiated instruction skills of primary school teachers, which may positively influence the intervention fidelity.

Local characteristics include the school district, community, school principal and teachers. According to Fullan and Stiegelbauer (1991), “the local school system represents one major set of situational constraints or opportunities for effective change” (p. 73). A risk to implementation is that schools maintain a culture of caution (Le Fevre, 2014). For example, when pupils are allowed more initiative in their own learning activities, as is the case in differentiated instruction, teachers may fear a loss of control. Their perceived risk in the face of uncertainty may result in their demonstrating a conservative impulse and being motivated by a need to protect their current practice. Also, strong beliefs can persist, both at the individual teacher level and collectively at the school level, and can function as obstacles to improving teacher practice (Le Fevre, 2014). For example, Dutch teachers in early primary school often show a resistance towards academic activities, because they believe that early primary school is a play space and not a learning space (Oberon, 2013). Also, the belief exists that high-ability pupils do not need to be challenged in class (Doolaard & Harms, 2013; Tomlinson et al., 2003). Thus, local factors such as school culture and teacher perceptions may hamper the implementation of differentiated instruction.

Finally, external factors include the government and other agencies. These external parties often present conflicting demands on education (Bergen & Van Veen, 2004; Luttenberg, Van Veen, & Imants, 2013). For example, adjusting the needs of all pupils in the classroom, as is the case in differentiated instruction, conflicts with a strong focus on covering prescribed curricula (Engel, Claessens, & Finch, 2013). When confronted with multiple, conflicting agendas, teachers feel vulnerable and uncertain (Le Fevre, 2014), which may negatively affect the implementation.
Current Study

This chapter reports on design-based research findings in a larger study to implement differentiated instruction in Dutch primary schools and to evaluate its effects on the learning and development of early primary school pupils, in particular high-ability pupils (Mooij et al., 2014). The current study focuses on how Fullan’s (2007) factors influence intervention fidelity in the first intervention year. Using a design-based research approach, this information can be taken into account to enhance the quality and implementation process for the second intervention year.

Method

This research used a mixed-methods approach, as recommended in design-based research (Anderson & Shattuck, 2012), employing qualitative and quantitative methods in the same study. The research included a cross-case analysis that aimed to identify relevant factors for intervention fidelity.

Intervention

Design-based research (DBR) is situated in the educational context and happens in collaboration between researchers and practitioners (Anderson & Shattuck, 2012; Barab & Squire, 2004). A DBR approach was used to design and evaluate the intervention. The intervention was based on an extensive literature review and earlier pilots (Mooij, 2007a, 2008). It aims at improving teachers’ differentiation practices, with particular focus on how teachers can support high-ability pupils. In this intervention, schools use or develop three ‘critical components’ (see O’Donnell, 2008), as previously discussed in Chapter 2.

The first component is the screening of school-entry characteristics of all incoming 4-year-old pupils (Mooij, 2000). This is based on the assumption that teachers need knowledge of individual pupils’ cognitive and social needs and levels to appropriately use a differentiated curriculum, and that a screening would help teachers achieve this. The screening took the form of a 29-item questionnaire for parents and teachers (Cronbach’s alpha range from .65 to .92) to estimate the pupil’s developmental levels in seven areas: social interaction/communication, general cognition, language proficiency, preliminary arithmetic, sensory-motor level, emotional-expressive level and expected educational behaviour/motivation of the pupil. The response options estimate whether a pupil is less (1), slightly less (2), about the same (3), slightly more (4), or more (5) developed compared with his or her peers. In this way, parents and teachers can cooperate to inform each other about the levels and needs of the pupils when they begin primary school and help teachers make informed decisions about appropriate learning activities.

Second, teachers were asked to develop a framework of the learning materials available in their classrooms that matched the curriculum learning goals. This component was based on the assumption that teachers need knowledge of the structure and levels of the curriculum in order to match pupils’ levels and needs to appropriate curricular learning activities. This frame-
work for arithmetic and language separately consisted of a table in which centrally defined learning goals (Stichting Leerplan Ontwikkeling, 2010a, 2010b) were matched with the levels, assessment methods and learning materials corresponding to these goals. Teachers were asked to arrange the materials in the classroom cabinets according to the levels in the framework. Generally, grades 1 and 2 of Dutch primary schools keep most playing and learning materials on shelves distributed throughout the classroom, along the walls or in the corridors. Pupils may access these materials on their own initiative, at specific times or because of an assignment by the teacher who may want to promote some pedagogic or instructional criterion. The typical ordering of these materials is not according to the specific domain or ability level. In the intervention, the materials should be ordered with respect to domain and difficulty level. Teachers can use different colours and icons to indicate the ordering of both content and levels. Such prepared playing-learning situations enable small groups of pupils or individual pupils to access and use materials and instructions independent of their age. Of course, pupils will always need the teacher, but for different pupils this support is needed for different types of activities and to varying degrees.

The third component was the development of a school policy protocol with information on how assessment and differentiated instruction takes place, with a special focus on high-ability pupils. This component was based on the assumption that a structured, preventive approach provides guidance within the team and for parents. In this way, it was clear for both teachers and parents how the school handles assessing pupils’ levels and what the school’s differentiation approach was.

Participants
Eighteen primary schools were recruited from the school network of the researchers and participated in the intervention. Participating schools received financial compensation for purchasing learning materials and for allotting teachers time for intervention activities. With one exception, all schools had a combined first and second grade of primary school. From these schools, all school principals (n = 18) and first and second grade teachers (n = 35) took part.

Procedure
A 1-year pilot intervention was carried out, as previously described. Support sessions were organised to help teachers implement the components in the first two grades of the primary schools (see Chapter 2). Schools participated in three to five meetings per year. All school principals received a manual with information on the intervention and background information about necessary curriculum changes and how to realise them. The principals were also asked to distribute the information to their staff and teachers and to discuss the intervention regularly with the team. The manual or other documents and the implementation characteristics and changes were discussed in regional sessions. The researchers clarified the meaning of the successive components and promoted the correct development or implementation of the components in each school. Teachers within each school were expected to collaborate and develop or implement the components stepwise in their own practice.
Measures
O’Donnell (2008) recommends measuring the fidelity of critical components and processes present in the intervention and including the extent to which participants are engaged by and involved in the activities and content of the program. Therefore, the variables investigated in this study were intervention fidelity, participants’ perceptions of the intervention and the implementation process in the schools.

**Intervention fidelity.** The extent to which the critical components of the intervention were implemented in each school was scored using a fidelity rubric checklist. Each component was scored separately, that is: (1) screening school-entry characteristics, (2) using a differentiation framework for the arithmetic (a) and language (b) curriculum and the corresponding organisation of materials in the cabinets, and (3) a policy protocol for differentiation practices and high-ability pupils in the school. The researchers developed the rubrics (see Table 3.1) collaboratively based on ten randomly chosen schools, and then applied them to all schools.

For the screening, category *fully implemented* means that >90% of new 4-year-old pupils in the school were screened by parents and a teacher. The category *partially implemented* means that only a portion of the pupils were screened, and category *not implemented* means that <10% of the pupils were screened.

The differentiation frameworks for arithmetic and language and the corresponding organisation of materials were scored using categories *developed*, which means the framework corresponds with the materials in the cabinets, *advanced development*, which means that the school largely developed this, but needed to fine-tune the correspondence between framework and materials, *started development*, which means that the school developed a first version of the framework and *not developed*.

Categories for the policy protocol were *fully developed* for complete protocols, partially developed for a partially developed protocol and *not developed*. The researchers scored the second and third components collaboratively.

**Perceptions of the intervention.** A 7-item questionnaire with two multiple choice items with two corresponding explanation items, and three open-ended questions was developed to measure participants’ (i.e., teachers, principals) expectations about intervention activities (three components) and perceptions of outcomes/effects. The questions (see Table 3.2) related to the expected work needed for the intervention and expected benefits and effects. Further, participants were asked about the extent to which the expectations were fulfilled and if they had any suggestions for improving the support given by the researchers.

**Implementation process.** The implementation process in each school was tracked via the researchers’ field notes and logs. During the support sessions, the main discussion points about the intervention and a summary of agreements were recorded in field notes. In addition, communication between schools and researchers was recorded in a log.

Data Collection
The perceptions questionnaire was administered via a web portal using NetQ®. Response rates were 100% for both teachers and principals. Intervention fidelity data were collected in several
ways. The extent to which the screening of school-entry characteristics was implemented was tracked for each school in NetQ®. All teachers presented their cabinets with materials to the researchers during visits to their classrooms. Further, between and after the support sessions, teachers sent written frameworks and/or policy protocols to the researchers. The intervention fidelity data were scored at the end of the school year using the fidelity rubric.

**Data Analyses**

First, the intervention fidelity data were analysed for all schools using descriptive statistics. Participants’ perceptions of the intervention were analysed using a grounded theory approach (Creswell, 2007). Data were imported into a Microsoft Excel® file and anonymised. First, data were coded using *open coding*. For each question, all respondents’ answers were analysed for content, and new codes were created when previous codes did not apply or were insufficient. After coding the entire data set in this way, *axial coding* was used in which codes were merged to form new, overlapping codes. This resulted in four codes or categories per question.

The implementation process data were analysed using Fullan’s framework (2007). For each school, relevant statements were recorded per factor. Then, three schools were selected for more thorough discussion, serving as exploratory multiple case studies (Baxter & Jack, 2008). These schools were the three for which the most information on the implementation process was available. A cross-case analysis was used to present the results, as this facilitated comparing commonalities and differences between the cases (Miles & Huberman, 1994).

**Results**

**Intervention Fidelity**

The level of implementation of the intervention components in schools, as assessed by the researchers, is shown in Table 3.1. The screening of new 4-year-old pupils was partly or fully implemented by 14 schools; 4 schools did not implement screening at all. The screening was more widely implemented than the differentiated curricula for arithmetic and language. A majority preferred beginning with arithmetic; 8 schools started the implementation, 6 were advanced and 2 completed their design of a differentiated arithmetic curriculum so that pupils could work at their own level and pace. The numbers are lower for the language domain, with only 8 schools developing or having completed a differentiated curriculum. Finally, only 2 schools worked on an explicit differentiation policy in early primary school. In the majority of the support sessions, this component was not discussed, because schools needed a relatively long time to implement the first two. In sum, there was variation in the level of implementation for each component.
Table 3.1  Intervention fidelity (n = 18 schools)

<table>
<thead>
<tr>
<th>Intervention component and scoring categories</th>
<th>Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Screening entry characteristics</td>
<td></td>
</tr>
<tr>
<td>Not implemented</td>
<td>4</td>
</tr>
<tr>
<td>Partially implemented</td>
<td>5</td>
</tr>
<tr>
<td>Fully implemented</td>
<td>9</td>
</tr>
<tr>
<td>Differentiation arithmetic curriculum</td>
<td></td>
</tr>
<tr>
<td>Not developed</td>
<td>2</td>
</tr>
<tr>
<td>Started structuring framework and materials</td>
<td>8</td>
</tr>
<tr>
<td>Advanced structuring and organising framework</td>
<td>6</td>
</tr>
<tr>
<td>Framework and organisation of materials developed</td>
<td>2</td>
</tr>
<tr>
<td>Differentiation language curriculum</td>
<td></td>
</tr>
<tr>
<td>Not developed</td>
<td>10</td>
</tr>
<tr>
<td>Started structuring framework and materials</td>
<td>3</td>
</tr>
<tr>
<td>Advanced structuring and organising framework</td>
<td>3</td>
</tr>
<tr>
<td>Framework and organisation of materials developed</td>
<td>2</td>
</tr>
<tr>
<td>Differentiation policy protocol</td>
<td></td>
</tr>
<tr>
<td>Not developed</td>
<td>16</td>
</tr>
<tr>
<td>Partially developed</td>
<td>2</td>
</tr>
<tr>
<td>Fully developed</td>
<td>-</td>
</tr>
</tbody>
</table>

Perceptions of the Intervention

In a first attempt to understand this variety, participants’ perceptions were studied (see Table 3.2). The results show that a large number of respondents (30%) had little or no expectations about the intervention activities. Some respondents mentioned that they were not properly informed about the intervention beforehand. The difference between teachers and principals in having few or no expectations was striking: 40% vs. 11%, respectively. Another 30% of respondents expected to learn an educational approach for high-ability pupils, such as “taking up giftedness of pupils and then adjusting the didactic and pedagogic learning needs” (teacher 56).

About a quarter of respondents expected the actual intervention activities, while for 73%, the actual activities differed from expectations. Most respondents reported having to do more than they had expected (e.g. attending meetings, arranging learning materials and completing screening questionnaires), which was negatively perceived. One teacher (110) puts it aptly, “The workgroups, completing the questionnaires requires more time than expected…and we already have to do so much!” Principal 1018 wrote, “Structuring the learning materials in the classrooms was a new element for me. It’s also a big job that cannot be realised in a year”.

Some respondents indicated that although the educational approach was more extensive than expected, they appreciated it. This was evident in principal 1024, “Beforehand, I didn’t estimate such an impact of the project on our teaching. It takes more time than expected and the changes are quite large as well. The latter I think is positive”. Again, some respondents were insufficiently informed prior to the intervention, as evidenced by teacher 239, “Beforehand we
Table 3.2 Teachers’ and school principals’ perceptions of the intervention

<table>
<thead>
<tr>
<th>Perceptions</th>
<th>Teachers (n = 35)</th>
<th>School principals (n = 18)</th>
<th>Total (n = 53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Expectations about activities</td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Few/no expectations</td>
<td>40</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td>Educational approach</td>
<td>29</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>Identification</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Research activities</td>
<td>9</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Coherence of activities with expected activities</td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Yes</td>
<td>23</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>No, I had to do more things</td>
<td>46</td>
<td>33</td>
<td>42</td>
</tr>
<tr>
<td>No, I had to do other things</td>
<td>23</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>No, I had to do fewer things</td>
<td>6</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Expectations about outcomes/effects</td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Few/no expectations</td>
<td>26</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>Educational approach</td>
<td>46</td>
<td>56</td>
<td>49</td>
</tr>
<tr>
<td>Identification</td>
<td>23</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>Student results</td>
<td>6</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Team/teachers/policy</td>
<td>3</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Coherence of outcomes with expected outcomes</td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Yes</td>
<td>37</td>
<td>39</td>
<td>38</td>
</tr>
<tr>
<td>No, more outcomes</td>
<td>23</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>No, fewer outcomes</td>
<td>37</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Points of improvement</td>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Support sessions</td>
<td>34</td>
<td>56</td>
<td>42</td>
</tr>
<tr>
<td>Planning</td>
<td>6</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>Communication</td>
<td>17</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Continuation</td>
<td>-</td>
<td>11</td>
<td>4</td>
</tr>
</tbody>
</table>

Note. As some respondents did not answer particular questions, percentages may not add up to 100%.

knew about completing the questionnaires twice a year. I did not know about attending several meetings".

In addition, about half of respondents (49%) expected an educational approach for high-
ability pupils to be the main outcome of the intervention. Again, 23% had few or no expect-
tations, and teacher 116 said, “Whether to participate in the intervention was not decided in consultation with teachers”. Some principals also mentioned outcomes at the team level, “A policy that guides the school that you can make fixed rules in your team about high-ability pupils” (1011).

More than a third of respondents expected the actual outcomes, such as teacher 121 no-
ted, “I gained insights on my view of teaching high-ability pupils which are required to give them what is necessary” and teacher 247, “I see pupils flourish indeed and I am very happy with that”. Some respondents stated that it was still too early to look at the outcomes, because the intervention required more time than one year to be fully implemented. In contrast, other res-
pondents were more negative and felt they had not received any new information in the inter-
vention. Differences were also observed between teachers and principals regarding outcomes; teachers more often perceived fewer actual outcomes than expected, and principals more often perceived more actual outcomes than expected.

A large number of respondents mentioned points of improvement. They focused mainly on the support sessions that needed to be more practical and to convey the purpose and method of the intervention more clearly. Principal 1011 summarised this as follows, “More practical. More time for discussions. Maybe occasionally do an assignment in the classroom. Make more use of images”. Some respondents also mentioned better planning and better communication, as principal 1038 suggested, “There should be a route + timetable how your school could implement the intervention”.

Table 3.3 Case characteristics including intervention fidelity of schools A, B, and C

<table>
<thead>
<tr>
<th>Case characteristics</th>
<th>Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>School characteristics</td>
<td></td>
</tr>
<tr>
<td>Number of pupils</td>
<td>198</td>
</tr>
<tr>
<td>Number of grade 1 and 2 classes</td>
<td>3</td>
</tr>
<tr>
<td>Class type</td>
<td>multi-grade</td>
</tr>
<tr>
<td>Part of the Netherlands</td>
<td>middle</td>
</tr>
<tr>
<td>Number of support sessions</td>
<td>5</td>
</tr>
<tr>
<td>Intervention fidelity</td>
<td></td>
</tr>
<tr>
<td>Screening of entry characteristics</td>
<td>absent</td>
</tr>
<tr>
<td>Differentiation arithmetic curriculum</td>
<td>absent</td>
</tr>
<tr>
<td>Differentiation language curriculum</td>
<td>absent</td>
</tr>
<tr>
<td>Differentiation policy protocol</td>
<td>absent</td>
</tr>
</tbody>
</table>

Implementation Process in Three Case Studies: A Cross-Case Comparison

Participants’ perceptions gave the first indication that certain intervention characteristics and local factors, such as teacher time and motivation, were relevant for implementing the intervention. However, the perceptions questionnaire was short and only completed at the end of the year. For a complete picture of the relevant implementation factors, it is important to study the complete implementation process during the school year. Therefore, the implementation process in three case studies (i.e., schools A, B and C, see Table 3.3) are compared using Fullan’s (2007) factors. These schools differ in size, the use of multi-grade classes and their intervention fidelity. Roughly, the intervention fidelity was highest at school C and lowest at school A. In the following description, quotes are from teachers, internal counsellors or principals.

**Need.** School A did not specify a need during the meetings. School B mentioned a specific need, namely receiving information about “learning materials for the best pupils”. In school C, there was a strong need to improve teaching for high-ability pupils, “we need to do something with the pupils who are more able”. This was partly caused by their experiences with no intervention or too late intervention for high-ability pupils in upper primary school, according to the
principal, “because we run [sic.] into this problem for years”. In this school, many initially high-ability pupils became underachievers.

**Clarity.** During the sessions, participants from school A regularly mentioned that the intervention had to be more specified, in particular the second component. This school wanted more clarity concerning “what learning materials were suitable for which learning objectives, and how do you determine what each pupil is going to do”. School B wanted more clarity on the practical side, “I just want to know how to do it. Give us the real practical advice about how we have to do it, not that we have to reinvent the wheel”. School C experienced difficulties understanding the practical aspects. As the principal put it, “I think everyone is motivated to let each pupil work at his/her own level, but we don’t know what the end point actually is”. This remained difficult during the implementation, as a teacher once said at the end of a session, “I’ve got a lot of answers, I’m very happy. But I still have many questions as well”.

**Complexity.** The intervention was quite complex for school A. Participants wondered how level-based education could be combined with group plans and age-based curricula. “We’re used to age-based classes. How is it feasible to have education at one’s own level?” In addition, questions arose about the consequences of this intervention for higher grades: “What is going to happen later in grade 3?” Further, classification of learning materials was experienced as complex, because “the material is often suitable for different levels, but then the instructions are very different”.

School B experienced problems with the complexity for classroom management. As the internal counsellor puts it, “What does a day look like for such a pupil? How to organise it? A day is all organisation”. This school had difficulty with leaving the age group approach behind and were not keen on doing so. “It needs to be adapted, everyone on their own level, but within our current system”.

School C acknowledged this complexity, too, but this school was more open to change and was better able to deal with it. The principal said in a meeting, “It will be difficult with personnel formation. Now we work in a year group system, and we will slowly bend it”. And later, “We have to put a lot aside. Is it going to be like we expect?” Subsequently, the school continued the intervention and a teacher emailed, “You will understand that this is very exciting for us and we would therefore like to hear from you how you perceive it”. Thus, the intervention was complex for this school as well, but the school tried and wanted feedback from the researchers on their progress.

**Quality and practicality of the intervention.** The intervention’s quality and usefulness were negatively perceived by school A. First, this concerns the use of the screening, as the principal indicated, “We have been using more lists, may we decide that we do not use this screening too? What is the added value of this list?” In addition, the importance of organising the materials based on pupil levels was not recognised, “I would not like to structure it separately for each class, because now all pupils can use it”. Finally, this school had few materials to completely fill the level-based curriculum.

School B also experienced this situation. Moreover, classroom space was an issue, a threat to the quality and usefulness of the intervention. There was no space available in the classrooms for the additional cabinets that were required to classify the learning materials. At that moment,
the materials were not structured at all, and the content of the cabinets was unclear for both teachers and pupils. This school did not see any relevance of pupils working at an accelerated pace, as “nowadays, methods are usually enriched, and in three levels”. This school believed that the current methods provided sufficient challenge for high-ability pupils.

School C wondered about space as well, but they estimated the quality and usefulness of the intervention very highly. “Building blocks, cabinets, organising between groups, are beautiful ideas. It feels safe too”. However, they wondered how to avoid “that gifted pupils have completed the regular curriculum of the school in a very short amount of time”. Moreover, higher level testing of pupils was not always useful for this school, because it took more time than expected and not all tests were suitable for young pupils.

**School board/district.** School A appeared, without being aware, to have applied to take part in the intervention as a result of the school board’s actions. During meetings, it became clear that the school was obliged to participate. The board’s influence was large, since board representatives were present during sessions as well, and they interfered with the intervention’s content. School B, on the other hand, wanted more involvement from their board. As the internal counsellor put it, “There have been issues going which are school-wide policy. We actually want to achieve this at board level. I think we need to develop our policy school board-wide”. This school had a wait and see attitude and wanted prior board approval for the intervention. A clear role for the board was not shown. In school C, the board played no role.

**Community.** Competition between schools played a role for school A, as “there is an primary school nearby in XX, where gifted pupils receive extra support three times per week”. High-ability pupils moved there, and the school was afraid of more pupils leaving. The community, and particularly parents, served a different role in school B. “They are just a bit programmed, in YY, like you have to be normal”. This school mentioned that parents prefer not to accelerate their pupils. School C has “relatively many smart pupils here at school”. This school felt pressure from parents to do something for high-ability pupils, because parents would otherwise move their pupils to a neighbouring ‘Leonardo’ school (a school for gifted pupils only). The parents at this school were characterised as highly educated, articulate and very demanding of their pupils.

**Principal.** School A’s principal was present once, and soon transferred responsibility to a teacher. Thereafter, he played no role in the intervention. In school B, the principal was never present and played no role. The principal had an important role in school C, was present at every meeting and also founded an internal project group in the school that worked on the intervention between official sessions. The principal also participated in this group, primarily intervening in discussions and democratically reaching decisions. For example, he asked, “How can we make it easy for each other? Maybe we can implement school wide times for instruction, and try this next year”. He stressed the importance of success experiences, “We need a success experience right now. Otherwise it remains vague and unstructured, and then we won’t make it to the finish”. He also intervened when teachers were overloaded, “The enthusiasm is still high, but as principal I think: Isn’t this intervention too ambitious? I also want everyone to make it to the finish. We have to keep it manageable”.


**Teachers.** Teachers from school A were not always present during support sessions. One had negative experiences with accelerating her daughter, who first accelerated and later repeated a grade because of her socioemotional development. This experience was a barrier for this teacher and school. In addition, she said, “We think that using material only is detrimental for the pupils, because playful learning is very important”. According to the internal supervisor, the culture in this school was strongly focused on playful learning, also for high-ability pupils. Colleagues were not informed about the intervention. Teachers from School B also were not present all the time. One teacher, who was always present, did not value the intervention, as “the good pupils will make it anyway”. The other teachers at the school were not informed about the intervention. In addition, making time for intervention activities was a problem for this teacher. In school C, all teachers of the first through fourth grade were present at each meeting and realised that their colleagues need to be informed. “This requires a decision of the whole team”. There was a constructive atmosphere. One teacher was still a little uneasy about the intervention, saying, “I'd like to continue with those kids, but I don't think they can continue to second grade at the end of the year. I don't dare accelerate them”. Another teacher replied, “Trust yourself. We all think it is exciting”. The tension between keeping the pupils with them and releasing them came back regularly: “I think it's difficult if you do not always see your pupils. I'm afraid I lose the overview”.

**Government and other agencies.** The government and other agencies were not mentioned in schools A and B. The Dutch Inspectorate of Education played a small role in school C. According to the principal, it would be difficult to justify higher-level assessments and subject acceleration to the Dutch Inspectorate of Education, as proposed in the intervention.

**Discussion**

The success of an educational intervention – and thus the future determination thereof – depends largely on its implementation in everyday school practices (Fullan, 2007). It is, therefore, essential to study the implementation in detail. This study examined the fidelity of an intervention to improve teachers’ differentiation practices in Dutch early primary schools with a particular focus on how this would support high-ability pupils, and what factors influenced the intervention fidelity.

Results showed that the level of intervention fidelity differed considerably between schools. In most schools, the implementation of the screening and differentiated curricula took more time than expected, which led to less or no time for the policy protocol. Based on participants’ perceptions and cross-case analyses of the implementation in three schools, the following interacting factors appeared to contribute to successful implementation of this intervention: the experiencing of a strong need for educational change for high-ability pupils, pressure from parents, an actively involved principal who facilitates teachers in the intervention and the trust and support of a team in which everyone is aware of the intervention. Barriers for implementation were ambiguity and complexity of the intervention, which was partly due to lack of information and lack of communication between individuals; an interfering or reluctant school board; an ab-
sent principal; and certain beliefs, low motivation and little support and time among teachers. However, the case studies showed that factors can vary greatly per school, and that schools differ in how they deal with these factors.

Noteworthy is the difference in how principals and teachers perceived the intervention. In some schools, teachers were not informed beforehand about participating in the intervention. This was even the case for two school principals, who were surprised by their school boards, which were responsible for the participation but had refused to communicate this to the principals. A similar thing was noted by Kirschner and Prins (2008) who studied the nationwide implementation of three different ‘innovations’ in Dutch secondary schools. In their study of parents’, teachers’ and administrators’ experiencing of the innovations, they found (1) a large degree of agreement between parents’ and teachers’ experience, who found the innovation to be top-down, poorly planned and poorly funded in terms of materials, time and money; and (2) a large discrepancy between these two groups and the administrators, who were much more positive about the innovations and their implementation. They note, “there is a chasm between school administrators (i.e., principals) and teachers primarily over the goals and the achievement thereof” (p. 121). Problems in relationships and communication between school principals and teachers may result in weak relational trust (cf. Le Fevre, 2014), which may have negatively affected implementation processes. As shown in this study, a lack of ownership when interventions are imposed on schools can hamper implementations (see also Bergen & Van Veen, 2004; Swann & Brown, 1997).

Further, this study confirmed that implementation variation between schools is the result of a complex interaction between different factors (Fullan, 2007). As some schools showed a culture of caution (Le Fevre, 2014), others, even while demonstrating uncertainty, deliberately took the challenge. In this respect, the interaction between factors is visible in such a way that teachers and principals support each other, as there is a strong will to change in early primary school and support high-ability pupils at their own level (cf. Deunk & Doolaard, 2013). According to Le Fevre (2014), a school culture that is non-punitive but which embraces inquiry as a model of professional learning might reduce the perceived degree of risk in trying something new. Research has shown that successful implementation is enhanced in school cultures with safe contexts for conversations and sharing, when teacher teams collaborate and learn from each other and when teams have positive attitudes towards educational change (Bergen & Van Veen, 2004). An example of such a school culture can be seen in school C. In schools like school C, with strong organisational learning cultures, teachers are more likely to report higher levels of psychological safety, experimentation and leadership, which reinforces learning (Le Fevre, 2014).

Influencing factors are often general to all educational interventions, such as teacher motivation and the involvement of principals (see Fullan, 2007; McKenna et al., 2014), but also partly specific to interventions for high-ability pupils, such as teacher attitudes towards high-ability pupils and their tuition and the complexity of differentiation. One of the strongest hampering factors seems to be the belief that high-ability pupils do not need to receive education at their own level. Some teachers thought that high-ability pupils had no need for difficult subject matter, which confirmed earlier research (Doolaard & Harms, 2013). This is often referred to as a
non-competitive mentality and has traditionally long been present in the Dutch society (Hofstede, 1997). In this respect, Mooij and Fettelaar (2010) clarify that ‘equal opportunities’ in education are often confused with ‘equal teaching.’ In the latter sense, equality is interpreted as equal education for every pupil, regardless of level, thereby neglecting the learning needs of high-ability pupils.

Further, the complexity of the intervention, that is the skill to adequately differentiate for all pupils in a class, including high-ability pupils, is a specific factor for this intervention. Teachers experienced difficulties in integrating the concepts of the intervention into their teaching. This is not surprising, as earlier research showed that the differentiation skill has not been mastered by a large percentage of Dutch teachers (Van de Grift, 2010). It is, thus, important that there is training to support teachers in adopting differentiation in their teaching practices. From the case studies presented here, it became clear that the intervention partly succeeded in this challenge, but that specific intervention improvements and more support are necessary.

Lessons Learned for Future Interventions

Differentiation in an age-related school system requires a lot from teachers (cf. Segers & Hoogeveen, 2012). As this study showed, it is not easy to implement an intervention in early primary school to enhance differentiation for high-ability pupils. It is thus important to take the following learned lessons into account in future interventions (Swanson et al., 2013).

Generally, during a training session, teachers need to be given opportunities to learn new concepts, how to present content and how to interact with pupils. In the case of differentiated instruction, there is a need to train the differentiation skills of teachers specifically. This is especially important because this study revealed difficulties with the complexity of the intervention.

In addition, it is crucial that those who ‘deliver’ an intervention listen to the concerns of teachers (Le Fevre, 2014). This can help to resolve conflict and promote a sense of fairness and trust. In the case of differentiated instruction, this involves taking teachers’ existing beliefs about high-ability pupils and classroom practices into account when introducing new ideas. A change in mentality is required for teachers before they will teach high-ability pupils at their own level.

Further, a focus on support for and ownership by teachers is very important. Teachers’ motivation and their will to engage and learn must be present before their engagement in any learning activity (Castro-Villarreal, Rodriguez, & Moore, 2014; Gorozidis & Papaioannou, 2014). The administration, school board, team and community need to support teachers, but the first step must take place in the mind of the teacher. As the Evaluation and Advisory Committee for Appropriate Education (Evaluatie- en adviescommissie Passend Onderwijs, 2009) puts it, “If they are not willing and able to achieve the required change, then these changes will not be realised” (p. 17). Not only could the facilitation of teachers be improved, but also communication between management and teachers could be enhanced, to ensure that teachers do not feel overwhelmed by the required intervention activities.
Finally, research has shown that the quality of delivery and the level of enthusiasm of deliverers influences implementations (Darrow, 2013; McKenna et al., 2014). Based upon the DBR-approach used here (Anderson & Shattuck, 2012), some adjustments in the intervention delivery can be recommended. Specifically, more attention should be given to the clarity and complexity of the intervention. This could be done by using more representations (i.e., images of cabinets from other schools, etc.), completed examples and process worksheets (i.e., a plan of a level-based curriculum, protocols, etc.) and assignments during the sessions. Sustainability can be enhanced by better communication of the intervention activities beforehand and noting agreements at each meeting to implement a specific part of the intervention before the next meeting. By doing this, the intervention is expected to better fit the needs of the participants and be implemented with more fidelity.
Chapter 4

Improving Teachers’ Differentiation Practices to Better Anticipate Pupil Differences in Early Primary School

Abstract

This chapter presents the findings from a teacher intervention in Dutch primary schools aimed at improving teachers’ differentiation practices to better anticipate pupil differences in early primary school. The intervention was designed to improve the match between pupil levels and curricular activities, in particular for high-ability pupils and consists of three components: screening the developmental levels of pupils entering primary school; curricular differentiation of the arithmetic and language curriculum; and development of a school-wide protocol for differentiation. A pretest-posttest cluster randomised design was used with three conditions: control (n = 34), pilot intervention (n = 32), and improved intervention (n = 34). Quantitative results demonstrate that the intervention fidelity was relatively highest in the improved intervention. Correlations confirmed that teacher-reported differentiation practices were higher in schools where the intervention was more completely implemented. Further, teacher-reported differentiation practices were enhanced in both intervention conditions, but showed greater improvement in the improved intervention. Qualitative data revealed process characteristics that reflect problems schools encounter with this intervention. Early primary school pupils’ needs and skills differ greatly. Teachers can be supported in improving differentiation practices, but this requires school-wide intensive and long support.

This chapter is submitted for publication as:
Pupils entering early primary school differ greatly in terms of cognitive and socioemotional development, socioeconomic and cultural background, and so forth, all of which can be highly relevant for their future learning. Unfortunately, these differences are not always taken into account in their formal education. A large-scale study (Engel, Claessens, & Finch, 2013) in the United States, for example, showed a misalignment between pupil skills and content coverage in kindergarten with pupils often exposed to arithmetic content that they have already mastered. Moreover, teachers often provide the same activities to all pupils rather than using available assessment data to provide different types of activities to pupils with different ability levels or skills (Al Otaiba et al., 2011). In northern European countries, academic activities in kindergarten or early primary school may be even less adapted to pupil cognitive levels, since the emphasis here is traditionally on socialisation and play and not ‘learning’ (Oberon, 2013; Organisation for Economic Cooperation and Development, 2006; Tazouti et al., 2011).

A lack of fit between needs, abilities, and prevalent teaching practices often results in pupils not functioning optimally; that is, they do not function at a level concomitant with their abilities. This is the case for high-ability pupils who underachieve (cf. Colangelo, Assouline, & Gross, 2004) as well as pupils who lag behind their age peers (cf. Mulder, Roeleveld, & Vierke, 2007). Both groups were found to have diverse academic and socioemotional problems due to this mismatch (Claessens, Engel, & Curran, 2013; Csikszentmihalyi, Rathunde, Whalen, & Wong, 1993; Schmitz & Winskel, 2008; Tomlinson et al., 2003).

In the Netherlands, differentiation in instruction and curricula traditionally aims to improve the achievement of lower-scoring pupils and enhance the general education level (De Boer, Minnaert, & Kamphof, 2013; Doollaard & Harms, 2013), hereby neglecting high-ability pupils. This neglect is not limited to the Netherlands. For example, in the United States, Brighton, Hertberg, Moon, Tomlinson, and Callahan (2005) showed that teachers believed their gifted pupils did not ‘need’ differentiation; when teachers differentiated, they tended to focus on struggling pupils. However, optimal learning requires effective instruction interactions (Cabell, DeCoster, Lo-Casale-Crouch, Hamre, & Planta, 2013), in which abilities and learning activities match (Bronfenbrenner & Morris, 2006). Instruction and curricula therefore need to be adapted to the levels and needs of individual pupils – including high-ability pupils – in a classroom. Unfortunately, within the current educational context, teachers often lack a clear picture of the levels at which their pupils function (Al Otaiba et al., 2011; Doollaard & Harms, 2013; Mooij, 2000; National Association for the Education of Young Children, 2009). Furthermore, teachers are often unaware of the cognitive levels required for specific curricular learning activities (Mooij, 2007a; Oberon, 2013; Tomlinson et al., 2003). Even if teachers are aware of pupil levels, they are often unable to adjust curricular learning activities to this.
This chapter presents an intervention entitled Excel Kwadraat (Excel Squared) aimed at solving these problems by improving teachers’ differentiation practices in Dutch early primary schools. The intervention was designed to improve the match between pupil levels and curricular activities, in particular for high-ability pupils. The ultimate goal was to enhance the learning and development of all pupils, including the high-ability pupils. But before checking pupil outcomes, it is important to assess the intervention fidelity and actual changes in teacher differentiation practices (O’Donnell, 2008; Swanson, Wanzek, Haring, Ciullo, & McCulley, 2013). Whether the intervention succeeded in improving teachers’ differentiation practices by using a design-based research approach (Anderson & Shattuck, 2012; Barab & Squire, 2004) is the focus of this chapter.

Child Characteristics X Instruction Interaction

Learning is the result of dynamic interactions among innate abilities, environmental characteristics and personal characteristics (Bronfenbrenner & Ceci, 1994; Bronfenbrenner & Morris, 2006; Gagné, 2011; Heller, 1999; Heller, Mönks, Sternberg, & Subotnik, 2000; Magnusson & Allen, 1983; Reis & McCaugh, 2000). According to Bronfenbrenner and Morris (2006), pupils develop through everyday interactions with the environment. Socio-cognitive theorists such as Vygotsky (1978) assign a crucial role to the support from the social environment, such as guided participation. The role of education, particularly of teachers, is to allow pupils to have experiences that are in the zone of proximal development (ZPD; Vygotsky, 1978). ZPD constitutes the difference between what the pupil is able to achieve without help and with help. Experiences in this zone are essential for learning. As the ZPD differ according to each pupil’s abilities, effects of particular instructional strategies will vary (Al Otaiba et al., 2011; Connor, Morrison, Fishman, et al., 2011; Connor, Morrison, Schatschneider, et al., 2011; Tomlinson, 2005). In this respect, Kalyuga, Ayres, Chandler, and Sweller (2003) refer to the expertise reversal shift, meaning that instructional designs which are effective with inexperienced or less knowledgeable learners have negative effects when used with experienced or more knowledgeable learners. Teachers should take these so-called child characteristic by instruction interactions (Connor, Morrison, Fishman, et al., 2011) or aptitude-treatment interactions (ATI, Cronbach & Snow, 1977) into account.

Adjusting the curriculum to the learning of individual pupils and thus meeting pupils’ developmental needs (National Association for the Education of Young Children, 2009) and adequately anticipating pupil differences, involves effective differentiation in content, process, product, and/or learning environments, based on variances in pupils’ readiness levels, interests, and learning profile preferences (Tomlinson, 2005; Tomlinson et al., 2003). The ultimate goal is to “maximize the potential of all learners by proactively designing learning experiences in response to individual needs” (Santangelo & Tomlinson, 2012, p. 310). This means minimizing whole-group interaction and increasing working in flexible small groups and with individual pupils. Flexible pacing is one way of addressing existing learner variance (see Vygotsky, 1978). For example, in a little store set up in the classroom, one pupil can be challenged by the teacher to select a certain number of groceries while another calculates the total price of the groceries, and a third
by taking in play money and giving back change; all are challenged by different learning goals (i.e., counting, addition, and subtraction). By providing additional support for pupils who need it, and enrichment activities for pupils who are ready to move ahead more quickly, teachers can maximise learning for all pupils.

Differentiated instruction in small groups can be beneficial for pupils of all ability levels with regard to achievement and learning behaviour in various contexts such as literacy skills (Al Otaiba et al., 2011; Connor, Morrison, Fishman, et al., 2011), oral reading fluency (Firmender, Reis, & Sweeney, 2013; Reis, McCoach, Little, Muller, & Kaniskan, 2011), mathematics and science content (Simpkins, Mastropieri, & Scruggs, 2009; Ysseldyke & Bolt, 2007), and study habits, social interaction, cooperation, attitude towards school, and general mental health (Gayfer, 1991).

**Improving Teachers’ Differentiation Practices in Early Primary School**

Although, in theory, adequately anticipating pupil differences is possible by providing differential learning activities, many teachers acknowledge that putting differentiation into practice is difficult (Tomlinson & Imbeau, 2012). The complex skill of effective differentiation has not been mastered by all teachers (Santangelo & Tomlinson, 2012; Van de Grift, 2010). Furthermore, it is not only teachers’ differentiation skills that come into play; for successful differentiation practices, several diagnostic, instructional, management, and system aspects are required (Mooij, 2007a).

First, learning must start with some type of diagnostics of an individual pupil’s level of competence within a specific domain. Determining pupils’ entry level and then regularly monitoring their progress is necessary in order to continually modify free play and instruction and vary grouping patterns for meeting pupils’ changing characteristics and needs (Purcell, Burns, Tomlinson, Imbeau, & Martin, 2002). Teachers often lack the necessary knowledge of both pupil levels and learning activities to be able to match activities to pupils’ needs. For instance, Doolaard and Harms (2013) found that Dutch teachers were unaware of their pupils’ skill levels. An overload of assessment instruments and lack of knowledge on how to effectively use them for monitoring progress may be responsible for this problem (Doolaard & Harms, 2013; Tomlinson et al., 2003).

Second, teachers need to be comfortable with and gain proficiency in the curriculum they are teaching (Tomlinson et al., 2003) to be able to make appropriate instructional decisions. This requires a solid understanding of a subjects’ (or skills’) learning goals and developmental progression as well as instructional strategies for using a differentially implemented curriculum (see Chapter 2; Tomlinson et al., 2003). Learning processes can be evaluated and managed in order to provide for further learning steps. However, the levels, use and effects of learning materials are often not clear to teachers, in particular the materials for high-ability pupils (Doolaard & Harms, 2013).
Third, beliefs and practices related to “how we do school” (i.e., systemic issues) need to fit differentiated instruction in a flexible system (Tomlinson et al., 2003, p. 125), as systemic factors such as school climate, resources, etc. as well as teacher attitudes can impede the use of differentiated instruction (Maier, Greenfield, & Bulotsky-Shearer, 2013; Roy, Guay, & Valois, 2013). A strong focus on covering prescribed curricula, limited space in the classroom, standardised schedules and class time, inflexible routines and management strategies, and/or perceptions that the teachers differentiate already complicates differentiation (Engel et al., 2013; Maier et al., 2013; Tomlinson et al., 2003).

**Intervention**

Professional development interventions can help teachers and schools overcome the problems mentioned and improve differentiation practices in classrooms (Fullan, 2007; Sheridan, Edwards, Marvin, & Knoche, 2009; Tomlinson et al., 2003). In this study, a design-based research approach is used to design and evaluate such an intervention. Design-based research (DBR) is situated in the educational context, and happens in collaboration between researchers and practitioners (Anderson & Shattuck, 2012; Barab & Squire, 2004). The intervention was designed based on extensive literature review and earlier pilots. It aims at improving teachers’ use of differentiated instruction for all pupils, with a particular focus on how it could support high-ability pupils. A detailed description can be found in Chapter 2. We will discuss the three ‘critical components’ that are at the heart of the intervention (e.g. O’Donnell, 2008).

**Intervention Design**

The first critical component in the intervention is the screening of school-entry characteristics of all incoming 4-year-old pupils (Mooij, 2000). This is based on the assumption that teachers need adequate knowledge of individual pupils’ cognitive and social needs and levels to appropriately differentiate in the curriculum. The screening uses a 29-item questionnaire for parents and teachers which is psychometrically based (Cronbach’s alpha range from .65 to .92). It estimates the relative pupil development in seven areas: social interaction/communication, general cognition, language proficiency, preliminary arithmetic, sensory-motor level, emotional-expressive level, and expected educational behaviour/motivation of the pupil. The response options estimate whether a pupil is less (1), slightly less (2), about the same (3), slightly more (4), or more (5) developed compared with his or her peers. In this way, teachers and parents cooperate and inform each other about the pupil’s levels and needs when they start in primary school so that teachers can make informed decisions.

Second, teachers and researchers collaborate on the development of a differentiation framework. This component is based on the assumption that teachers need knowledge of the structure and levels of the curriculum in order to match pupils’ levels and needs with appropriate curricular learning activities (see Mooij et al., 2014). This framework – for arithmetic and language separately – consisted of a table in which the centrally defined learning goals (Stich-
ting Leerplan Ontwikkeling, 2010a, 2010b) were connected with the levels, assessment methods, and the learning materials corresponding to these goals. Teachers were asked to arrange learning materials in the cabinets in the classroom according to the levels in the framework. Generally, Dutch primary schools keep most of the pupils' playing and learning materials in first and second grade on shelves distributed throughout the classroom, along the walls, or in the corridors. Pupils work with these materials on their own initiative, at specific times, or because of an assignment by the teacher who may want to promote some pedagogic or instructional criterion. The way these materials are organised is generally not according to the specific domain or ability level. In this intervention, the materials need to be ordered with respect to content such as arithmetic and language, and difficulty level. Teachers use different colours and icons or other symbols on each of the shelves to indicate the ordering of contents and levels. Such prepared playing-learning situations enable small groups of pupils or individual pupils to use the materials and instructions independent of their age. Of course, pupils will always need the teacher, but for different pupils this support is needed for different types of activities and to varying degrees.

The third component was the development of a policy protocol per school with information about how pupil assessment and differentiated instruction took place, with a special focus on high-ability pupils. This component was based on the assumption that a structured, preventive approach provides guidance within the team and for parents. The protocol clarifies for both teachers and parents how the school handles the assessment of pupils' levels and what the school's differentiation approach is for high-ability pupils in particular.

Support sessions. In-school support or training sessions were organised to help implement the intervention. Presence of first and second grade teachers, the internal counsellor and the principal was mandatory. All principals had received information on the three components of the intervention necessary curriculum changes and how to realise them. The principals were asked to distribute the information to their teachers and regularly discuss the intervention in their team. In the sessions, the implementation characteristics and changes were discussed. The researchers clarified the meaning of the successive components and promoted the correct development or implementation of the components in each school. Early primary school teachers (grade 1 and 2; pupils aged: 4–6) within each school were expected to collaborate and develop or implement the components stepwise in their own practice.

The Current Study

A 1-year pilot intervention was carried out as described above. As recommended in design-based research, the intervention was evaluated at the end of the year (see Chapter 3). It appeared that not all teachers had an accurate picture of the expected activities in the intervention beforehand. Teachers reported being unclear about the intervention's means and goal and having difficulty with integrating the complex intervention in the school organisation.

DBR allows researchers to refine interventions involving iterations (Anderson & Shattuck, 2012), as there is always room for improvements in the design and delivery. Based on the evaluation, the support sessions were adjusted to better communicate the intervention in the following year. In the so-called 'improved intervention,' the necessary adaptations in teachers'
practices were structured more around the three components and teachers received criteria. The necessary concrete changes in practice were further clarified by using more representations (i.e., images of structured learning material from other schools, etc.), worked examples (i.e., framework of a level-based curriculum, protocols, etc.), and assignments during the sessions. For example, teachers were asked to describe in detail the subsequent steps they took with a pupil in their class whose school-entry characteristics were scored highly by parents and/or by themselves. While discussing these cases during support sessions, teachers could adjust their handling and teaching of high-ability pupils using appropriate differentiation. Setting agreements at each meeting to implement a specific part of the intervention before the next meeting enhanced sustainability. In addition, schools presented and explained to other schools how they tried to implement the components. This enhanced intervention-directed interactions between schools to help schools to learn more from each other.

The main question for the current research was formulated as: Does the intervention for early primary school teachers positively affect their differentiation practices? Teacher-reported differentiation practices will be used to answer this question.

Method

A mixed-methods approach employing qualitative and quantitative methods in the same study was used as recommended in DBR (Anderson & Shattuck, 2012).

Research Design and Hypotheses

The study uses a randomised design with “multiple treatments and control with pretest” (Shadish, Cook, & Campbell, 2002, p. 258). Schools were randomly assigned to either the pilot intervention or the control condition. Randomisation ensured that the conditions were similar to each other before the intervention. Teachers in the control condition did not participate in the training and continued with their regular teaching. Teachers in the pilot intervention condition participated in a 1-year training. The improved intervention was implemented in the original control group the following year. In this way, all teachers were trained while the research benefits a control group. Table 4.1 presents the design. Teacher-reported differentiation practices (DP) were measured at the start (pretest) and end (posttest) of the school year. The posttest in the control condition is used as pretest in the improved intervention condition.

Table 4.1 Research design

<table>
<thead>
<tr>
<th>Year</th>
<th>Pretest</th>
<th>Condition</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DP</td>
<td>Control</td>
<td>DP</td>
</tr>
<tr>
<td>2</td>
<td>DP</td>
<td>Pilot Intervention</td>
<td>DP &amp; Intervention fidelity</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>Improved Intervention</td>
<td>DP &amp; Intervention fidelity</td>
</tr>
</tbody>
</table>
The delivery of an intervention as intended or designed (O’Donnell, 2008) can influence the effect of the intervention greatly. Therefore, to answer the main question, intervention fidelity was determined. In the current research we hypothesise that intervention fidelity is higher in the improved than in the pilot intervention condition, which in turn would result in more improved teacher-reported DP. In the control condition we expect no improvement of teacher-reported DP.

Sample and Procedure
Schools were recruited from the school network of the researchers and ranged in size from 42 to 392 pupils. From the 37 schools, 19 schools ($n = 34$ teachers) were initially control schools, 18 schools ($n = 32$ teachers) participated in the pilot intervention, and 19 (originally control) schools ($n = 34$ teachers) participated in the improved intervention. All schools received a financial compensation to purchase learning material and for allotting teachers the necessary time for intervention activities, where relevant. Teachers, internal counsellors and principals participated in about four (range: three to five) regionally support sessions per year, with one to six schools per region/session.

Instrumentation
Intervention fidelity. The extent to which the critical components of the intervention were implemented in the schools was scored at the end of the school year. Each component was scored separately, that is: (1) screening of school-entry characteristics, (2) using a differentiation framework for the arithmetic (a) and language (b) curriculum and corresponding organisation of materials in the cabinets, and (3) using a policy protocol for differentiation practices and high-ability pupils in the school. The 3- and 4-point scoring categories (see Table 4.2) were collaboratively established and defined by the researchers based on ten randomly chosen schools and then applied to all schools. For the screening, category fully implemented means that over 90% of new 4-year-old pupils in the school were screened by parents and teacher, category partially implemented means that only a portion of these pupils were screened, and category not implemented means 10% or fewer of these pupils were screened. The differentiation frameworks for arithmetic and language and corresponding organisation of materials were scored using categories developed which means the framework corresponds with the materials in the cabinets, advanced development which means that the school largely developed this, but needed to fine-tune the correspondence between framework and materials in the cabinets, started development which means that the school developed a first version of the framework, and not developed. Categories for the policy protocol were fully developed for complete protocols, partially developed for a partially developed protocol, and not developed. The second and third component were collaboratively scored by the researchers.

Teacher-reported differentiation practices (DP). DP were measured with a self-report questionnaire in which teachers indicated the extent to which 11 statements applied to their differentiation practices (range: 0–100%; cf. Mooij, 2007a). Statements were based on Mooij and concerned the teachers’ use of specific diagnostics and assessment methods, instruction and
management strategies, and activities for high-ability pupils (see Table 4.3). For example: “For each subject area, pupils are grouped in homogeneous groups based on their abilities” and “For high-ability pupils, additional content or projects are taught”.

Field notes. The procedures and consensus reached during the training sessions were recorded by two researchers in field notes. The information was collected per school. In this way, qualitative data concerning the intervention fidelity and the promotion of DP in each school’s practice became available.

Data Collection
DP were measured at the start (pretest, September) and at the end (posttest, June) of the school year. Teachers were invited by email to complete the digital DP questionnaires in NetQ®, a web-based program for administering questionnaires. If the teachers did not complete the questionnaire within two weeks of receiving the first email, the email was sent twice at intervals of two weeks. The response rates for the pretest and the posttest were 95% and 100%, respectively.

Intervention fidelity data was collected in several ways. The extent to which the screening of school-entry characteristics was implemented was tracked for each school in NetQ®. All teachers presented their cabinets with materials to the researchers face-to-face in their classroom. Further, in-between and after the training sessions, teachers sent written frameworks and/or policy protocols to the researchers.

Data Analyses
DP data were checked for normal distribution of answers by using the Shapiro-Wilk test (Razali & Wah, 2011). None of teacher-reported DP were normally distributed (all $p < .05$). Therefore, non-parametric tests were used to answer the research question. First, differences in initial teacher-reported DP (pretest) between the three conditions were assessed to confirm that randomisation of schools was successful. The Kruskal-Wallis test revealed that only one DP differed between conditions, namely the screening of school-entry characteristics ($T = 8.50$, $df = 2$, $p = .014$). Thus, randomisation was largely successful. To test the relation between the schools’ intervention fidelity and final teacher-reported DP, Spearman’s rank order cross-level correlations were used. Teachers’ DP scores at posttest were related to their school’s intervention fidelity as assessed by the researchers. In addition, the Wilcoxon signed-rank test was used to assess pretest–posttest differences in teachers’ DP scores. Finally, the field notes were analyzed by ordering and summarising the procedures and outcomes of each intervention meeting per school and across schools. We present a summary of the main issues in the intervention.

Results

Quantitative Results
Intervention fidelity. The intervention fidelity in both intervention conditions is shown in Table 4.2. The screening of new 4-year-old pupils was met in 50% of the pilot schools and in nearly
Table 4.2 Intervention fidelity (n = 37 schools)

<table>
<thead>
<tr>
<th>Component and scoring categories</th>
<th>Pilot intervention</th>
<th>Improved intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (schools)</td>
<td>%</td>
</tr>
<tr>
<td>Screening of school-entry characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening not implemented</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>Screening partially implemented</td>
<td>5</td>
<td>28</td>
</tr>
<tr>
<td>Screening fully implemented</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>Differentiation arithmetic curriculum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framework not developed</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Started structuring in framework and materials</td>
<td>8</td>
<td>44</td>
</tr>
<tr>
<td>Advanced structuring and organising framework</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Framework and organisation of materials developed</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Differentiation language curriculum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framework not developed</td>
<td>10</td>
<td>56</td>
</tr>
<tr>
<td>Started structuring in framework and materials</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Advanced structuring and organising framework</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Framework and organisation of materials developed</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Differentiation policy protocol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policy not developed</td>
<td>16</td>
<td>89</td>
</tr>
<tr>
<td>Policy partially developed</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Policy fully developed</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

90% of the improved intervention schools. The differentiation of the language and arithmetic curricula (completing a framework of the curricula and organising learning materials based on this framework) was developed in nearly 70% of the improved intervention schools, while in the pilot intervention only two out of 18 schools (11%) fully developed these components. None of the pilot schools and about half of the improved intervention schools fully developed a school-wide differentiation policy protocol. It seemed to be difficult for the schools to establish such a general document, since it must be approved by many persons and could take many discussions and a lot of time. In sum, the intervention fidelity was higher in the improved intervention than in the pilot intervention, which means that the adaptations in the intervention delivery enhanced the intervention fidelity.

Relation between intervention fidelity and final teacher-reported DP. The cross-level relationships between intervention fidelity and final DP were assessed with Spearman correlations (see Table 4.3).
Table 4.3  Spearman rho correlations between the Intervention fidelity and teacher-reported DP at posttest \( (n = 66) \)

<table>
<thead>
<tr>
<th>Differentiation Practices</th>
<th>Screening school-entry characteristics</th>
<th>Differentiation arithmetic curriculum</th>
<th>Differentiation language curriculum</th>
<th>Differentiation policy protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostics and assessment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess pupils’ school-entry characteristics</td>
<td>.07</td>
<td>.22</td>
<td>.26*</td>
<td>.22</td>
</tr>
<tr>
<td>Discuss pupil levels with parents</td>
<td>.14</td>
<td>.41**</td>
<td>.46**</td>
<td>.45**</td>
</tr>
<tr>
<td>Assessment based on observation</td>
<td>.05</td>
<td>.09</td>
<td>.12</td>
<td>.12</td>
</tr>
<tr>
<td>Assessment occasions based on pupils’ readiness</td>
<td>-.05</td>
<td>.27*</td>
<td>.34**</td>
<td>.16</td>
</tr>
<tr>
<td><strong>Instruction and management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual learning pace</td>
<td>.18</td>
<td>.28*</td>
<td>.27*</td>
<td>.02</td>
</tr>
<tr>
<td>Subject-based ability grouping</td>
<td>-.14</td>
<td>-.09</td>
<td>.02</td>
<td>.14</td>
</tr>
<tr>
<td>Independent work in small groups</td>
<td>-.09</td>
<td>-.05</td>
<td>-.09</td>
<td>.05</td>
</tr>
<tr>
<td>Activities for high-ability pupils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration in subjects</td>
<td>.32**</td>
<td>.34**</td>
<td>.27*</td>
<td>.05</td>
</tr>
<tr>
<td>Curriculum compacting</td>
<td>.20</td>
<td>.43**</td>
<td>.40**</td>
<td>.31*</td>
</tr>
<tr>
<td>Additional subjects and projects</td>
<td>.36**</td>
<td>.43**</td>
<td>.48**</td>
<td>.28*</td>
</tr>
<tr>
<td>Pupil choice for extra learning activities</td>
<td>.18</td>
<td>.27*</td>
<td>.28*</td>
<td>.20</td>
</tr>
</tbody>
</table>

* = significant at .05 level; ** = significant at .01 level.

Table 4.3 shows that 20 out of 44 correlations between the intervention fidelity and the teacher-reported DP are significant. They range from rho = .26 for the intervention fidelity of differentiated language curriculum with teacher-reported assessment of pupils’ school-entry characteristics, to rho = .48 for intervention fidelity of differentiated language curriculum with additional subjects and projects for high-ability pupils. Most correlations are found between intervention components and activities for high-ability pupils. In general, these correlations confirm the relation between the intervention fidelity and the final teacher-reported DP. In other words, teacher-reported DP are higher when the intervention is more completely implemented.

**Pretest–posttest differences in teacher-reported DP.** Table 4.4 presents the results for the teacher-reported DPs in each condition on the pretest and the posttest. Only one teacher-reported DP (variable testing times \( z = 1.98, p = .048 \)) was improved in the control condition, which confirms the stability of DP. In the pilot intervention, three teacher-reported DP were improved: teachers more often screened pupils’ school-entry characteristics \( z = 4.24, p = .00 \), assessed using observations \( z = 2.27, p = .02 \) and grouped by ability per subject \( z = 2.33, p = .02 \) than before the intervention. In the improved intervention, even more DP were improved. These are screening of school-entry characteristics \( z = 4.15, p = .00 \), discussing screening with parents \( z = 3.37, p = .00 \), assessment by observation \( z = 1.98, p = .048 \), and curriculum compacting \( z = 1.95, p = .051 \), borderline significant. Thus, the improved intervention condition was relatively most successful in improving the teacher-reported DP.
Table 4.4  Medians and ranges of teacher-reported DP in three conditions

<table>
<thead>
<tr>
<th>Differentiation practices</th>
<th>Control condition (n=34)</th>
<th>Pilot intervention (n=32)</th>
<th>Improved intervention (n=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
</tr>
<tr>
<td></td>
<td>Mdn Range</td>
<td>Mdn Range</td>
<td>Mdn Range</td>
</tr>
<tr>
<td>Diagnostics and assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assess pupils' school-entry characteristics</td>
<td>75 100</td>
<td>50 100</td>
<td>70 100</td>
</tr>
<tr>
<td>Discuss pupil levels with parents</td>
<td>75 100</td>
<td>75 100</td>
<td>50 100</td>
</tr>
<tr>
<td>Assessment based on observation</td>
<td>75 75</td>
<td>75 100</td>
<td>75 100</td>
</tr>
<tr>
<td>Assessment occasions based on pupils' readiness</td>
<td>50 100</td>
<td>50* 100</td>
<td>50 100</td>
</tr>
<tr>
<td>Instruction and management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual learning pace</td>
<td>75 90</td>
<td>75 100</td>
<td>50 100</td>
</tr>
<tr>
<td>Subject-based ability grouping</td>
<td>58 100</td>
<td>50 100</td>
<td>75* 100</td>
</tr>
<tr>
<td>Independent work in small groups</td>
<td>80 50</td>
<td>78 80</td>
<td>78 75</td>
</tr>
<tr>
<td>Activities for high-ability pupils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration in subjects</td>
<td>50 100</td>
<td>50 100</td>
<td>75 100</td>
</tr>
<tr>
<td>Curriculum compacting</td>
<td>60 100</td>
<td>50 95</td>
<td>50 90</td>
</tr>
<tr>
<td>Additional subjects and projects</td>
<td>50 95</td>
<td>38 100</td>
<td>50 90</td>
</tr>
<tr>
<td>Pupil choice for extra learning activities</td>
<td>50 95</td>
<td>33 100</td>
<td>50 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = significant at .05 level; ** = significant at .01 level.

Qualitative Results

Summary of field notes. This section presents the main issues a majority of schools encountered, as noted by the researchers during the training sessions. Working along the intervention guidelines was new for early primary school teachers. The first challenge for the teachers was understanding the pedagogic-psychological approach to systematically improving development and learning for every pupil, and the aim of realising this approach by providing corresponding systemic play, learning, and organisational conditions in each class.

In addition, the activities for increasing pupil-based differentiation in a traditional age-related school required a lot of comprehension and additional work by the teachers. The researchers observed that some teachers showed resistance to systematically educating young pupils, because the teachers preferred a play-based mentality in early primary school. Other teachers believed that pupils at the higher end of the ability spectrum had no need for difficult subject matter.

It became clear during the intervention sessions that some teachers or schools initially resisted screening school-entry characteristics. For example, some teachers and schools were not keen on using ‘another’ questionnaire for parents, mainly because the schools did not want to ‘bother’ parents or because the schools expected some parents would act in a problematic way. However, after several weeks of using this questionnaire and comparing the parents’ outcomes with the teachers’ outcomes, the teachers indicated that the screening questionnaire gave them valuable information about the pupil’s development. Apart from the initial resistance, implementing the screening in schools was found to be convenient.
The main qualitative finding is that, as expected, matching the outcomes of the screening for each pupil with the appropriate levels of challenge in learning tasks is essential at the beginning and for further development of each pupil. The training sessions showed that teachers and schools lacked enough time and expertise to include complete diagnostic information about pupil levels based on screening and norm-based and criterion-based tests. This was further complicated by the overload of different types of assessment instruments and learning materials.

Discussion

Conclusions

It is important to study the implementation of an intervention before studying pupils outcomes, as the first can be more or less optimal and thereby effecting the latter. Our research shows that the intervention with three critical components based on important features for differentiation, is not easily adopted by teachers. Schools in the pilot intervention scored suboptimal on intervention fidelity. As recommended in DBR, the intervention was evaluated and adapted. A higher level of intervention fidelity indicated an improved level of implementation of the aimed intervention in the schools. Spearman correlations confirmed the significance of meaningful relationships between the intervention fidelity as assessed by the researchers and teacher-reported DP in schools. Furthermore, there was a difference in effect of the pilot and improved intervention: teacher-reported DP were enhanced in both cases, but showed relatively greater improvement in the improved intervention.

The quantitative and qualitative research results and the necessary adjustments in the support sessions from pilot to improved intervention demonstrate that improving differentiation practices is definitely not a minor modification (see Tomlinson et al., 2003). Systemic change requires a much longer period than one year to be completed (Duffy et al., 2006). Teachers reported doing more differentiation practices related to level determination of pupils, but these practices are only the first step in a continuing process of offering appropriate play and learning tasks. Further transforming a school’s orientation and change for effective differentiation practices including diagnostically based variations in free play and curriculum progress turned out to be more difficult (see also Mooij, 2007a). Some of the teacher-reported DP did not improve in both intervention conditions, for example, individual learning pace. This result is not surprising, since this practice requires the largest changes in the curriculum and is directly related to a more academic mentality instead of a play-based mentality. Furthermore, teachers usually prefer differentiation practices that require little preparation or tailored instruction, if teachers use such practices at all (Roy et al., 2013).

Some teachers in this study perceived that high-ability pupils had no need for difficult subject matter (cf. Doolaard & Harms, 2013; Reis & Westberg, 1994). This noncompetitive mentality has traditionally been present in Dutch society (Hofstede, 1997). In this respect, Mooij and Fette-laar (2010) clarified that equal opportunities in education are often confused with uniform teaching. Equality is then psychologically mistakenly interpreted as equal education for every pupil,
regardless of level. Teachers have to understand that the curriculum, instruction, and learning pace can be different for different pupils in the same classroom. By implementing the three critical components screening, framework of learning materials and a school wide policy protocol, differentiated instruction becomes mandatory instead of facultative, which changes “how we do school” (see Tomlinson et al., 2003, p. 125). Within most of the schools in our study, this will require more years of research, including training or other adequate support.

For a successful implementation of differentiated instruction, the teachers themselves must be motivated to change existing practices, work in a professional team culture, and require adequate support from the principal (Fullan, 2007; Oberon, 2013; Sheridan et al., 2009; Smit & Humpert, 2012). These factors were not present in all schools (see Chapter 3). For example, the principal was invisible in some schools, and negative teacher attitudes turned out to be persistent, resulting in continuing resistance to facilitating high-ability pupils at their own level. Other studies have also found that teachers’ attitudes and beliefs were an obstacle (Hertberg-Davis, 2009; Smit & Humpert, 2012).

Limitations
This study is based on a sample of schools taken from the researchers’ network of schools, with an interest in curricular differentiation and high-ability. The sample is thus not completely representative of Dutch education and may be somewhat biased. However, as shown in the studies cited, comparable processes and experiences as reported in our study have been found by other Dutch and international researchers which supports the present findings and conclusions. However, this limitation also indicates that trying to realise comparable changes in primary schools involved in a representative, non-self-selected sample will be even more difficult.

A second limitation is that we used DP as reported by teachers, who may be sensitive for socially desired answers (Wen, Elicker, & McMullen, 2011). However, Desimone, Smith, and Frisvold (2010) observed that several studies have shown that anonymous teachers’ self-reports on their teaching are highly correlated with classroom observations and that one-time surveys that ask teachers questions about the content and instructional strategies the teachers emphasise are quite valid and reliable. In this study, the concrete actions, learning material and descriptions with pupils presented during the training, provide some tangible evidence of teachers differentiation practices. However, in future studies classroom observations should be included in the research design to gain more information about differentiation and relevant applied practices in classes, and to further increase and check the validity of the assessments.

A final limitation concerns the length and intensity of the intervention and support sessions. More support sessions per year within the schools, and a longer period of intensive consultation and support, will likely enhance the implementation of the critical components and differentiation practices in school. Teachers may also benefit more from other teachers’ knowledge, skills, and products when stronger collaboration between schools is stimulated and realised. Further, teachers must be trained more, in a wide array of play, instructional, and diagnostic techniques, to facilitate systemically differentiated instruction and thus to improve the teachers’ differentiation practices.
Implications

As the study shows, implementing differentiated instruction, including instructional adaptations and academic progress monitoring (Roy et al., 2013), is not a minor transition (Hertberg-Davis, 2009). Focusing on support for and ownership of the teacher is also important (Evaluatie- en adviescommissie Passend Onderwijs, 2009). A change in mentality is required for some teachers before they will teach pupils at the lower and higher ends of the spectrum at their own level. Or as the Evaluation and Advisory Committee for Appropriate Education puts it: “If they are not willing and able to achieve the required change, then these changes will not be realised” (Evaluatie- en adviescommissie Passend Onderwijs, 2009, p. 17).

In addition, schools can be supported more, and in particular adequately, in developing procedures and practices that diagnostically base knowledge of pupils’ levels and needs, and to develop and implement corresponding curriculum differentiation throughout the entire school. Furthermore, a school’s principal and teachers can collaborate on relevant preconditions and their realisation in practice. Only then will a shared view of differentiation be developed and distributed gradually in the whole school.

For sustainable implementation, long-term professional development is also important (Fullan, 2007). After the intervention ended, some schools in this study decided to collectively continue improving their differentiation practices. Ongoing support would give these schools the opportunity to further develop teaching practices for diverse pupils. Causal analyses of longitudinal pupil data should then also be used to indicate whether the education and differentiation improvement at school and class level improved the pupils’ academic and socioemotional functioning.
Chapter 5
Effects of a Teacher Intervention for Differentiation on Academic Achievement of Early Primary School Pupils

Abstract
This chapter examined the effects of an intervention for teachers’ differentiation practices on the academic achievement of pupils in early primary school, especially high-ability pupils. The intervention includes screening pupils’ school-entry characteristics, matching their needs with curricular activity levels, and implementing a school-wide approach to differentiation. Schools were randomly assigned at the start of the first year to an intervention condition (n = 147 pupils) or a control condition (n = 208 pupils). Variance analyses were carried out including pretest achievement measures as well as background characteristics as covariates. Results showed that the intervention positively influenced the arithmetic development of early primary school pupils (Cohen’s $d = 0.27$), with stronger effects for high-ability pupils (Cohen’s $d = 0.80$). No intervention effects were found for language development. The chapter concludes with discussions of the limitations of the study and possible further research steps.

This chapter is submitted for publication as:
Teachers in early primary school work with a diverse group of pupils in their classrooms, who differ in such factors as gender, ethnicity, socioeconomic background, cognitive development, and self-regulatory capabilities, all of which can affect learning processes. One group is formed by those pupils who are often referred to as being bright, talented, gifted, or high-ability pupils (c.f. Colangelo, Assouline, & Gross, 2004; Gagné, 2004). Compared to cognitively less able pupils, the learning processes of high-ability pupils are generally characterised by higher initial ability levels, larger learning steps, more abstract learning, more self-structuring, longer periods of concentration, less repetition, and the willingness and ability to work independently (Mooij, 1992). These factors result in strong verbal and/or mathematical skills at a young age (Colangelo et al., 2004; Gross, 1999).

Because learning processes in primary school are usually organised according to age, most learning activities are adapted to the mean age of the pupils (Colangelo et al., 2004; Mooij, Roeleveld, Fettelaar, & Ledoux, 2012). This implies that most of the learning activities fit the needs and abilities of most pupils in the classroom, but not those of high-ability pupils or pupils who lag behind their age peers. In this respect, Gagné (2011) refers to the age/grade lockstep, meaning that linking one academic year to one chronologic year does not make sense to those pupils that deviate most from the mean. In other words, instruction and curricula do not sufficiently take these differences into account.

As a consequence, pupils who clearly function above or below the level of their age-peers often do not learn optimally: they do not score at a level concomitant with their abilities (cf. Colangelo et al., 2004; Mulder, Roeleveld, & Vierke, 2007). A large number (30–40%) of high-ability pupils, for example, were found to academically underachieve in grades 4, 6 and 8 in the Netherlands (Onderwijsraad, 2007); this percentage is twice that of pupils from all other ability levels combined. In addition, low motivation is also a serious problem for high-ability pupils (Colangelo et al., 2004). These two problems may manifest themselves in boredom, negative perceptions of school, stress, disruptive behaviour or relatively low grades (Gross, 1999). Similar problems are found with pupils who lag behind their age peers (Roeleveld, Smeets, Ledoux, Wester, & Koopman, 2013).

Differentiation might prevent these problems, but instruction and curriculum differentiation is usually directed only towards lower-scoring pupils (De Boer, Minnaert, & Kamphof, 2013; Doolaard & Harms, 2013), thereby neglecting the needs of high-ability pupils. Education in the Netherlands, for example, seems to show significant achievement in bringing low-ability pupils to a standard level due to strong remedial teaching, but the Dutch system struggles in working with advanced or high-ability pupils (Meelissen et al., 2012). This neglect is also found in other countries, albeit not to the degree that is found in the Netherlands. For example, research sug-
gests that United States teachers differentiate only for struggling pupils, believing that gifted pupils did not ‘need’ differentiation (Brighton, Hertberg, Moon, Tomlinson, & Callahan, 2005).

Optimal learning requires that all pupils are provided with appropriate learning activities (cf. Bronfenbrenner & Morris, 2006; Cronbach & Snow, 1977). To achieve optimal learning, instruction and curricula should be adapted to the levels and needs of individual pupils in a classroom (Tomlinson et al., 2003). To this end, teachers need to have an accurate view of pupils’ levels of understanding, and to know which instruction and learning activities are appropriate for pupils at different levels, given the goals the pupils strive for (Deunk, Doolaard, Smale-Jacobse, & Bosker, 2015). Teachers often do not have a clear picture of the levels at which their pupils function, however, especially high-ability pupils (cf. Al Otaiba et al., 2011; Doolaard & Harms, 2013; Mooij, 2000). Another problem is that the cognitive levels required for specific curricular learning activities are often not known by teachers (cf. Chapter 2; Tomlinson et al., 2003), resulting in a lack of fit between learning needs and learning activities.

These problems might be overcome by providing teachers with information about the pupils’ levels and learning activities in order to make appropriate matches for the individual pupils in class (see Mooij et al., 2014). In this chapter, our aim is to investigate if doing this will be beneficial for learning.

**Theoretical Framework**

**Child Characteristics x Instruction Interactions**

In learning, innate abilities, personal characteristics and environmental influences continually interact (cf. Bronfenbrenner & Ceci, 1994; Bronfenbrenner & Morris, 2006; Gagné, 2011; Magnusson & Allen, 1983). According to the bio-ecological model of learning (Bronfenbrenner & Morris, 2006), pupils learn and develop through everyday interactions. Crucial in these interactions is the support from the social environment (i.e., guided participation; Vygotsky, 1978). In school, teachers should strive to guide pupils in experiences that match their *zones of proximal development* (ZPD; Vygotsky, 1978); that is, what pupils can achieve with help but not without.

Because pupils differ in their ZPDs, effects of particular instructional strategies on pupils’ learning will vary (Al Otaiba et al., 2011; Connor, Morrison, Fishman, et al., 2011; Connor, Morrison, Schatschneider, et al., 2011; Tomlinson, 2005). Research on the *expertise reversal effect* (Kalyuga, Ayres, Chandler, & Sweller, 2003) has shown that certain instructional designs can be effective with less knowledgeable or inexperienced learners, but that the same designs can have negative effects on more knowledgeable or experienced learners, and vice versa. For example, pupils who start in early primary school with larger vocabularies and more developed phonological awareness are at a relative advantage when they are exposed to written language in school, which in turn further expands their vocabulary, phonological skills, and automaticity in reading. In contrast, pupils who are poorly equipped in vocabulary and phonological awareness require systematic teaching in these basic skills (National Institute of Child Health and Human Development, 2000).
These so-called child characteristic \textit{x} instruction interactions (Connor, Morrison, Fishman, et al., 2011) or aptitude-treatment interactions or ATIs (Cronbach & Snow, 1977), are important for teachers to take into account. Teachers may anticipate differences in pupils’ ability levels, learning preferences, or interests by differentiating in learning processes, content, products, and/or learning environments (Tomlinson, 2005; Tomlinson et al., 2003). By doing this, they can “maximize the potential of all learners by proactively designing learning experiences in response to individual needs” (Santangelo & Tomlinson, 2012, p. 310). To this end, teachers use flexible pacing and spend more time working with pupils individually and in small groups (see Vygotsky, 1978). Teachers can optimise the learning of all pupils by giving additional support to those who lag behind, and providing extension activities for those who are advanced. To do this, a wide range of materials in the early primary school classroom is required to connect learning with pupils’ interests and learning profiles.

\textbf{Effects of Differentiation on Learning and Development}

Differentiation practices in early primary school are not as widely studied as practices in higher grades of primary school are (Deunk et al., 2015). A study by Al Otaiba et al. (2011) showed that it was possible to enhance individualised and small-group instruction, with positive effects on kindergarten pupils’ reading skills. According to a recent review of differentiation practices, within-class ability grouping in early primary school has a moderately positive effect on language performance, with effect sizes ranging from $d = 0.068$ to $d = 0.911$ (Deunk et al., 2015). It was not clear from the included studies, however, if teaching was adapted to the needs of different groups.

Research in primary education showed beneficial effects of differentiated instruction in small groups on word reading achievement, reading comprehension, and vocabulary performance (Connor et al., 2013; Connor, Morrison, Fishman, et al., 2011; Connor, Morrison, Schatschneider, et al., 2011; Reis, McCoach, Little, Muller, & Kaniskan, 2011), as well as mathematics and science achievement (Simpkins, Mastropieri, & Scruggs, 2009; Ysseldyke & Bolt, 2007; Ysseldyke et al., 2003). In addition, when tasks interest pupils more, they become more engaged with the tasks; they are more creative, productive, and autonomous; they express more positive feelings about learning; and they exhibit a stronger self-concept and a higher level of intrinsic motivation (Lou, Abrami, Spence, & Poulsen, 1996; Ryan & Deci, 2000; Simpkins et al., 2009; Tomlinson et al., 2003).

\textbf{Differential Effects For High-Ability Pupils}

Few studies have been conducted on differentiation effects on high-ability pupils’ academic outcomes in the early primary school years (Walsh, Kemp, Hodge, & Bowes, 2012), and their results are inconclusive (Deunk et al., 2015). Gettinger and Stoiber (2012) studied the effectiveness of an early-literacy intervention of ability grouping combined with adaptive education and high-quality instruction, and found this to be beneficial for pupils of all ability levels. The intervention was most beneficial to average-ability pupils, followed in turn by low-ability and high-ability pupils. Other research confirmed the slightly positive results of naturally occurring
ability grouping combined with high instruction time for all ability groups (Hong, Corter, Hong, & Pelletier, 2012).

A meta-analysis of research studies on primary education showed that within-class ability grouping may have stronger positive effects for high-ability pupils than for the other pupils, but it remains unclear if instruction was adapted in these studies to the needs of the different groups (Deunk et al., 2015). For example, Condron (2008) showed with data from the Early Childhood Longitudinal Study Kindergarten cohort that within-class ability grouping has positive effects on high-ability pupils only, with no effects on average ability pupils and negative effects on low-ability pupils.

In addition to simple ability grouping, specific instructional strategies for high-ability pupils can be integrated in differentiated instruction. Research on such strategies in primary education has shown positive effects of curriculum compacting, enrichment programmes with more difficult content, and tempo acceleration for high-ability pupils’ learning and achievement (Aljughaiman & Ayoub, 2012; Kulik & Kulik, 1992; Reis & Purcell, 1993; Steenbergen-Hu & Moon, 2011) and social outcomes (R. Cohen, Duncan, & Cohen, 1994; Olenchak, 1995; Steenbergen-Hu & Moon, 2011). Enrichment that include research projects, for example, might fit these pupils’ interests better, since high-ability pupils prefer self-pacing and complex, extracurricular topics; they prefer to work with others at least some of the time; and they prefer to choose the format of the products of their learning (Kanevsky, 2011). Thus, instruction can be differentiated with positive consequences for high-ability pupils.

**Improving Teachers’ Differentiation Practices in Early Primary School**

For successful differentiation, certain aspects in the organisation of teaching are required (Mooij, 2007a). First, the levels on which individual pupils function in each learning domain need to be assessed with some type of diagnostics (Tomlinson et al., 2003). This, and monitoring their learning progress (since pupils’ needs can change) is required for continually modifying learning activities and varying grouping patterns (Deunk et al., 2015; Purcell, Burns, Tomlinson, Imbeau, & Martin, 2002).

Further, to make appropriate decisions about instruction, teachers need to know which cognitive levels are required of learners for the various curricular learning activities (Tomlinson et al., 2003). Both awareness and understanding of the pupils’ developments and the corresponding learning goals in each subject or domain, as well as strategies for using a differentiated curriculum are required (see Chapter 2; Deunk et al., 2015; Tomlinson et al., 2003). By evaluating pupils’ learning according to learning goals in a differentiated curriculum, further steps in learning can be determined.

Finally, systemic aspects – i.e., beliefs and practices related to “how we do school” (Tomlinson et al., 2003, p. 125) – should support differentiated instruction and curricula in school, as several studies have found that teacher attitudes, school climate, resources, etc. have an effect on the use of differentiated instruction and curricula (Kingore, 2004; Maier, Greenfield, & Bulotsky-Shearer, 2013; Roy, Guay, & Valois, 2013).
**Intervention**

Several studies have found that teachers and schools can be supported in improving their differentiation practices in the classroom (Fullan, 2007; Sheridan, Edwards, Marvin, & Knoche, 2009; Tomlinson et al., 2003), but interventions have usually focused on just one domain, for example reading (e.g. Connor et al., 2013). The intervention presented in this chapter called *Excel Kwadraat* (*Excel Squared*) integrates the differentiated instruction practices of the arithmetic and language curricula immediately from the start of primary school in a flexible system. This intervention was designed based on existing research and earlier pilots (Mooij, 2007a, 2008). Central to this intervention is implementing differentiated instruction and curricula in early primary school, with particular attention to how this could support high-ability pupils.

**Intervention design.** In this intervention, schools used or developed three ‘critical components’ (see O’Donnell, 2008). The first component constitutes a screening of beginning or school-entry characteristics of pupils (Mooij, 2000); this component is based on the assumption that teachers need to know what the developmental levels of the pupils are in order to offer them appropriate learning activities that match with the pupils’ needs. The screening was offered to parents and teachers of incoming 4-year-old pupils, in the form of a 29-item psychometrically based questionnaire. This screening estimates the developmental levels of pupils in seven areas: social interaction/communication, general cognition, language proficiency, preliminary arithmetic abilities, sensory-motor level, emotional-expressive level, and the pupil’s expected educational behaviour/motivation (Cronbach’s alpha range from .65 to .92). Respondents estimated the pupil’s development in relative terms compared to those of age peers. If the results were unclear, or if the pupil’s development was estimated to be ahead of (or to lag behind) others, pupils could be tested further with other types of diagnostics. By using this screening method, information from parents and teachers about the pupil could be used to make informed decisions about the pupil’s learning.

Second, teachers were asked to develop a framework that consisted of the learning materials available in their classrooms matched with the curriculum learning goals. This component is based on the assumption that knowledge of the structure and levels of the curriculum is required for teachers to appropriately connect learning needs with learning activities for each pupil (see Chapter 2). Teachers developed a framework (i.e., a table) separately for arithmetic and language, in which the learning materials were connected to the levels and assessment methods corresponding with the centrally defined learning goals (Stichting Leerplan Ontwikkeling, 2010a, 2010b). Then, learning materials were arranged in the classroom cabinets following the levels in the frameworks. In the preparatory grades of primary school in the Netherlands, learning materials are usually kept on shelves in cabinets along the walls in the classrooms, or in the corridors. Pupils may access these materials upon their own initiative, or teachers may assign specific materials to pupils to promote some pedagogic or instructional criterion. The materials are generally not ordered according to ability levels in a (sub)domain. With respect to arithmetic and language content and difficulty level, teachers can order the materials and use colours or icons on each shelf to indicate the ordering. This prepared ordering of learning activities enables
individuals or small groups of pupils to use the materials independent of their age. The kind and degree of teacher support can differ between activities and pupils.

The last component concerns a policy protocol to be developed by the schools with information on pupil assessment and differentiated instruction and curricula, with special attention for high-ability pupils. A structured, preventive approach (as agreed upon in a protocol) is assumed to provide guidance within the teacher team and for parents. By developing this, it is clear for teachers and parents how the school determines pupil levels and what the school’s approach is towards differentiated instruction and curricula.

The Current Study
Based on the child characteristics x instruction interactions, and in line with the research of Tomlinson (2005); Tomlinson et al. (2003), Mooij (2007a, 2008), and Mooij et al. (2014), we hypothesise that an intervention in early primary school consisting of (a) an assessment of each pupil at the start of school, (b) improving teacher curriculum and diagnostic knowledge, and corresponding differentiated ordering of activities, and (c) a school-wide approach to differentiation and high-ability will positively affect all pupils’ academic achievement, including high-ability pupils. Such an integrated programme for all pupils in mixed-ability classrooms has not yet been tested in the early primary school years (Walsh et al., 2012). The questions guiding the study are as follows: (a) Does the intervention (as compared with a randomised control condition) positively influence the academic achievement of early primary school pupils? and (b) Does this effect differ for pupils who are initially characterised as being high-ability pupils?

Method
Sample
In the Netherlands, two preparatory grades and six grades of basic education form primary schools for pupils aged 4 through 12. In this effect study, the preparatory grades of 27 primary schools (i.e., early primary school) with 355 pupils were involved. These schools represent a wide range of socioeconomic statuses and pupil achievement heterogeneity; they included urban, suburban, and rural locations, and were spread throughout the Netherlands. In this respect, the schools can be considered to be representative of the Netherlands as a whole. A limited compensation was available for schools to purchase learning materials if necessary, and to allot teachers time for intervention activities. Early primary school pupils were automatically assigned to the study unless their parents or caregivers did not approve and opted out of the study (informed consent was used).

Research Design
A pretest-posttest control group design (Shadish, Cook, & Campbell, 2002) was used. Schools were randomly assigned to either the intervention or the control condition. Teachers from schools in the control condition did not participate in the intervention, and continued with their
'business as usual.' Teachers in the intervention condition participated in a 1-year intervention. Pupil measurements took place at the start and end of the school year: September/October (pretest) and May/June of the following calendar year (posttest); the intervention took place in between these time periods.

**Intervention Fidelity**

The study described in Chapter 3 assessed the implementation of the critical components that were central to this intervention using a fidelity rubric checklist. The screening was implemented in over 75% of the schools; the differentiated arithmetic curriculum was partially or completely developed in nearly 90% of schools; for the differentiated language curriculum, this was nearly 50% of the schools, but the policy protocol was developed in only 11% of the schools. In addition, the effects of the intervention on teacher differentiation practices was studied in Chapter 4, and revealed positive effects of the intervention on a number of differentiation practices, in particular on the use of specific diagnostic and assessment methods.

**Variables**

**Academic achievement.** Standardised, norm-referenced early primary school tests for language and arithmetic were used (CITO LOVS, the national learning monitoring system in the Netherlands). These tests were administered by group by the teacher, and took 40–60 minutes to complete. The reliability of these tests was good for Dutch language abilities (MAcc > .84; Lansink & Hemker, 2010) and arithmetic abilities (MAcc > .87; Koerhuis, 2010). Assignments in the pretest and posttest differ. The language tests (pretest: 48 items; posttest: 60 items) included oral and written language skills, and the arithmetic tests (pretest: 46 items; posttest: 48 items) included number sense, size, and geometry. Data from the arithmetic pre- and posttest were available for 315 pupils (89%); the figure for the language test was 303 pupils (85%). The items for pretest and posttest were different, but the test produces ability scores that are comparable over time (i.e., pretest and posttest).

**Initial high-ability.** Controversy exists over the definition of the term high-ability. In this study, we follow Gagné's definition of giftedness in his *Differentiated Model of Giftedness and Talent* (2004):

> Giftedness designates the possession and use of untrained and spontaneously expressed natural abilities (called outstanding aptitudes or gifts), in at least one ability domain, to a degree that places an individual at least among the top 10 percent of age peers. (p. 120)

The independent variable therefore indicated a score within the top 10% of scores compared to age peers on the language pretest, the arithmetic pretest, or both. A linear regression analysis was performed with pupils' age as predictor and the score on the language or arithmetic pretest as dependent variable. Age was a highly significant predictor for both pretests (p < .001), and residuals were saved. Pupils who scored within the highest 10% residuals of the sample were assigned in the dataset as initial 'high-ability', and the other 90% of the pupils were assigned
initial 'non-high-ability'. The variables for language and arithmetic were then combined into one variable that indicated that the pupil was a high-ability pupil in either the arithmetic domain, the language domain, or both. This procedure resulted in 49 initially high-ability pupils (= 1) and 306 initially non-high-ability pupils (= 0).

**Background characteristics.** Background characteristics such as gender, age, work attitude, and parental involvement have been shown to be important for child development (Peetsma, Van der Veen, Koopman, & Van Schooten, 2006; Ruijs, Van der Veen, & Peetsma, 2010). We therefore controlled for these characteristics in the analyses. Teacher-reports from the COOL 5-18 cohort study were used to measure work attitude and parental involvement (Driessen, Mulder, Ledoux, Roeleveld, & Van der Veen, 2009). Teachers assessed three statements about both variables on a 5 point scale ranging from 1 (*definitely untrue*) to 5 (*definitely true*). The reliability of the scales (using Cronbach's alpha) was .82 for work attitude and .88 for parental involvement. The scale score was calculated as the mean score of the combined items, with the scores for negatively formulated items reversed. The pupils’ background characteristics are presented in Table 5.1.

**Condition.** Schools were randomly assigned to either the intervention condition (= 1), in which the early primary school teachers participated in the intervention, or the control condition (= 0), in which the schools’ regular teaching ('business as usual') continued. The control schools did not use a screening of school-entry characteristics or a policy protocol for differentiation, nor did they use a differentiated curriculum with learning materials ordered according to the level of difficulty.

**Data Collection**
The schools’ administration officers collected the background characteristics and the language and arithmetic achievement test outcomes and sent the scores to the researchers. These test scores were manually imported into a database. A web portal was used for measuring each pupil’s work attitude and parental involvement. Teachers were invited by email to complete a questionnaire in NetQ®. If the teachers did not complete the questionnaire within two weeks of the first email, the email invitation was repeated twice, at intervals of two weeks. The response rate was 99% (n = 353).

**Analyses**
The two outcome variables are arithmetic achievement and language achievement. Because pupils are nested in classrooms in schools, multilevel analyses seemed appropriate; however, according to Hox (2010), with fewer than 5 pupils per class and fewer than 50 classes, standard errors for fixed effects would have been too small (increased Type 1 errors), and random effects and their standard errors may have been underestimated. In this study, there were 10 classes with fewer than 5 pupils participating, and there were 40 classes in total, thus multilevel analyses were not appropriate.
As a result, analyses of covariance (ANCOVA) were used, as recommended by Field (2013). ANCOVA reduces the within-group error variance, allowing the researcher to assess more accurately the effects of the independent variable. Further, confounding variables can be eliminated in analysis of covariance; it removes the bias of these variables by including them as covariates.

After the missing values were analysed, common assumptions in data analysis were checked. Some assumptions were violated: there were unequal variances across groups (Levene’s test $p < .00$), a number of outliers, and non-normality of residuals (in histograms and Q-Q plots). In the subgroups of non-high-ability pupils and high-ability pupils, these assumptions were largely met. Further, collinearity was assessed using the correlation matrix and proved to be no problem in the subsamples. Therefore, separate covariate analyses were performed for non-high-ability pupils and high-ability pupils. The pretest scores were included as covariates, as well as background characteristics that were related to the outcome variable or the condition. Condition was included to assess the main effect of the intervention on pupils’ academic achievement. Because covariates shared no effect with the condition effect, independence between the covariates and the condition effect was checked. Further, the regression slopes were homogeneous.

The explained variances were assessed as well as effect sizes (partial $\eta^2$) to determine the relative contribution to the academic achievement of the pupils. Finally, to assess the difference in effects on non-high-ability and high-ability pupils, effect sizes were compared across subsamples. The adjusted Cohen’s $d$ was calculated to facilitate effect size comparison. In this case, the adjusted mean difference was divided by the square root of the MSerror.

Table 5.1  Descriptive statistics of measures ($n=355$)

<table>
<thead>
<tr>
<th>Measures</th>
<th>Mean (SD) or percentage</th>
<th>Non-high-ability pupils</th>
<th>High-ability pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention ($n=128$)</td>
<td>Control ($n=178$)</td>
<td>Intervention ($n=19$)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>43%</td>
<td>50%</td>
<td>58%</td>
</tr>
<tr>
<td>Girl</td>
<td>57%</td>
<td>50%</td>
<td>42%</td>
</tr>
<tr>
<td>Age</td>
<td>6.00 (.32)</td>
<td>6.00 (.37)</td>
<td>5.94 (.38)</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>3.70 (.82)</td>
<td>3.73 (.67)</td>
<td>4.11 (.32)</td>
</tr>
<tr>
<td>Work attitude</td>
<td>3.22 (.82)</td>
<td>3.26 (.81)</td>
<td>3.82 (.59)</td>
</tr>
<tr>
<td>Arithmetic achievement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>68.22 (9.46)</td>
<td>70.48 (8.30)</td>
<td>88.37 (12.54)</td>
</tr>
<tr>
<td>Posttest</td>
<td>88.24 (11.73)</td>
<td>87.58 (10.56)</td>
<td>111.79 (16.17)</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>20.02</td>
<td>17.10</td>
<td>23.47</td>
</tr>
<tr>
<td>Language achievement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>55.58 (10.38)</td>
<td>56.98 (8.85)</td>
<td>77.00 (9.53)</td>
</tr>
<tr>
<td>Posttest</td>
<td>70.18 (12.42)</td>
<td>69.96 (10.40)</td>
<td>86.79 (12.85)</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>14.60</td>
<td>12.98</td>
<td>9.79</td>
</tr>
</tbody>
</table>
Results

Descriptive Statistics

Descriptive statistics for the variables and bivariate correlations are shown in Table 5.1 and Table 5.2, respectively. As seen in Table 5.1, the conditions are quite similar in background characteristics, although high-ability pupils in the intervention seem to outperform their counterparts in the control condition on work attitude and parental involvement. As expected, t-tests confirmed \( p > .05 \) that conditions were comparable for both ability groups on all background variables and pretests, i.e. randomisation was successful.

Table 5.2  Bivariate correlations between variables (n=355)

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Condition</td>
<td>1.04</td>
<td>-0.04</td>
<td>-0.02</td>
<td>0.00</td>
<td>-0.09</td>
<td>0.02</td>
<td>-0.05</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Gender</td>
<td>-0.03</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.29**</td>
<td>-0.07</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Age</td>
<td>0.04</td>
<td>-0.13*</td>
<td>-0.07</td>
<td>0.20**</td>
<td>0.07</td>
<td>0.15**</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. High-ability</td>
<td>0.11**</td>
<td>0.16**</td>
<td>0.59**</td>
<td>0.47**</td>
<td>0.58**</td>
<td>0.39**</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Parental involvement</td>
<td>0.15**</td>
<td>0.19**</td>
<td>0.18**</td>
<td>0.20**</td>
<td>0.22**</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Work attitude</td>
<td>0.17**</td>
<td>0.25**</td>
<td>0.18**</td>
<td>0.27**</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Pretest</td>
<td>0.68**</td>
<td>0.64**</td>
<td>0.51**</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Posttest</td>
<td>0.48**</td>
<td>0.63**</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2  Bivariate correlations between variables (n=355)

Pupils in the intervention condition scored on average higher on the posttest than their respective counterparts in the control condition. The largest difference was found in the arithmetic posttest scores of the high-ability pupils: 111.79 points in the intervention condition versus 102.90 points in the control condition. As expected, high-ability pupils scored higher than non-high-ability pupils on both posttests. Also, the differences between pretests and posttests were the largest in the intervention groups on both outcome variables.

The correlations in Table 5.2 reveal strong relations between the academic achievement measures, as well as strong relations between the pretest and the posttest. In addition, work attitude and parental involvement were related to the pupils’ academic achievement. Highability was positively related to academic achievement on the pre- and posttest and work attitude. Gender and age were not related to condition or the posttests. As recommended by Field (2013), continuous variables that correlated with the condition or outcome variable were included in the analyses of covariance; in our study, these were parental involvement and work attitude.
Table 5.3 Results of ANCOVA for academic achievement posttest scores for non-high-ability and high-ability pupils separately.

<table>
<thead>
<tr>
<th>Source</th>
<th>Non-high-ability pupils</th>
<th>High-ability pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
</tr>
<tr>
<td>Arithmetic achievement posttest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Intercept)</td>
<td>26.02</td>
<td>4.99</td>
</tr>
<tr>
<td>Pretest</td>
<td>.73</td>
<td>.06</td>
</tr>
<tr>
<td>Work attitude</td>
<td>2.15</td>
<td>.67</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>1.52</td>
<td>.75</td>
</tr>
<tr>
<td>Condition</td>
<td>2.39</td>
<td>1.08</td>
</tr>
<tr>
<td>Language achievement posttest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Intercept)</td>
<td>23.56</td>
<td>4.46</td>
</tr>
<tr>
<td>Pretest</td>
<td>.59</td>
<td>.06</td>
</tr>
<tr>
<td>Work attitude</td>
<td>2.46</td>
<td>.70</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>1.62</td>
<td>.79</td>
</tr>
<tr>
<td>Condition</td>
<td>1.05</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Note. SE = standard error. Total explained variance and sample sizes for non-high-ability pupils: $R^2 = .40$ and $n = 266$ for arithmetic; and $R^2 = .33$ and $n = 261$ for language. For high-ability pupils: $R^2 = .28$ and $n = 49$ for arithmetic; and $R^2 = .12$ and $n = 42$ for language.

Non-high-ability pupils. In the analysis of arithmetic posttest scores, the pretest significantly explained 35% of the variance, $F(1, 261) = 139.10, p < .001$. Work attitude and parental involvement were also significantly related to the posttest, $F(1, 261) = 10.27, p < .01$ and $F(1, 261) = 4.12, p < .05$, respectively. As expected, there was a significant positive effect of condition on posttest scores after controlling for the covariates, $F(1, 261) = 4.87, p < .05$. When compared to the control condition, pupils in the intervention condition scored on average 2.39 points higher on the posttest. The partial $\eta^2$ is .02, indicating that 2% of the total variance is explained by the intervention. The total amount of explained variance $R^2 = .40$. The adjusted means (see Table 5.4), controlled for the covariates, reveal that non-high-ability pupils in the intervention condition scored 89.21 points on average, while these pupils in the control condition only scored 86.83 points. The effect of condition on achievement was small, with Cohen’s $d = 0.27$ (J. Cohen, 1988).

For the language scores, the pretest was a significant covariate for the language posttest scores, $F(1, 256) = 89.20, p < .001$, explaining 26% of the variance. Work attitude explained 5% ($F(1, 256) = 12.24, p < .001$) and parental involvement explained 2% ($F(1, 256) = 4.20, p < .05$) of variance in language posttest scores. Contrary to our expectations, condition did not significantly explain variance of the posttest scores, after controlling for the covariates.

Analyses of Covariance
Of primary interest in the analyses were (a) the condition effects, and (b) the comparison of these effect sizes for the non-high-ability and high-ability pupils subsamples. Per subsample, covariance analyses were computed on the arithmetic and language achievement posttest scores (see Table 5.3). The adjusted posttest scores as a function of condition are shown in Table 5.4.
Table 5.4 Adjusted means for posttests of arithmetic and language achievement, controlled for covariates.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Non-high-ability pupils</th>
<th></th>
<th>High-ability pupils</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted M</td>
<td>SE</td>
<td>CI</td>
<td>Adjusted M</td>
</tr>
<tr>
<td>Arithmetic achievement posttest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>89.21</td>
<td>0.81</td>
<td>87.61–90.81</td>
<td>113.00</td>
</tr>
<tr>
<td>Control</td>
<td>86.83</td>
<td>0.71</td>
<td>85.43–88.22</td>
<td>102.14</td>
</tr>
<tr>
<td>Language achievement posttest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>70.69</td>
<td>0.88</td>
<td>68.96–72.42</td>
<td>86.23</td>
</tr>
<tr>
<td>Control</td>
<td>69.64</td>
<td>0.77</td>
<td>68.13–71.15</td>
<td>81.94</td>
</tr>
</tbody>
</table>

Note. Adjusted M = adjusted mean controlled for covariates: pretest, work attitude, and parental involvement. SE = standard error, CI = 95% confidence interval.

Discussion

Findings
In this study, the effects of integrated in-school intervention for teachers’ differentiation practices on early primary school pupils’ academic outcomes was confirmed. The intervention included screening the pupils’ school-entry characteristics, matching their needs with curricular activities, and implementing a school-wide approach to differentiation. Results showed that the intervention – compared to a control condition – positively influenced the arithmetic achievement $(F [1, 256] = .81, p > .05)$. The total amount of explained variance $R^2 = .33$. Also, the adjusted means (see Table 5.4), controlled for the covariates, did not substantially differ between the intervention and control condition. Non-high-ability pupils in the intervention condition scored 70.69 points, versus 69.64 points in the control condition. In sum, the intervention had a small positive effect on the arithmetic achievement of non-high-ability pupils, but no effect was found on language achievement (research question a).

High-ability pupils. For high-ability pupils, the arithmetic achievement data showed that only one covariate significantly related to the pupils’ posttest scores: the pretest $(F [1, 44] = 11.37, p < .001)$. As expected, condition significantly affected the posttest scores $(F [1, 44] = 6.50, p < .001)$. The partial $\eta^2$ was .13, indicating that 13% of the total variance is explained by the intervention. The total amount of explained variance $R^2 = .28$. High-ability pupils in the intervention condition scored 10.86 points higher on average than high-ability pupils in the control condition, resulting in adjusted means of 113.00 versus 102.14 points, respectively. Here, the effect of condition on achievement was large, with a Cohen’s $d$ of 0.80. This effect was not found in the language achievement of high-ability pupils. None of the covariates were significantly related to posttest scores; neither did condition explain variance in the scores.

In sum, the intervention positively influenced the arithmetic achievement and this effect was stronger for high-ability pupils than for non-high-ability pupils (research question b). This indicates that the intervention enhanced the learning of all pupils, and in particular the learning of high-ability pupils.
ment of early primary school pupils, and that this effect was stronger for high-ability pupils than for non-high-ability pupils. No effects were found in the intervention on language achievement.

The fact that only the arithmetic achievement was enhanced, may be due to the intervention fidelity being higher in the schools for the differentiated arithmetic curriculum than for the language curriculum (see Chapter 3). Thus, teachers may have been more aware of the structure and levels of the arithmetic curriculum. A clear content- and difficulty level-based organisation of the learning materials on the shelves in the cabinets may result in better strategies for level-appropriate arithmetic learning.

The intervention makes clear that the learning of all early primary school pupils, including high-ability pupils, can be enhanced without too much extra effort and independent of their entry level, by matching their needs with appropriate learning activities (see also Hertberg-Davis, 2009). High-ability pupils benefitted from the intervention as well. This is important, since traditional differentiation practices in the Netherlands have been aimed at lower-achieving pupils, thus putting the high-ability pupils at a disadvantage (De Boer et al., 2013; Doolaard & Harms, 2013). This intervention could be the first step in solving Gagné’s age/grade lockstep (Gagné, 2011). Higher level learning activities become available for younger pupils, who can benefit from learning at their own level while being among age peers. To continue the positive results found in this study, it is important to integrate the intervention components in subsequent grades in primary education as well.

**Limitations**

Several limitations must be considered when interpreting the present results. A first limitation concerns the number of pupils in this study. A larger number of pupils and schools took part in the intervention, but only the current sample could be used in this effect study because only these schools used the arithmetic and language tests with their early primary school pupils. In addition, six high-ability pupils and one non-high-ability pupil scored the highest level possible on the arithmetic posttest. For language, the number was four pupils in each ability group. Thus, ceiling effects may have decreased the power to detect effects.

A second limitation is the lack of observations in the classrooms. Although the intervention implementation was studied in Chapters 3 and 4, observation data of differentiation practices is lacking. The results could therefore only be credited to the integrated implementation of the intervention components in the early primary schools, not to teachers’ actual differentiation practices concerning specific pupils. We recommend the inclusion of teacher observations in future research to more clearly measure the improvement in differentiation practices.

A final limitation concerns the intervention fidelity. As the fidelity differed between schools, it would have been interesting to take these differences into account. Effects of interventions can be associated with the degree to which schools and teachers accept the proposed innovations and implement them (Fullan, 2007), because change is “a process, not an event” (p. 68). Fidelity was only measured in the intervention schools, however. The focus of this study was the comparison between the intervention and control conditions. Further research – with a larger
Implications

Most interventions for pupils at the higher end of the spectrum start halfway through primary school, when they have already started underachieving, thus neglecting the relevance of early childhood education for development (Cabell, DeCoster, LoCasale-Crouch, Hamre, & Pianta, 2013; McClelland, Acock, & Morrison, 2006). This intervention started in early primary school, allowing pupils to learn at their own ability level starting with their first day. This may prevent high-ability pupils from underachievement and concomitant cognitive and social problems later on in their schooling, provided that teachers’ differentiation practices are adequately organised in subsequent grades of primary education.

Although differentiation based upon individual needs can be a complex and time-consuming skill for teachers to carry out (Deunk & Doolaard, 2013; Doolaard & Harms, 2013; Van de Grift, 2010), this study shows that it is essential that they develop this skill to best stimulate each pupil’s development. Changing teacher practice requires focussed attention; this is because, of all the school factors that influence pupil outcomes, the teacher is the most important (Hattie, 2009). Successful adoption and implementation of reform begins at the individual (i.e., teacher) level. The study described in Chapter 3 found that one year was too short a period to fully implement the intervention in schools, especially the school-wide policy aspect. Although teachers may have clear ideas about what they should do (because they have been informed), this is not always visible in their differentiation practices; this result was also found by Wen, Elicker, and McMullen (2011). Still, these results indicate that the intervention, even when suboptimally implemented, enhanced pupil development. Thus, matching pupil levels and needs with appropriate learning activities is highly relevant for all early primary school pupils’ learning, and should be stimulated in educational practice.
Chapter 6
General Discussion
This dissertation presented *Excel Kwadraat* (Excel Squared), an educational intervention aimed at facilitating early primary school teachers’ differentiation practices so as to better anticipate differences between pupils including high-ability pupils. Over a 2-year period, 37 primary schools in the Netherlands implemented the intervention. Researchers supported the schools in developing or implementing three ‘critical’ intervention components: parent and teacher screening of the school-entry characteristics of all incoming 4-year-old pupils within two months of admission; differentiated curricula for arithmetic and language with learning materials ordered on difficulty level; and a school-wide policy for differentiation focusing on how to support high-ability pupils (see Chapter 2). By offering such differentiated curricula, pupils capable of self-regulating their learning are both stimulated and enabled to do so, whereas pupils who need more teacher assistance can receive this support.

The expectation was that these components would benefit the academic learning or achievement of all pupils, as they could learn more optimally within their zones of proximal development in a school-wide organisation of differentiated learning (cf. Mooij, 2007a, 2013; Tomlinson, 2005; Vygotsky, 1978). Also, the strongest effects were expected for the high-ability pupils, because their learning opportunities in traditional education are generally less suited than those of non-high-ability pupils (see Introduction and Chapter 1). The quantitative results in Chapter 5 showed that *Excel Kwadraat* indeed positively influenced the academic achievement of early primary school pupils. More precisely, a small positive effect was found in the intervention schools on the achievement development of non-high-ability pupils in the arithmetic domain, and a large effect for high-ability pupils. No intervention effects were found in the language domain. Mitigating factor here was probably the degree of implementation of the intervention (i.e., the fidelity of the intervention; see the following paragraphs) with more complete implementation in arithmetic than in language. In conclusion, *Excel Kwadraat* benefitted the arithmetic achievement of both high-ability and non-high-ability pupils.

Changing teacher practice as aimed in *Excel Kwadraat* is not an easy task. Chapters 3 and 4 showed that teachers and schools did not easily adopt *Excel Kwadraat*. The intervention fidelity, that is, the level of the implementation of an intervention as designed or intended (O’Donnell, 2008), differed considerably between schools. The study in Chapter 3 identified a number of factors that seemed to function as stimulation or barrier for the implementation of *Excel Kwadraat*. Barriers for implementation included the perceived complexity of the intervention, a lack of communication between teachers and principal, an interfering or reluctant school board, an absent principal, and certain beliefs, low motivation and little time of teachers. Factors that appeared to contribute to the successful implementation of *Excel Kwadraat* were teachers’ experience of a strong need for educational change for high-ability pupils, pressure from parents, and
Teaching High-Ability Pupils in Early Primary School

An actively involved principal. These factors could vary greatly per school, and schools differed also in how they dealt with these factors. Some schools showed a culture of caution (Le Fevre, 2014), others, even while demonstrating uncertainty, deliberately took the challenge. In the latter case, the teachers and principal supported each other, as there was a strong will to change and to support high-ability pupils at their own level.

With respect to the implementation of the components, the intervention fidelity as estimated by the researchers was the strongest for screening school-entry characteristics, and the weakest for development of a policy protocol for whole-school differentiation. Furthermore, the development of the differentiated curricula was stronger for arithmetic than for language. As aimed for, in schools with higher intervention fidelity, teachers improved their self-reported differentiation practices to a higher degree, particularly in relation to the initial level determination and progress monitoring of pupils (see Chapter 4). The fact that only the arithmetic achievement was enhanced may, thus, be due to the intervention fidelity being higher for the differentiated arithmetic curriculum than for the language curriculum.

<table>
<thead>
<tr>
<th>Personal variables (school-entry)</th>
<th>Environmental variables (home, school)</th>
<th>Personal variables (primary school)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic base</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Identity dimensions:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Social-communicative level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- General cognitive level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Language proficiency level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Pre-arithmetic level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Emotional-expressive level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sensory-motor level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- (Academic) motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-regulation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Home variables:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Parents’ stimulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Parents’ education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Primary school variables:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School level:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Integrated curricula</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Integrated enrichment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class level:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Teacher’s differentiation skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Teacher’s management skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mean achievement/behaviour</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pupil level:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Differentiation in instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Differentiation in content complexity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Identity dimensions:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Social-communicative level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- General cognitive level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Language proficiency level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Pre-arithmetic level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Emotional-expressive level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sensory-motor level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- (Academic) motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-regulation</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 6.1** Environmental home and primary school influences on a pupil’s development (simplified version of 3-level model, Mooij 2013).

Revisiting the 3-level model (see Figure 6.1) from Chapter 1, *Excel Kwadraat* particularly focused on the teacher-independent educational characteristics that are relevant for high-ability pupils’
academic development. The screening of school-entry characteristics (i.e., identity dimensions, see Figure 6.1) gives schools an indication for which learning activities are appropriate. By developing differentiated curricula, in which learning activities of different grades including enrichment activities are integrated, schools can provide all their pupils, including those of high-ability, with uninterrupted learning paths. This dissertation showed that schools can be successfully supported in doing this, which resulted in positive effects on high-ability pupils’ academic achievement, while at the same time also benefiting the non-high-ability pupils’ achievement (see Figure 6.1). Thus, by improving teacher-independent educational characteristics, Excel Kwadraat successfully supports pupils in more fully realising their learning potential.

Methodological Considerations

A number of methodological considerations needs to be taken into account when interpreting the findings. The aim of the Onderwijs Bewijs (Education Evidence) research programme, of which Excel Kwadraat is part, is to provide evidence-based knowledge using randomised experimental designs also known as randomised controlled trials (RCTs). With respect to gaining scientific evidence, RCTs are seen as the ‘golden standard’. In practice, however, realising experimental designs including intervention implementations is difficult. As Chapters 3 and 4 showed, schools differed in how they perceived and implemented the intervention. It is therefore more interesting and relevant to study how the particular characteristics of each school can be used or taken into account when implementing an intervention. In this dissertation, we took the approach to fit Excel Kwadraat – as much as possible – in each school’s unique way of “how we do school” (Tomlinson et al., 2003, p. 125). To this end, a design-based research approach (DBR) was used, wherein research is situated and refined in the educational context (Anderson & Shattuck, 2012; Barab & Squire, 2004). The scientific evidence in this study is, thus, more complex to interpret than it looks at first sight.

Some limitations concern the representativeness of the sample of pupils and schools. For assessing pupil outcomes, only a small part of the total sample of pupils could be used due to the limited use of achievement tests in the schools. Some schools, for example, did not administer tests to their youngest pupils because they felt that these tests were harmful for them or that the tests did not properly assess the pupil’s achievement level. Therefore, the analyses in Chapter 5 included only a limited number of pupils. Furthermore, the sample of schools was taken from the researchers’ network of schools, all with an interest in better supporting high-ability pupils. The sample may thus be not completely representative of Dutch primary schools and may be somewhat biased. Moreover, the schools received financial support for implementing the components, which may have influenced their (extrinsic) motivation to sign-up for participation. It seems plausible that realising comparable changes in primary schools involved in a representative, non-self-selected sample will be more difficult (cf. Shadish, Cook, & Campbell, 2002).
Another limitation concerns the operationalisation of high-ability. At the start of *Excel Kwadraat*, the outcomes of one paper-and-pencil test determined the ability (i.e., high-ability vs. non-high-ability). There are some disadvantages associated with this operationalisation. First, the outcomes of young pupils’ tests are only valid for a short period of time, as these pupils may develop rapidly and abruptly (Koerhuis, 2010; Lansink & Hemker, 2010). Also, test outcomes can be distorted due to possible lapses in concentration of the pupil at the moment of taking the test, and/or differences in the language level between pupils. The use of multiple assessment instruments including screening and observation could provide a way to better determine high-ability (cf. Brown et al., 2005). In this research, the screening by parents and teachers was part of the intervention and therefore implemented in the experimental schools only and not in the control schools. Still, even when the operationalisation could include the school-entry screening results, the predictive value of high-ability for high achievement in such young pupils will always be less reliable than for older pupils, because, as stated, such cognitive measurements in young pupils are less reliable (test-retest reliability).

Furthermore, the use of a self-reporting questionnaire for teachers’ differentiation practices which was not validated, is an important limitation. Although a theoretical framework developed by Mooij (2007a) formed the basis for the questions, the questionnaire did not undergo systematic validation by, for example, consulting content experts, testing pilot versions, and correlating outcomes with classroom observations or other teacher questionnaires. Furthermore, although research showed that teachers could assess their own teaching quite well (Desimone, Smith, & Frisvold, 2010), other research shows that teachers may be sensitive to socially desirable answers (Wen, Elicker, & McMullen, 2011). The improvements in pupil achievement could therefore in this research not be credited to the actual, teacher-dependent differentiation practices, but only to the teacher-independent educational characteristics (i.e., the integrated implementation of the intervention components) that are central in *Excel Kwadraat*.

Finally, some methodological considerations concern the intervention fidelity measures. First, differences occurred between schools in their working according to the intervention components before the intervention started. Thus, we do not know if some of the effects found can be solely attributed to the intervention. A few schools, for example, already worked with differentiated arithmetic and language curricula in the early grades. As we did not systematically assess to what extent schools implemented or developed the components before participation, it was not possible to take the starting level of working according these components into account in the analyses. Further, as the researchers functioned as trainers/deliverers of the intervention too, the critical distance required for estimating the intervention fidelity per school and for evaluating results could have been suboptimal. In DBR, both of these methodological considerations are actually great strengths of the research design (Anderson & Shattuck, 2012), reflecting the ecological validity of the research in everyday practice in early primary school. Thus, being limitations for attributing effects to the intervention on the one hand (e.g. evidence-based), at the same time these considerations emphasise the validity of the intervention taking into account each school’s unique characteristics.
What *Excel Kwadraat* is or is not

When discussing *Excel Kwadraat* with teachers or researchers, some questions are raised time and again that relate to a number of misconceptions, which will shortly be explained here. Implementing *Excel Kwadraat* does not mean that pupils in early primary school are not allowed to play anymore, or that the preparatory grades of primary school become learning factories in which the one and only focus is on the academic achievement without taking socioemotional development into account. In *Excel Kwadraat*, pupils are stimulated to play and learn, just as in other schools. The difference is that with *Excel Kwadraat*, the learning environment is prepared for offering differentiated learning activities when opportune, and working with this prepared learning environment is agreed upon in and is a part of school policy. Teachers or pupils are then able to choose learning activities that are appropriate, and these learning activities are preferably offered to them in small groups of pupils, to prevent isolation and stigmatisation and to save time for teachers. That does not mean that high-ability pupils may do whatever they want and never have to do individual or large-group activities that the teacher has planned or is carrying out. Some activities may be compulsory, as long as the level required for these activities is not below their own functioning. Choosing their own learning activities is important as well, to allow their self-regulated learning capabilities to guide and motivate their own learning (see Figure 6.1).

Further, *Excel Kwadraat* does not mean that new 4-year-old pupils have to perform difficult learning activities immediately. In the prepared learning environment, pupils are allowed the time to get used to the new, school-based situation, just as in other schools. The difference is that a high-ability pupil does not have to wait until the teacher offers him or her appropriate learning activities, but that the pupil can choose interesting, difficult activities from the cabinets him- or herself from day 1. Also, by screening all incoming young pupils (see Figure 6.1), the teacher knows at an earlier stage where each pupil stands compared to the other pupils, and can adapt the offering of learning activities if and when necessary. This is important, as the socioemotional development can be hampered when the pupil cannot fully cognitively develop (cf. Mooij, 2013). The socioemotional development, thus, is not forgotten but is taken into account from the first day on.

Finally, *Excel Kwadraat* neither encourages nor requires the use of more paper-and-pencil tests in early primary school. Continuous monitoring of progress is required to adapt the teaching, but paper-and-pencil tests are only one way to study progress. Instead, or in addition, teachers could observe their pupils when they play or perform specific learning tasks to assess their progress, as recommended in *Excel Kwadraat*. 
Implications for Educational Practice and Future Research

The research presented in this dissertation has important implications for educational practice and future research, which can be related to the intervention itself, educational change in schools, teachers and teacher education, educational policy in general, and research designs.

**Intervention Excel Kwadraat**

*Excel Kwadraat* represents only the first step for schools in optimally supporting high-ability pupils’ learning and development. It focuses on the teacher-independent educational characteristics that influence these pupils’ learning, such as the curricula offered and the educational policy in school. By preparing the curricula, including regular and enrichment activities, and determining learning goals for high-ability pupils, offering appropriate learning activities becomes less teacher-dependent and more self-regulated and pupil-centred (see Figure 6.1). This corresponds well with the direction of the Dutch Inspectorate of Education as discussed in Chapter 1 (Inspectie van het Onderwijs, 2015b). Even with prepared differentiated curricula, however, teachers will have to look for new ways to teach the high-ability pupil, in particular when the pupil is highly gifted or has special needs. In this respect, the educational system is never complete, and this requires both the school and the teachers to continue to search for the best possible teaching for and learning of each pupil.

This dissertation shows that high-ability pupils can benefit more from the early primary school years when appropriate learning activities are offered than is usual in regular education. In the current research, the teachers took the first step, that is, they screened the pupils’ school-entry characteristics and ordered the available learning activities into adequate instructional lines, including activities from higher grades and stimulating and challenging enrichment activities. Further research should more specifically focus on how the estimations of the school-entry characteristics of each incoming pupil in primary school could be used as starting point to realise more appropriate placement of the pupil in the main instructional lines of the differentiated curricula, including appropriate content complexity and instruction (see Figure 6.1). In this respect, school-entry screening results are only one type of indicator and should not be taken as absolute. They can and should be complemented with assessments, observations, etc. By doing this, pupils can be more accurately offered learning activities that match their zones of proximal development within 1–2 months after admission, with possibly even greater benefits of *Excel Kwadraat* on their learning and development; both cognitive and socioemotional (see Figure 6.1).

For continuing support of high-ability pupils’ learning, it is crucial that *Excel Kwadraat* is not limited to the early years of primary school. Further research should focus on how grades 3–8 in primary schools could also be included in *Excel Kwadraat* and can differentiate their curricula in order to make individual learning paths possible. This was one of the major issues in the support sessions with the teachers and the schools: what to do with a high-ability pupil who is offered reading or writing activities in early primary school when he or she enters third grade? By then, the pupil may master the reading and writing skills that are central in third grade, and will be
ready for fourth or fifth grade content which may not be offered to him or her. In this respect, some differences between the preparatory grades (i.e., 1–2) and higher grades (i.e., 3–8) of primary school can be relevant, such as the more structured learning organisation, the stronger reliance on text books and learning methods, the larger number of plenary lessons etc. One way to integrate differentiated curricula in the schools is to work with subject ateliers, that is when a subject such as arithmetic is scheduled at the same moment in all classes. Pupils can then visit the classroom where the level of arithmetic being taught corresponds with their own level (i.e., at, above or below their chronologic age level), and return afterwards to their own age-appropriate class. To provide continuing, uninterrupted learning paths for high-ability pupils, it is important to study subject ateliers and other ways to integrate the differentiated curricula into these higher grades with their stronger structured organisation.

In this respect, ICT has the potential to support the educational differentiation needed for pupils. The current ICT-based pupil-monitoring systems for schools are organised according to pupils’ age and grade (Nieveen & Kuiper, 2012) and therefore not 1:1 suitable for more differentiated learning, independent of age and grade as proposed in Excel Kwadraat. Initially, an ICT prototype was introduced in the intervention schools to facilitate the development and implementation of the differentiated curricula, but soon it became clear that this did not work as hoped (see Chapter 2). Teachers and principals first wanted to have the components of the intervention clarified in the training sessions which took more time than expected. Moreover, teachers lacked the time to master the integration of learning activities into the ICT prototype. Therefore, it was decided to reduce the attention on ICT and focus instead on the critical components of the intervention. Further research could focus on improving the efficiency of the ICT prototype, and the best ways to use and integrate this programme in everyday teaching practice.

**Educational Change in Schools**

Implementing differentiated curricula, including instructional adaptations and academic progress monitoring, is not a minor transition (Tomlinson et al., 2003). This dissertation once again stresses the importance of taking teacher beliefs into account when schools want to implement differentiated curricula in their teaching. The belief that high-ability pupils do not need to receive education at their own level still existed (cf. De Boer, Minnaert, & Kamphof, 2013), even though most participating schools voluntarily participated in this research and were willing to better support their high-ability pupils. It is important that these beliefs are identified before participation and are anticipated by the deliverers of a training or intervention as much as possible, because if the teachers do not want to change, the change will not succeed. Clear communication from the start – which also includes insuring that the message as given is the same as the message as received – can ensure that teachers feel and remain motivated and perceive that they and their problems are taken seriously. Here, an important task is identified for the principal. By providing support where teachers need it, and facilitating time and collaboration among teachers, the principal is crucial in taking care of a culture of progress and development (see Chapter 3).
In addition, it seems that long-term professional development is required to fully work according the components of Excel Kwadraat. To this end, collaboration between schools is encouraged. After the intervention ended, some schools that participated in this study decided to collectively continue improving their differentiation practices in early primary school and higher grades. Ongoing support and profiting from the experiences of other schools would give these schools the opportunity to further develop their teaching practices for diverse types of pupils. In this respect, the use of a community of practice approach (Lave & Wenger, 1991; Sheridan, Edwards, Marvin, & Knoche, 2009) is recommended, wherein participants can share and discuss ideas with colleagues.

**Teachers and Teacher Education**

Excel Kwadraat focused primarily on improving the teacher-independent characteristics relevant for high-ability pupils' learning, such as developing differentiated curricula and an educational policy for differentiation. Optimal differentiation in instruction and curricula between pupils in a mixed-ability classroom, however, is much more than that, and asks a lot from teachers (cf. Hertberg-Davis, 2009). Teachers need to be able to identify learning needs of all pupils and respond to these differences with learning experiences that match these needs. Although the components of Excel Kwadraat are requirements for optimal differentiation, in the end teachers’ differentiation skills (see Figure 6.1) are essential for providing adequate activities for each pupil in class. A complicating factor is the high complexity of the differentiation skill, which can only be learned when the basic skills such as providing clear and structured instruction, are acquired by teachers in their studies (Van de Grift, 2010).

A next research step, thus, could focus on how teachers could best be taught (i.e., in pre-service) and trained (i.e., in in-service) in improving their differentiation skills. Here, pre-service and in-service teacher education can play an important role by providing teachers with knowledge about the characteristics and needs of high-ability pupils and by more intensive training in the acquisition of differentiation skills. Currently, the Ministry of Education, Culture and Science stimulates research that aims at helping pre-service and in-service teachers with more optimally differentiating between their pupils (Dekker, 2015). The universities of Leiden and Groningen are currently working together with teacher education institutes and schools to develop a practical method for differentiation within the classroom which aims at benefiting both pre-service and in-service teachers’ differentiation skills. The research will deliver a toolbox with domain-specific applications and examples of classroom differentiation (outcomes are expected 2015–2017). By integrating a practical training method for teachers’ differentiation skills in *Excel Kwadraat*, the intervention can improve both the requirements for and the skill of differentiation between pupils, to more optimally serve the pupils on their own level.

**Educational Policy**

Further, schools need to be supported in making their teaching for high-ability pupils more teacher-independent. Currently, the Dutch Inspectorate of Education stimulates schools to develop teaching that is less teacher dependent, and one of the features they stimulate is the
development of clear policy how to support high-ability pupils similar to one of the components of Excel Kwadraat. When the policy concerning level determination and offering appropriate learning activities for high-ability pupils is clear, both teachers and parents know where they stand and in this way, a developed and implemented policy may help all pupils in fully realising their potential.

Furthermore, when high-ability pupils are able to work in their own pace on their own learning path, it is possible that they finish primary education at an earlier age than their age peers. Schools need to be organised in a more flexible manner in order to anticipate different learning paths for different learners. Currently, the Ministry of Education, Culture and Science is working along this direction (Dekker, 2015). One current example is secondary schools that are experimenting with the possibility of taking exams in different levels for different subjects; thus breaking with the traditional year-based curriculum. In this way, pupils who are advanced in subjects can take their final exams in the subject earlier. These pilots support the idea that pupils can follow different learning paths. Further research into initiatives for more flexible schooling systems is encouraged. In this respect, the outcomes (expected end 2015) of an advice from the Educational Council of the Netherlands can be relevant. The Council has been asked to deliver an advice concerning the possibilities for greater flexibility of assessment tests and exams in primary and secondary education, and to take the consequences of individual learning paths into account for admissions to schools.

Research Designs
It is remarkable that “to explore (...) which ways contribute to the identification and development of excellence/talent” (Ministerie van Onderwijs, Cultuur en Wetenschap, 2010, p.15), the use of randomised experiments was mandatory in the Onderwijs Bewijs research programme. This research aim will usually require the design, development and/or implementation of ‘a way’ (i.e., an intervention) in a practice (i.e., a school). For this type of research, the use of design-based research and design experiments are generally more suitable (Cobb, Confrey, diSessa, Lehrer, & Schuble, 2003), as it allows the researchers to collaborate with teachers in the designing, testing, and refining of an intervention in a natural setting. An important advantage of this in-service development is the opportunity to evaluate the school relevance, or ecological validity, of the intervention. Therefore, in-school development and implementation is recommended to study the optimal conditions for high-ability and non-high-ability pupils’ learning and development.

In this respect, the 3-level model (see Figure 6.1) provides good starting points for further research. In addition to the cognitive or academic development, research of pupils’ socioemotional development is encouraged. In the home context, research could focus on how to improve the parental stimulation for the pupils’ developments in the different identity dimensions. In the school context, the variables at the pupil and class level need more in-depth investigation, as previously argued. For example, a series of class observations in the research design can gain more information about teachers’ every day differentiation practice; what it is and how it develops. When data is available on the differentiation practices of teachers, it could be used to
study the effects of this practice on pupils' learning and development. This data will validate and complement the findings from the self-reporting questionnaire.

**Conclusion**

This dissertation showed that *Excel Kwadraat* can successfully support schools in their teaching for high-ability early primary school pupils. By implementing a screening of school-entry characteristics for all incoming pupils, developing differentiated curricula of regular and enrichment learning activities, and developing a school-wide policy for differentiation in relation to high-ability pupils, the learning activities can be better matched with the levels and needs of individual pupils. This was confirmed by the greater academic achievements of high-ability pupils in *Excel Kwadraat* schools compared to regular schools. Interestingly, the non-high-ability pupils benefitted from the intervention as well. As the results give rise to improving the implementation of the intervention, further in-depth research of promoting relevant school context variables for high-ability pupils' learning and development is encouraged.
Appendix

An appendix with more information about the intervention *Excel Kwadraat*, the fidelity rubrics, and the questionnaires is available digitally via [dspace.ou.nl](http://dspace.ou.nl).
References


References

Hertberg-Davis, H. (2009). Myth 7: Differentiation in the regular classroom is equivalent to gifted programs and is sufficient: Classroom teachers have the time, the skill, and the will to differentiate adequately. Gifted Child Quarterly, 53, 251-253. doi: 10.1177/0016986209346927
Inspectie van het Onderwijs (2015b). Hoe gaan we om met onze best presterende leerlingen? [How do we handle our best achieving students?]. Utrecht, the Netherlands: Author.
Teaching High-Ability Pupils in Early Primary School


Lansink, N., & Hemker, B. (2010). Wetenschappelijke Verantwoording van de toetsen Taal voor kleuters voor groep 1 en 2 uit het LOVS. [Validation of the LOVS tests Language for kindergarten pupils]. Arnhem, the Netherlands: CITO.


Teaching High-Ability Pupils in Early Primary School


Oberon (2013). Opbrengstgericht werken bij kleuters [Achievement oriented education for young pupils]. Utrecht, the Netherlands: Author.


Teaching High-Ability Pupils in Early Primary School


Summary

Learning new knowledge and acquiring new skills requires pupils to learn at a pace and through a type of activity that matches their learning needs (Vygotsky, 1978). Teaching, therefore, should be attuned to the unique abilities and needs of the pupils in the classroom. However, pupils in one classroom differ in many aspects. While traditionally the Dutch government paid much attention to how teaching could be better differentiated for those pupils who lag behind others in cognitive or academic aspect, the more advanced or high-ability pupils in the Netherlands have been neglected for a long time. Since the turn of the century, however, it became clear that the achievement level attained by many high-ability pupils in school does not reach the level that might be predicted based on their abilities. A number of international comparisons of pupil achievement showed that Dutch education does very well in bringing lower performing pupils up to a basic level, but struggles with getting high-ability pupils to excel. At the same time, the Educational Council reported that 10–18% of the primary school pupils underachieved, and this percentage was much higher for high-ability or gifted pupils (Onderwijsraad, 2007).

The Dutch government realised that the schools were not fulfilling the needs of pupils who were more advanced than their age peers. To remedy this, the Ministry of Education, Culture and Science launched new research initiatives aimed at stimulating the learning of these pupils, including the funding of a research programme Onderwijs Bewijs (Education Evidence). This programme aimed to promote the development of evidence-based innovations in education in a number of topics, including giftedness and excellence. By funding this programme, the government hoped to gain knowledge about what enables the successful early identification of excellent pupils (best 10% compared to age peers) and the realisation of their full potential.

In this dissertation, one of the funded research projects on cognitively excellent pupils is studied. Central to this project is the development and implementation of an intervention called Excel Kwadraat (Excel Squared) in early primary school, which aims at facilitating teachers’ differentiation practices in order to better anticipate pupil differences, including excellent or high-ability pupils. In the end, the intervention aims at enhancing the academic achievement of both high-ability and non-high-ability pupils. During the school year 2011/2012, 37 Dutch primary schools were randomly assigned to either an intervention or a control condition. In 2012/2013, the initial control-condition schools implemented Excel Kwadraat as well. In this way, all schools participated in Excel Kwadraat while the research benefits from a control group. The central question in this thesis is: Does Excel Kwadraat, compared with the regular education that was given in the control-condition schools, positively affect high-ability pupils’ academic achievement?
Teaching High-Ability Pupils in Early Primary School

To answer this question, a number of studies investigate the current teaching practices for high-ability pupils, and the development, implementation, and effects of *Excel Kwadraat*.

Chapter 1 presents a literature study which explores to what extent the current teaching practices in the Netherlands support high-ability pupils’ learning. It focuses on regular primary education, as underachievement of high-ability pupils generally seems to start in this early educational context (Mooij & Driessen, 2008). This chapter introduces a simplified version of a 3-level model originally developed by Mooij (2013) as theoretical framework, containing relevant home and school variables which may influence a pupil’s development. Based on recent information from the Dutch Inspectorate of Education and others, the chapter continues by evaluating the current teaching practices using the school-context variables from the model. A number of shortcomings turn up including, among others, the strong teacher-dependence in offering appropriate learning activities and the lack of educational goals for enrichment or extracurricular learning activities. Furthermore, the curricula lack integration of learning activities for high-ability pupils, with activities usually being offered on an *ad hoc* basis. The chapter ends with new directions for better integrated teaching of high-ability pupils in regular education, focussing on pupil assessment and progress monitoring, school-wide differentiated curricula, and teachers’ differentiation skills.

Following these directions, Chapter 2 sketches the theoretical framework for and development of *Excel Kwadraat*. The theoretical framework presents a number of pedagogic-didactic, organisational, and ICT guidelines that, when implemented, are expected to enhance differentiated, self-regulated playing and learning for each pupil – including the high-ability pupil – in primary school. The main idea is that instruction and curricula should be adapted to the levels and needs of individual pupils in the classroom (see Mooij, 2007a; Tomlinson, 2005). However, in practice, teachers often do not have a clear picture of the levels at which their pupils function, which goes especially for high-ability pupils. Another problem is that the cognitive levels required for specific curricular learning activities are often unknown to teachers, resulting in a misfit between pupils’ learning needs and learning activities, in particular for high-ability pupils. To overcome these problems, the chapter describes the development of the intervention *Excel Kwadraat*, which supports schools to use or develop three ‘critical components’.

The first component is the screening of school-entry characteristics of all incoming 4-year-old pupils. This component is based on the assumption that teachers need knowledge of the structure and levels of the curriculum in order to match pupils’ levels and needs with appropriate differentiation in the curriculum, and that a screening would help teachers achieve this. The screening takes the form of a 29 item questionnaire for parents and teachers in which they estimate the child’s developmental levels in seven areas.

Second, schools develop a framework for matching the learning materials available in their classrooms with the curriculum learning goals for arithmetic and language (i.e., Dutch). This component is based on the assumption that teachers need knowledge of the structure and levels of the curriculum in order to match pupils’ levels and needs to appropriate curricular learning activities. To this end, teachers arrange the materials in the classroom cabinets according to the ability levels and domains in the framework. Such prepared playing-learning situations
enable small groups or individual pupils to use materials independent of their age.

The third component is the development of a school policy protocol with information on how assessment and differentiated instruction takes place, with a focus on high-ability pupils. This component is based on the assumption that a structured, preventive approach provides guidance within the team and for parents.

Chapter 2 also presents some first impressions of the implementation. To help teachers implement the components in each school, three to five support sessions were held between the schools and the researchers. Teachers within each school jointly developed or implemented the components in their own practice. Initially, the researchers introduced an ICT prototype to facilitate the development and implementation of the three components, but soon it became clear that this did not work as hoped. Due to the complexity of the intervention itself and limited teacher time for mastering the ICT prototype, the researchers reduced the attention on the prototype and chose to focus on the three components of the intervention.

Changing teacher practice is not an easy task. Effects of interventions are to a large extent determined by the degree to which schools and teachers both accept the proposed changes and implement them (Fullan, 2007). Chapter 3 presents an in-depth study of the implementation of Excel Kwadraat. It reports on the implementation process in the intervention schools in its first year, identifying crucial success factors and barriers for its implementation. To this end, this chapter introduces the concept of intervention fidelity: the degree to which the implementation of an intervention as designed or intended is achieved (O'Donnell, 2008). The study uses Fullan's (2007) framework of nine implementation factors for educational change as the basis for the analyses, consisting of characteristics of the intervention itself, local factors, and external factors. The results show that the intervention fidelity differed between schools. In general, intervention fidelity was highest for the screening of school-entry characteristics and lowest for the school-wide policy. Further, the fidelity was higher for the differentiated arithmetic curriculum than for the language curriculum. Qualitative analyses show that an experienced strong need for change, pressure from parents, an involved principal, and teacher time and motivation contributed to successful implementation. Implementation barriers were the intervention's complexity, teacher beliefs, an absent principal and low teacher motivation, which was partly due to some communication problems.

Based on the findings in Chapter 3, the researchers used a design-based research approach to slightly adapt the support sessions in the second year of the intervention, particularly to better clarify the complexity of the intervention. Although the content remained the same, the support sessions in the so-called 'improved intervention' condition (i.e., the first year's control condition) included more representations, worked examples, and assignments. Further, schools explicited agreements at each meeting to implement a specific part of the intervention before the next meeting. In addition, they presented and explained to other schools how they had tried to implement the components.

This new condition is part of the study Chapter 4 describes. As Excel Kwadraat aims to improve high-ability pupils' learning by facilitating teachers' differentiation practices, the study in Chapter 4 explores the effects of the intervention on teachers' differentiation practices.
and after the intervention, teachers reported their differentiation practices related to specific diagnostics and assessment methods, instruction and management strategies, and activities for high-ability pupils. The expectation was that schools in the improved intervention would show higher intervention fidelity, which in turn would relate to more or greater improvements in teacher-reported differentiation practices. No improvements were expected of teacher-reported differentiation practices in the control condition. This study uses a pretest-posttest cluster randomised design with three conditions: control condition (i.e., regular education), intervention (i.e., first year), and improved intervention. The results show that, as expected, the intervention fidelity in the improved intervention was higher than in the first year intervention, indicating that the adapted support sessions were helpful for schools. Further, correlations confirmed that teacher-reported differentiation practices were higher in schools where the intervention fidelity was higher. Finally, teacher-reported differentiation practices improved in both intervention conditions, but showed greater improvements in the improved intervention, particularly in relation to the initial level determination and progress monitoring of pupils. Qualitative data reveal process characteristics that reflect problems schools encountered with this intervention. This chapter shows that teachers can be supported in improving differentiation practices, but this requires intensive and long school-wide support.

Finally, Chapter 5 examines the effects of Excel Kwadraat on the academic achievement of early primary school pupils. To this end, pupils made an arithmetic and language test prior to and at the end of the intervention, and these scores were compared to those of pupils in the control condition. As the literature shows that effects of a programme like Excel Kwadraat can be different for high-ability and non-high-ability pupils, effects are calculated separately for both groups. In this study, initial high-ability is based on Gagné’s (2004) definition of giftedness: a score within the top 10% of age peers’ scores on the arithmetic pretest, the language pretest, or both. Results show that the intervention – compared to the control condition – positively influenced the arithmetic development of non-high-ability pupils (Cohen’s $d = 0.27$), with stronger effects for high-ability pupils (Cohen’s $d = 0.80$). No intervention effects were found for language development. The fact that Excel Kwadraat only improved pupils’ arithmetic achievement, may be due to the intervention fidelity being higher in the schools for the differentiated arithmetic curriculum than for the language curriculum.

In the end, the General Discussion provides an overview of the main findings of this dissertation, discusses the methodological considerations with regard to the study as well as the theoretical and practical implications, and the questions it raises for future research. Taken together, the studies presented in this dissertation provide evidence that schools can be successfully supported in developing differentiated curricula, in which learning activities of different ability including enrichment activities are integrated, with positive effects on high-ability and non-high-ability pupils’ learning. To come back to the central research question, compared to regular education, Excel Kwadraat positively affects high-ability pupils arithmetic achievement, while non-high-ability pupils benefit from the intervention as well. As the results give rise to improving the implementation of the intervention, further in-depth research is encouraged.
Samenvatting

Voor het leren van nieuwe kennis en vaardigheden is het noodzakelijk dat het leertempo en de leeractiviteiten passen bij de leerbehoeften van leerlingen (Vygotsky, 1978). Daarom zou het onderwijs afgestemd moeten worden op de unieke vaardigheden en leerbehoeften van de leerlingen in de klas. Leerlingen in één klas verschillen echter op veel gebieden van elkaar. Hoewel de Nederlandse overheid traditioneel gezien vooral aandacht had voor het beter differentiëren van onderwijs voor leerlingen die achterlieten op cognitief gebied, werden de voorlopende of excellente leerlingen in Nederland lange tijd genegeerd. Sinds het begin van de 21e eeuw werd echter duidelijk dat de schoolprestaties van veel excellente leerlingen niet het niveau haalden dat verwacht kon worden op basis van hun cognitieve vermogens. Een aantal internationaal vergelijkende studies van leerling prestaties lieten zien dat het Nederlandse onderwijs de lager presterende leerlingen goed naar een basissniveau bracht, maar meer moeite had met het laten excelleren van excellente leerlingen. Tegelijkertijd maakte de Onderwijsraad (2007) bekend dat 10–18% van de basisschoolleerlingen onderpresteerde, en dat dit percentage veel hoger lag bij excellente of hoogbegaafde leerlingen.

De Nederlandse overheid begreep dat de scholen niet voldeden aan de leerbehoeften van leerlingen die meer aankonden dan hun leeftijdgenoten. Om het leren van deze leerlingen te bevorderen kondigde het Ministerie van Onderwijs, Cultuur en Wetenschap daarom nieuwe onderzoeksinitiatieven aan, waaronder de subsidie voor het onderzoeksprogramma Onderwijs Bewijs. De bedoeling van dit programma was het ontwikkelen van evidence-based innovaties in het onderwijs met betrekking tot onder meer de thema’s hoogbegaafdheid en excellentie. Met deze subsidie hoopte de overheid kennis te verkrijgen over wat werkt in de vroege identificatie van excellente leerlingen (beste 10% vergeleken met leeftijdsgenoten) en in het optimaal benutten van hun leerpotentieel.

In deze dissertatie wordt één van de gesubsidieerde onderzoeksprojecten met betrekking tot cognitief excellente leerlingen onderzocht. In het project Excel Kwadraat staat de ontwikkeling en implementatie van een interventie in de groepen 1 en 2 van het basisonderwijs centraal. Doel van de interventie is het faciliteren van de differentiatiepraktijken van leerkrachten zodat zij beter kunnen inspelen op verschillen tussen leerlingen, waaronder ook excellente leerlingen. Uiteindelijk beoogt de interventie de schoolprestaties van zowel de excellente als de niet-excellente leerlingen te verbeteren. In schooljaar 2011/2012 werden 37 basisscholen gerandomiseerd en toegewezen aan een interventie- of controlegroep. In 2012/2013 implementeerden de oorspronkelijke controlescholen Excel Kwadraat eveneens. Door deze onderzoeksopzet konden
alle scholen uiteindelijk deelnemen aan *Excel Kwadraat*, waarbij het onderzoek tegelijkertijd profiteert van een controlegroep. De centrale vraag in deze dissertatie is: Heeft *Excel Kwadraat*, vergeleken met regulier onderwijs zoals gegeven wordt in de controlegroep, een positief effect op de schoolprestaties van excellente leerlingen? Om deze vraag te beantwoorden zijn verschillende studies opgezet die zich richten op de huidige onderwijspraktijk voor excellente leerlingen, en op de ontwikkeling, implementatie en effecten van *Excel Kwadraat*.


In aansluiting hierop schetst hoofdstuk 2 een theoretisch kader voor de ontwikkeling van *Excel Kwadraat*. Er wordt een aantal pedagogisch-didactische, organisatorische en ICT-richtlijnen gepresenteerd die het gedifferentieerd en zelfregulerend spelen en leren in de basisschool zouden bevorderen, ook voor de excellente leerlingen. Het hoofdidee is dat instructie en curricula aangepast moeten worden aan de niveaus en leerbehoeften van individuele leerlingen in de groep (zie Mooij, 2007; Tomlinson, 2005). In de praktijk blijkt echter dat leerkrachten vaak geen duidelijk beeld hebben van de niveaus waarop hun leerlingen functioneren, vooral bij excellente leerlingen. Een ander probleem is dat leerkrachten vaak niet weten welke cognitieve niveaus er precies vereist zijn voor bepaalde leeractiviteiten, wat ervoor zorgt dat leeractiviteiten niet aansluiten op de leerbehoeften, wederom in het bijzonder bij excellente leerlingen. Om deze problemen tegen te gaan, beschrijft dit hoofdstuk de ontwikkeling van de interventie *Excel Kwadraat*, waarin scholen drie ‘kritieke componenten’ gebruiken of ontwikkelen.

De eerste component betreft de screening van beginkenmerken van alle nieuwe vierjarige leerlingen. Deze component is gebaseerd op de aannames dat leerkrachten kennis nodig hebben van de cognitieve en sociale niveaus en behoeften van individuele leerlingen om goed te kunnen differentiëren in het curriculum, en dat een screening de leerkrachten hierbij zou helpen. De screening wordt aangeboden in de vorm van een 29-item vragenlijst voor ouders en leerkrachten waarin zij de ontwikkeling van de leerling op zeven gebieden schatten.
Ten tweede ontwikkelen scholen een kader voor het koppelen van de beschikbare leermaterialen in hun groepen met de leerdoelen van de reken- en taalcurricula. Deze component is gebaseerd op de aanname dat leerkrachten kennis nodig hebben van de structuur en niveaus in de curricula om de leerniveaus en -behoeften van leerlingen goed te kunnen koppelen aan curriculaire leeractiviteiten. Hiervoor ordenen leerkrachten de materialen in de kasten in de klas volgens de niveaus en domeinen uit het kader. Zulke voorbereide speel-leeromgevingen maken het mogelijk materialen te gebruiken voor kleine groepjes of individuele leerlingen onafhankelijk van hun leeftijd.

De derde component is de ontwikkeling van een beleidsprotocol per school met daarin informatie over hoe de niveaubepaling en gedifferentieerde instructie plaatsvindt, met een focus op excellente leerlingen. Deze component is gebaseerd op de aanname dat een gestructureerde, preventieve aanpak richting geeft voor het team en voor ouders.

Hoofdstuk 2 geeft daarnaast een eerste impressie van de implementatie. Per school werden drie tot vijf sessies met de onderzoekers georganiseerd om de leerkrachten te ondersteunen met de implementatie van de componenten. Leerkrachten ontwikkelden en implementeerden gezamenlijk en stapsgewijs de componenten in hun eigen praktijk. In eerste instantie introduceerden de onderzoekers ook een ICT-prototype dat de ontwikkeling en implementatie van de drie componenten zou moeten faciliteren, maar al snel werd duidelijk dat dit niet werkte zoals beoogd. Vanwege de complexiteit van de interventie en de beperkte tijd van leerkrachten voor het onder de knie krijgen van dit ICT prototype, beperkten de onderzoekers de aandacht voor het prototype en kozen om te focussen op de drie componenten van de interventie.

Het veranderen van de onderwijspraktijk is geen makkelijke taak. Effecten van interventies worden voor een groot deel bepaald door de mate waarin scholen en leerkrachten de voorgestelde veranderingen zowel accepteren als doorvoeren (Fullan, 2007). Hoofdstuk 3 presenteert een dieptestudie naar de implementatie van Excel Kwadraat. Het rapporteert over het implementatieproces in de interventiescholen in het eerste jaar, en identificeert cruciale succesfactoren en belemmeringen voor de implementatie. Hiervoor introduceert dit hoofdstuk het concept intervention fidelity, de mate waarin een implementatie van een interventie is ingevoerd zoals ontworpen of bedoeld (O'Donnell, 2008). De studie gebruikt Fullan’s (2007) kader van negen implementatiefactoren voor onderwijsverandering als basis voor de analyses, waaronder kenmerken van de interventie, lokale factoren en externe factoren. De resultaten laten zien dat de intervention fidelity verschilde tussen scholen. Over het algemeen was de intervention fidelity het hoogst voor de screening van beginkenmerken en het laagst voor het schoolbrede beleidsprotocol. Verder was de intervention fidelity voor het gedifferentieerde rekencurriculum hoger dan voor het taalcurriculum. Kwalitatieve analyses laten zien dat een ervaren sterke behoefte, druk van ouders, een betrokken directeur, en tijd en motivatie van leerkrachten bijdroegen aan een succesvolle implementatie. Belemmeringen voor de implementatie waren de complexiteit van de interventie, leerkrachtattituden, een niet-betrokken directeur en weinig motivatie onder leerkrachten, welke gedeeltelijk veroorzaakt werd door enkele communicatieproblemen.

Gebaseerd op de uitkomsten van hoofdstuk 3 gebruikten de onderzoekers een ontwerpgerichte onderzoeksaanpak (design-based-research approach) om de sessies aan te passen voor het
tweede jaar van de interventie, vooral om de complexiteit van de interventie beter uit te leggen. Hoewel de inhoud hetzelfde bleef, werden in de ‘verbeterde interventie’ conditie (oorspronkelijke controlegroep uit jaar 1) meer beeldmateriaal, uitgewerkte voorbeelden en opdrachten gebruikt in de sessies. Ook spraken scholen tijdens elke sessie af welk deel van de interventie zij voorafgaand aan de volgende sessie zouden implementeren. Daarnaast presenteerden scholen aan elkaar en legden zij uit hoe zij de componenten probeerden te implementeren.

Deze nieuwe conditie is onderdeel van de studie die in hoofdstuk 4 wordt beschreven. Aangezien *Excel Kwadraat* het leren van excellente leerlingen beoogt te verbeteren door het faciliteren van de differentiatiepraktijken van leerkrachten, onderzoekt de studie in hoofdstuk 4 de effecten van de interventie op deze differentiatiepraktijken. Voorafgaand en na afloop van de interventie rapporteerden de leerkrachten over hun differentiatiepraktijken met betrekking tot diagnostiek en toetsing, instructie- en managementstrategieën, en activiteiten voor excellente leerlingen. De verwachting was dat scholen in de verbeterde interventie hogere intervention fidelity hebben, wat zou resulteren in meer of sterkere verbeteringen in de differentiatiepraktijken zoals door leerkrachten gerapporteerd. Er werden geen verbeteringen van differentiatiepraktijken verwacht in de controlegroep. Deze studie gebruikt een pretest-posttest cluster gerandomiseerd design met drie condities: controlegroep (regulier onderwijs), interventie (eerste jaar), en verbeterde interventie. De resultaten laten zien dat, zoals verwacht, de intervention fidelity hoger was in de verbeterde interventie dan in de interventie in het eerste jaar, wat erop wijst dat de aangepaste sessies voor scholen succesvol waren. Daarnaast bevestigden correlaties dat de differentiatiepraktijken zoals door leerkrachten gerapporteerd hoger waren in scholen waar de intervention fidelity hoger was. Tot slot bleken de differentiatiepraktijken in beide interventiecondities verbeterd te zijn, maar werden de sterkste verbeteringen gevonden in de verbeterde interventie, vooral in relatie tot niveaubepaling en voortgangmonitoring van leerlingen. Qualitatieve data laten enkele problemen zien die scholen tegenkwamen bij deze interventie. Dit hoofdstuk verheldert ook dat leerkrachten ondersteund kunnen worden in het verbeteren van differentiatiepraktijken, maar dat dit intensieve en langdurige, schoolbrede steun vereist.

Hoofdstuk 5 onderzoekt uiteindelijk de effecten van *Excel Kwadraat* op de schoolprestaties van de leerlingen. Voorafgaand en aan het einde van de interventie maakten de leerlingen een reken- en taaltoets, en deze scores werden vergeleken met die van leerlingen in de controlegroep. Aangezien de literatuur laat zien dat effecten van programma’s zoals *Excel Kwadraat* verschillend kunnen zijn voor excellente en de niet-excellente leerlingen, worden effecten apart berekend voor beide groepen. In deze studie wordt de aanvankelijke excellentie vastgesteld op basis van Gagné’s (2004) definitie van hoogbegaafdheid: een score binnen de top 10% van leeftijdsgenoten op de rekentest, de taaltest, of beide. Resultaten laten zien dat de interventie – vergeleken met de controlegroep – positieve effecten had op de rekenontwikkeling van de niet-excellente leerlingen (Cohen’s $d = .27$), met sterkere effecten voor de excellente leerlingen (Cohen’s $d = .80$). De interventie had geen effecten op de taalontwikkeling. Het feit dat *Excel Kwadraat* alleen de rekenontwikkeling van de leerlingen beïnvloedde, kan komen doordat de intervention fidelity in de scholen hoger was voor het gedifferentieerde rekencurriculum dan voor het taalcurriculum.
Tot slot geeft de algemene discussie een overzicht van de belangrijkste bevindingen van deze dissertatie, bediscussieert enkele methodologische overwegingen als ook de theoretische en praktische implicaties, en stelt vragen die uit dit onderzoek voortvloeien voor toekomstig onderzoek. Samenvattend laten de studies in deze dissertatie zien dat scholen succesvol ondersteund kunnen worden in het ontwikkelen van gedifferentieerde curricula, waarin leeractiviteiten van verschillende niveaus waaronder verrijkingsmateriaal geïntegreerd worden, met positieve leereffecten voor zowel excellente als de niet-excellente leerlingen. Het antwoord op de centrale onderzoeksvraag is dus dat, in vergelijking met het reguliere onderwijs, *Excel Kwadraat* positieve effecten heeft op de rekenontwikkeling van excellente leerlingen, terwijl de niet-excellente leerlingen ook profiteren van de interventie. Aangezien de resultaten aanleiding zijn tot het verder verbeteren van de implementatie van de interventie, wordt verder diept onderzoek aangemoedigd.
Dankwoord

Het zit erop. Na vier jaren literatuur lezen, scholen bezoeken, data analyseren en artikelen schrijven is het einde van mijn promotietijd dan toch echt in zicht. Het was een ontzettend leuke, bijzondere en leerzame tijd. Ik wil graag de gelegenheid nemen om enkele personen te bedanken die hieraan bijgedragen hebben.


Paul stond zowel inhoudelijk als geografisch iets verder van het onderzoek af, maar wist met zijn scherpe blik een essentiële bijdrage te leveren aan de totstandkoming van dit proefschrift. Hij motiveerde mij en relativeerde precies op de momenten wanneer ik dat nodig had. In de soms woelige wetenschappelijke wereld bleek zijn onvoorwaardelijke steun voor mij als promovendus onmisbaar en daarvoor ben ik hem dan ook grote dank verschuldigd.

Ook ben ik nog elke dag blij met het feit dat Amber Walraven vanaf najaar 2012 als dagelijks begeleider bij het onderzoek werd betrokken. Zij gaf me de ruimte om mijn eigen pad te volgen maar stuurde me ook bij waar nodig. Maar het belangrijkste was misschien nog wel dat Amber altijd achter me stond, ook als het even tegen zat. Dankzij haar optimisme en heldere adviezen ging ik na elk overleg met frisse moed aan de slag.

Dit onderzoek was niet mogelijk geweest zonder de deelname en inspanningen van de 37 basisscholen. Het was altijd weer een verrassing hoe de scholen Excel Kwadraat opvatten en implementeerden. Dat maakte het praktijkgedeelte van het onderzoek ontzettend dynamisch en interessant, waar ik erg van genoten heb. Ik waardeer de interesse en inzet van de leerkrachten en directies in het onderzoek dan ook enorm. Bovendien boden zij mij een bijzonder inkijkje in hun wereld, waar ik weer verder op kon bouwen in het onderzoek.

Met plezier denk ik terug aan de vele gesprekken met mijn collega’s van de Open Universiteit en het ITS van de Radboud Universiteit in de afgelopen jaren. Hoewel ik niet vaak op de OU in Heerlen was, voelde ik me er erg welkom en was er altijd wel iemand in voor een praatje. Mijn (voormalige) medepromovendi van de FEEEL vakgroep, waaronder Jérôme Gijselaers, Johan van Strien, Joyce Neroni, Kim Dirkx, Martin van Dijk, Milou de Smet en Pauline Reijners, zorgden voor de nodige mentale ondersteuning en gezelligheid. Door hun gezelligheid deden

Op het ITS was ik als enige promovendus een beetje een vreemde eend in de bijt. Gelukkig had ik leuke collega’s bij de afdeling Onderwijs waar ik altijd terecht kon voor vragen over mijn onderzoek. Met Annemarie van Langen in het begin en later Daan Fettelaar en Geert Driessen heb ik regelmatig van gedachten gewisseld over analyses, wat mij de nodige hoofdbreken bezorgde maar desalniettemin erg nuttig was. De oprechte interesse van directeur Jeroen Winkels in mijn onderzoek vond ik erg fijn en ik heb grote waardering voor zijn inspanningen om mijn promotietraject tot een goed einde te brengen. Bij mijn kamergenootje Tineke Paas kon ik altijd terecht voor allerlei dittjes en datjes. Zij heeft in belangrijke mate bijgedragen aan de plezierige periode die ik bij het ITS heb gehad, en ik vind het dan ook erg leuk dat zij mijn paranimf wil zijn.

Een tijd lang werkte ik op vrijdagen in de Universiteitsbibliotheek Utrecht samen met promovendus Susanne Lucieer, met het koffiemomentje als hoogtepunt van de dag. Het was een gezellige tijd, en er zullen vast nog vele koffiemomentjes volgen.

Tot slot wil ik graag de mensen die het dichtst bij me staan noemen: mijn lieve schoonfamilie en mijn broer Bart en schoonzus Zusan voor hun interesse en steun, en mijn ouders Otto en Thea, die altijd voor me klaar staan en me fantastisch helpen bij moeilijkheden en mogelijkheden. Vooral de discussies over excellentie en andere onderwijsontwikkelingen vond ik erg leuk, waarmee vooral mijn vader, als basisschooldirecteur vanuit de praktijk, mijn ideeën over het onderzoek heeft aangevuld. Het laatste woord van dank gaat uit naar Joost en onze lieve dochter Isa. Lieve Joost, mede dankzij jou sta ik hier vandaag. Jij zorgt zo goed voor Isa en mij. Jullie zijn er altijd voor mij en maken mij blij. Met jullie geniet ik elke dag!
ICO Dissertation Series

In the ICO Dissertation Series dissertations are published of graduate students from faculties and institutes on educational research within the ICO Partner Universities: Eindhoven University of Technology, Leiden University, Maastricht University, Open University of the Netherlands, University of Amsterdam, University of Twente, Utrecht University, VU University Amsterdam, and Wageningen University, and formerly University of Groningen (until 2006), Radboud University Nijmegen (until 2004), and Tilburg University (until 2002). The University of Groningen, University of Antwerp, University of Ghent, and the Erasmus University Rotterdam have been ‘ICO ‘Network partner’ in 2010 and 2011. From 2012 onwards, these ICO Network partners are full ICO partners, and from that period their dissertations will be added to this dissertation series.

List update February, 2015 (the list will be updated every year in January)


266. Azkiyah, S.N. (23-5-2013) The effects of Two Interventions - on Teaching Quality and Student Outcome Groningen: University of Groningen

267. Taminiau, E.M.C. (24-05-2013) Advisory Models for On-Demand Learning Heerlen: Open University of the Netherlands

268. Milliano, I.I.C.M. de (24-05-2013) Literacy development of low-achieving adolescents. The role of engagement in academic reading and writing Amsterdam: University of Amsterdam

269. Vandyck, I.J.J. (17-06-2013), Fostering Community Development in School-University Partnerships. Amsterdam: VU Universitstiy Amsterdam


277. Popov, V. (8-10-2013) Scripting Intercultural Computer-Supported Collaborative Learning in Higher Education. Wageningen: Wageningen University


284. Hagemans, M.G. (07-03-2014) On regulation in inquiry learning. Enschede: University of Twente


290. Loon, Marriette van (8-5-2014) *Fostering Monitoring and Regulation of Learning*. Maastricht: Maastricht University


294. Rutten, N.P.G. (5-9-2014) *Teaching with simulations*. Enschede: University of Twente


298. Gaikhorst, L. (29-10-2014) *Supporting beginning teachers in urban environments*. Amsterdam: University of Amsterdam

299. Wijnia, L. (14-11-2014) *Motivation and Achievement in Problem-Based Learning: The Role of Interest, Tutors, and Self-Directed Study*. Rotterdam: Erasmus University Rotterdam


301. Leenaars, F.A.J. (10-12-2014) *Drawing gears and chains of reasoning*. Enschede: University of Twente

302. Huizinga, T. (12-12-2014) *Developing curriculum design expertise through teacher design teams*. Enschede: University of Twente
