The effect of differentiated instruction on student mathematics achievement in primary school classrooms

Master Thesis

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Author: Quinten Mulder - s1199315

Supervisors: Dr. A.J. Visscher

J.M. Faber, MSc

UNIVERSITEIT TWENTE.

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SUMMARY

Differentiated instruction becomes more and more important in primary education, because students of the same age differ in the extent to which they need instruction and support during learning. Providing differentiated instruction means adapting instruction to the needs of students. It is assumed that differentiated instruction leads to more student achievement, but that is not clear. The aim of this study was to determine to what extent differentiated instruction has effect on student mathematics achievement in primary school classrooms.

Twenty-four primary school teachers in the Netherlands were observed three times by three observers with the purpose of determining the extent of differentiated instruction to explore what effect this has on mathematics achievement. The participants were selected on the basis of non-random sampling. The instrument used for the observations was developed for this study, partly based on the theoretical framework and partly based on the ICALT observation instrument from Van de Grift. Student mathematics achievement was measured through CITO mathematics test results. Multi-level analyses were performed to identify the effect of differentiated instruction on student mathematics achievement.

Results showed that differentiated instruction has no statistically significant effect on student mathematics achievement, which was against expectations. The relationship between differentiated instruction and mathematics achievement was positive, which means that the more the teacher differentiates, the higher the mathematics achievement of the students is. However, this can also be due to chance. This result may be due to the low variation between the extent of differentiated instruction provided by the teachers. The low variation may have been influenced by the way the data was collected. The conducted evaluations of teacher behavior were quite strict, making it difficult for teachers to obtain sufficient scores on providing differentiated instruction. Another reason for the low variation between teachers may have been the selection of the schools that was made by Focus staff. Focus staff selected strong, average and weak achievement-oriented approach schools to promote variation between the schools. However, this selection tells nothing about individual teachers within schools. If schools are selected as weak achievement-oriented schools, there is still much variation possible in the abilities of teachers within those schools. Results also showed that below-average students received statically significant more differentiated instruction than above-average student from teachers. Furthermore, results showed that providing above-average students extra challenge and evaluating the learning of students during the processing of the learning content, have the strongest positive influence on student mathematics achievement. This means that the more the teachers challenges above-average students, and the more the teachers evaluates the learning of the students, the higher the student mathematics achievement is. However, no statistically significant effect was found for that, so these results can also be due to chance.

In future research, to increase variation between teachers on providing differentiated instruction, the scoring system of the observation instrument has to be changed, making it more easy for teachers to achieve sufficient scores on providing differentiated instruction. This can be done by creating more variation in the scoring system. Because the internal consistency of the instrument was just below the appropriate level, the

instrument should be adjusted for future research in order to ensure that all the items of the observation instrument actually measure the amount of differentiated instruction provided by teachers. Further research should also investigate how teachers actually understand, engage with, and respond to diversity in the classroom, because it turned out to be that many teachers still face problems in providing differentiated instruction. When thoughts of teachers are identified, it is possible to determine why teachers do not provide differentiation or make certain decisions regarding differentiation in their classroom, which is useful to remove the problems the teachers face in providing differentiated instruction.

TALBE OF CONTENTS

1. INTRODUCTION

In this part, the rationale for the study, the scientific relevance of the study, and the main research question are presented.

1.1 Rationale for the study

Differentiated instruction is a trending topic in primary education. It means adapting instruction to the needs of students. Many teachers in primary education, also in the Netherlands, experience difficulty in providing differentiated instruction (Houtveen & Van de Grift, 2001; McTighe & Brown, 2005; Roy, Guay, & Valois, 2013; Tomlinson, Brighton, Hertberg, Callahan, Moon, Brimijoin, Conover, & Reynold, 2003). The majority just uses the same instruction for all students (Houtveen & Van de Grift, 2001; Inspectie van het Onderwijs, 2013). Some teachers believe in this way of teaching, because only then every student is treated equally. However, the approach of using the same instruction for all students probably falls short for many students because in that situation, the learning content is out of their zones of proximal development (Goodnough, 2010). Students of the same age differ in the extent to which they need instruction and support during learning (Houtveen & Van de Grift, 2001; Kanevsky, 2011; Landrum and McDuffie, 2010). Therefore, for students in primary education, it is important that teachers know their specific needs and take these needs into account in their teaching (Inspectie van het Onderwijs, 2013).

Reezigt (2012) states that differentiation is one of the weakest points in primary education in the Netherlands. This is a major problem. According to Landrum and McDuffie (2010), teachers should attempt to maximize the learning of each student and this can only be accomplished when teachers provide differentiated instruction. Therefore, still a lot that has to be improved regarding differentiated instruction in the classroom in primary education.

In the Netherlands, the achievement-oriented approach is seen as the most important key for the improvement of education and better differentiation (Inspectie van het Onderwijs, 2011). The achievement-oriented approach means that schools systematically and targeted work on maximizing student achievement (Inspectie van het Onderwijs, 2011). According to Visscher and Ehren (2011), the achievement-oriented approach not only leads to better understanding of the performance levels of student and to the goals related to those levels, but also to education that matches seamlessly with the prior knowledge of students. That way, the achievement-oriented approach is supposed to result in better differentiated education.

It is assumed that differentiated instruction will contribute to the development and learning of students (Goodnough, 2010; Hayes & Deyhle, 2001), but little is known about the precise relation between differentiation and the better learning of students (Reis et al, 2011). The effects of differentiated instruction on the learning of students are difficult to measure and relatively unknown.

1.2 Scientific and social relevance

The aim of this study is to investigate whether primary school teachers, who are trained in the achievement-oriented approach, effectively implement differentiated instruction and whether differentiated instruction leads to more student mathematics achievement in primary education. This leads to the following

main research question of this study:

''To what extent does differentiated instruction have effect on student mathematics achievement in primary school classrooms?''

Most research regarding differentiated instruction focuses on the use of instructional adaptations and academic progress monitoring strategies of teachers in general education classrooms and on the school conditions that support the implementation of differentiated instruction, but the effects of differentiated instruction have rarely been investigated. Hayes and Deyle (2001) claim that it is difficult to determine the possible effects of differentiated instruction on the achievement of students, because the effects of differentiation may differ in each school. Roy et al. (2013) state that differentiated instruction is assumed to foster the achievement of students, however, this has yet to be confirmed. Smit and Humpert (2012) argue that students who receive differentiated instruction do not experience poorer achievements, however, clear positive results from differentiated instruction still have to be found.

It is important to investigate whether differentiated instruction leads to more student achievement, because differentiated instruction becomes more and more important. This is largely due to the increasing educational trend towards full inclusion, meaning that every student, disabled or not, should be taught in a regular classroom (Goodnough, 2010, Roy et al., 2013, Rubenstein & Siegle, 2012, Tomlinson et al., 2003). In the Netherlands, this trend is an initiative of the Ministry of Education, Culture and Science. It implies significant reforms and changes of school practices and it makes the regular classroom become the center for dealing with differences among students (Houtveen & Van de Grift, 2001; Poon-McBrayer & Wong, 2013; Roy et al., 2013; Unianu, 2012). This forces primary school teachers to provide differentiated instruction.

In addition, it appears that only a few students have a high level of performance in primary education in the Netherlands (Inspectie van het Onderwijs, 2013). There is little variation between the level of performance of students in primary education. This is because above-average students seem to be challenged too little (Inspectie van het Onderwijs, 2013). According to Tomlinson et al. (2003), many teachers are unaware of the possibilities they have to differentiate their instruction for above-average students. Besides, when teachers do know the possibilities, they sometimes are not able to utilize these in their classroom. Many primary teachers focus only on how they can help below-average students, failing to address the needs of other students (Inspectie van het Onderwijs, 2011; Little, 2010; Tomlinson et al., 2003). According to Visscher, Dijkstra and Karsten (2012), this is because teachers believe it is difficult to develop education for every student, so more differentiated instruction for above-average students is important.

2. THEORETICAL FRAMEWORK

The theoretical framework will provide information about the definition of differentiated instruction, the activities of teachers who provide differentiated instruction and the limiting factors in providing differentiated instruction.

2.1 Differentiated instruction

2.1.1 Differentiated instruction as promising approach

Differentiated instruction is rooted in the belief that, because there is variability among any group of students, teachers should expect student diversity and adjust their instruction accordingly (Smit & Humpert, 2012). Students come to school with different experiences, skills, and knowledge, and therefore, the instruction needs to structure learning experiences that will build on where they are (Kanevsky, 2011). According to Dee (2010) and Roy et al. (2013), differentiated instruction can be labeled as a promising approach in improving education. They see differentiated instruction as the key to academic success for all students in regular classrooms.

2.1.2 Definition of differentiated instruction

There are several definitions of differentiated instruction. Roy et al. (2013) define differentiated instruction as *''an approach by which teaching is varied and adapted to match the abilities of students using systematic procedures for academic progress monitoring and data-based decision-making''* (p. 1187). Smit and Humpert (2012) define differentiated instruction as *''an approach that enables teachers to plan strategically to meet the needs of every student''* (p. 1153). Ruys, Defruyt, Rots & Aelterman (2013) define differentiated instruction as *''a set of strategies that will help teachers meet each student where they are when they enter class and move them forward as far as possible on their educational path''* (p. 94). Tobin and Tippett (2012) define differentiated instruction as *''an approach to teaching and planning that can address the needs of diverse learners in an inclusive classroom''* (p. 1). Although there are some differences between these definitions, they all seem to have in common that the purpose of differentiated instruction is to meet the needs of students in order to support the learning process of students so that all individual students in the classroom can develop their own individual capabilities as much as possible. Differentiated instruction requires teachers to consider several student characteristics when designing lessons and units (Goddard, Neumerski, Goddard, Salloum, & Berebitsky, 2010). This indicates that differentiated instruction is not a single strategy, but rather an approach to instruction that incorporates a variety of strategies (Hayes & Deyhle, 2001; Watts-Taffe et al., 2012). Such strategies can be working with students in small groups and providing student with different learning content.

Differentiated instruction is not the same as individualized instruction (Roy et al., 2013). Individualized instruction typically focuses on interventions intended to remediate learning difficulties of students (Landrum & McDuffie, 2010), while differentiated instruction has been developed in response to the tendency in many countries to include students of various abilities in the same classroom environment. So, individualized instruction can be seen as part of differentiated instruction.

Roy et al. (2013) mention the importance of academic progress monitoring. Academic progress monitoring fits perfectly in the achievement-oriented approach. When teachers get trained in the achievement-oriented approach, they learn to monitor the academic progress of students by analyzing the information they got from the student monitoring system. Therefore, in this study, the definition of Roy et al. (2013) is taken as basis. This leads to the following definition of differentiated instruction: ‘‘Differentiation can be defined as an approach to teaching in which teachers proactively modify and adapt their teaching to address the diverse needs of individual students and small groups of students to maximize the learning opportunity for each student in the classroom by using systematic procedures for academic progress monitoring and data-based decision-making.’’

2.2 Activities of teachers who effective provide differentiated instruction

2.2.1 Differentiated instruction has to be effective

According to Smit and Humpert (2012), teachers are the critical factor that affect the learning of students. They actually have to design and execute instruction (Chamberlin and Powers, 2010; Tobin & Tippett, 2012; Watts-Taffe, Laster, Broach, Marinak, McDonald Connor, & Walker-Dalhouse, 2012). Tomlinson et al. (2003) state that every teacher should be able to provide differentiated instruction. Teachers can design differentiated instruction beforehand, but they can also implement it after lessons has proved unsuccessful for particular students (Landrum & McDuffie, 2010; Roy et al., 2012). However, just providing differentiated instruction is not enough. Tomlinson et al. (2003) claim that differentiated instruction has to be effective and that is where most teachers struggle in providing differentiated instruction.

2.2.2 First activities of providing effective differentiated instruction

Providing effective differentiated instruction includes several activities. Goddard et al. (2010) and Watts-Taffe et al. (2012) claim that teachers have to share and discus ideas with each other about differentiated instruction, because then, they become much more effective in providing differentiated instruction. They can describe their views on differentiated instruction and explain how they want to implement differentiated instruction in the classroom in order to increase their knowledge of instructional modifications (Gettinger & Stoiber, 2012).

Chamberlin and Powers (2010) and Goodnough (2010) state that teachers must take into account that differentiated instruction is no recipe. It is guided by theory and can be translated into practice in many ways. Procedures of differentiation are neither simple nor straightforward (Hayes & Deyhle, 2001). Chamberlin and Powers (2010) and Smit and Humpert (2012) argue that teachers have to start small. That is why it is not wise that teachers immediately apply differentiated instruction in all the subjects they teach (Tomlinson et al., 2003). When the teachers provide effective differentiated instruction in one certain subject, they can start with other subjects.

If teachers have discussed various aspects of differentiated instruction and they have decided to apply differentiated instruction, they first have to recognize the differences between students (Chamberlin & Powers, 2010; Smit & Humpert, 2012). Watts-Taffe et al. (2012) claim that differentiated instruction is

central to honoring diversity. When teachers ignore differences between students, for whatever reason, differentiated instruction is not possible. Therefore, teachers must acknowledge the unique needs of every students and see students as individuals (Santangelo & Tomlinson, 2012). Chamberlin and Powers (2010) state that when teachers recognize differences, they accept students as they are. In the next part, it will be discussed what teachers actually do in the classroom when providing differentiated instruction.

2.2.3 Identifying differences between students

Recognizing differences is not knowing the nature of the differences. This means that identifying the differences between students is important if teachers want to provide differentiated instruction (Goddard et al., 2010; Hayes & Deyhle, 2001; Kanevsky, 2011; Little, 2010; Roy et al., 2013; Smit & Humpert, 2012). Formative evaluations are examples of such efforts and therefore useful and crucial for identifying the differences between students (Gettinger & Stoiber, 2012; Houtveen & Van de Grift, 2001; McTighe & Brown, 2005; Roy et al., 2013; Santangelo & Tomlinson, 2012; Smit & Humpert, 2012; Tobin & Tippett, 2012; Watts-Taffe et al., 2012). Formative evaluations are employed by teachers during the learning process in order to modify teaching and learning activities to improve student attainment. Through formative evaluations, teachers use data of students to make decisions about teaching adjustments and to assess the effectiveness of these adjustments after implementation (Reis et al., 2011; Roy et al., 2013; Smit & Humpert, 2012). These data can be very broad. Teachers gather data from several assessments, by observing the students closely as they work, by asking them questions about their thinking and their methods, by observing whether students reflect, and by asking them questions to determine their motivation (Watts-Taffe et al., 2012).

Roy et al. (2013) emphasize that academic progress monitoring procedures can be particularly helpful in making decisions about how to differentiate instruction to match a sufficient range of learning needs. Through academic progress monitoring, teachers look at data from test results. That is what teachers learn to do when they are trained in the achievement-oriented approach. Teachers must implement progress monitoring procedures to enable effective teaching adjustments (Tobin & Tippett, 2012; Watts-Taffe et al., 2012). This means that, in order to choose and apply appropriate strategies, teachers should assess the prior knowledge and background of students and monitor their subsequent achievement and improvements (Chamberlin & Powers, 2010; Landrum & McDuffie, 2010).

Little (2010) adds that the evaluation strategies used to determine student progress toward learning objectives must represent opportunities to demonstrate learning for students. Only then, teachers know which teaching and learning activities have to be modified in order to address the needs of students and in order to improve student attainment (Kanevsky, 2011; McTighe & Brown, 2005; Smit & Humpert, 2012; Watts-Taffe et al., 2012). Teachers can provide differentiated instruction and individualized support when delays are evident (Gettinger & Stoiber, 2012). For example, students who are not making adequate progress need differentiated instruction. However, students who show they already possess the learning content also need differentiated instruction, because they want to be challenged. So, when identifying differences between students, teachers use materials and activities to ensure that they know what the abilities of their students are,

and to ensure that they know what prior knowledge their students have (Landrum & McDuffie, 2010, Santangelo & Tomlinson, 2012, Tomlinson et al, 2003).

2.2.4 Setting goals

If teachers apply academic progress monitoring and differences between students have been identified, they are able to target meaningful goals regarding to what students need to learn next (Landrum & McDuffie, 2010). This helps to link assessment to curriculum and instruction (Chamberlin & Powers, 2010). Setting goals is essential for differentiated instruction, because it helps teachers to modify the instruction and curriculum for every student (Visscher & Ehren, 2011). The match between instructional practices and capabilities of students must be based on their actual competencies and the tasks to be performed (Watts-Taffe et al, 2012). When formulating the goals, it is important that they are formulated clearly, in order to evaluate whether they are met or not (Visscher, Peters & Staman, 2010).

When teachers set goals, they must challenge all the students in the classroom in order to increase learning (Chamberlin & Powers, 2010; Kanevsky, 2011). Smit and Humpert (2012) indicate that students learn best when presented with moderate challenges. However, the teachers must take into account that what is moderately challenging and motivating for one student, may be far too difficult for another student, so challenges must promote individual growth (Chamberlin & Powers, 2010).Therefore, it is important to set minimum goals for all students. That way, the teacher can also clearly see where students are in relation to the basic skills that have to be acquired. Optimal challenges stimulate and promote intrinsic motivation and achievement (Landrum & McDuffie, 2010). This means that teachers should allow the students to make choices about classroom experiences. For example, they let students decide which activities they want to do first. Yeh (2010) adds that, when challenges are moderate, students stay in their zone of proximal development, because then, students are more likely to be successful and feel that they can control their performance. Feelings of control and success reinforce effort and improve achievement.

2.2.5 Meeting the needs of students

Teaching and learning activities are diverse, so when differences between students are identified and goals have been set, teachers have lots of opportunities to differentiate. Tomlinson et al. (2003) state that teachers can differentiate the content, the process and the product of learning. Santangelo and Tomlinson (2012) give the following descriptions of those concepts:

- Content consists of what is being taught as well as how students access that information.
- Processes can be thought of as the activities that allow students to begin thinking about, working with, and personalizing the content.
- Product assignments are used to assess content mastery.

Varying content, process, and product has to occur according to the readiness, interests, and learning profiles of students. According to Landrum and McDuffie (2010) readiness levels are about what students know, understand, and can do in relation to the content. Landrum and McDuffie (2010) state that interests refer to the feelings and emotions that lead individuals to focus on something because that topic or pursuit is

important to the individual. Student interest connects with student motivation, which can impact engagement and understanding. Teachers can use interest to link the curriculum to things that matter to students, but also to encourage students to discover new interests (Chamberlin & Powers, 2010; Landrum & McDuffie, 2010; Santangelo & Tomlinson, 2012). Learning profiles refer to the mode of learning of students that can be affected by a numbers of factors, including learning style, intelligence preference, gender, and culture (Tomlinson et al., 2003; Tulbure, 2011). Learning profiles encompasses aspects of how individuals learn, how they process what they need to learn, or how they think about, remember, and use what they learned (Tobin & Timppett, 2012)

With in mind that varying content, process, and product has to occur according to the readiness, interests, and learning profiles of students, teachers can change the curriculum and the grading criteria, develop multiple materials and assignments, vary teaching strategies and the pace of instruction, adapt the learning environment, and provide extra support (Kanevsky, 2011; McTighe & Brown, 2005; Reis et al., 2011; Roy et al., 2013; Ruys et al., 2013; Smit & Humpert, 2012; Tomlinson et al., 2003; Watts-Taffe et al., 2012). However, it does not mean that each student receives an individual program or instruction (Goodnough, 2010; Ruys et al., 2013). Rather, students work individually or in small groups to participate in learning and assessment activities that are differentiated on the basis of content, process and product.

According to Tomlinson et al. (2003) and Yeh (2010), the instructional activities developed or modified by teachers to facilitate student achievement must be worthwhile and engaging and should include opportunities for students to reflect on the implications of their learning. To differentiate ***the content***, teachers must set minimum goals for all students and present them when the lessons starts, because the goals form the basis for the main skills of all students. The goals must be aligned with the prior knowledge and learning profiles of the individual students or groups of students being taught (Smit & Humpert, 2012). Teachers must ensure that students understand the purpose behind lessons and tasks and the possible implications of the learning involved for life beyond the classroom. When doing that, students develop senses of relevance between school and the outside world. It makes learning more effective (Landrum & McDuffie, 2010). Chamberlin and Powers (2010) mention that teachers can use activities in which different student groups focus on different aspects of topics to differentiate the content. Then, students are put in other groups and share with each other what they learned in their previous groups. In addition, the goals must be designed to be engaging and interesting for all students, so every student can value the tasks (Little, 2010). This is difficult, because students differ in interests and motivation. According to Bong (2009), some students are motivated because acquiring new knowledge and mastering new skills will improve their competence that leads them to invest genuine effort in learning. Other students study hard with the goal of outperforming their peers, because they believe doing so is the most sure way to verify their superior ability. For yet others, the primary purpose of engaging in schoolwork is to neither improve their competence nor document their superiority, but rather to hide their inadequacy from their teachers and peers. Therefore, teachers should help students to develop their own academic goals (Watts-Taffe et al., 2012). For example, teachers can let students think about which learning activities they want to have achieved at the end of the lesson, so they are able to work systematically towards that goal. Teachers can also do that by expressing

different expectations for students with different abilities.

Differentiating ***the process***, allows students to produce the same products in different ways (Watts-Taffe et al., 2012). This means that teachers should offer different ways to explore educational content. The process of how the material in lessons is learned may be differentiated for students based on their learning styles, taking into account what standards of performance are required in normal situations. This stage of differentiation allows students to learn in ways that are most easiest for them to acquire knowledge, or what may challenge them most. For example, some students may prefer to read about certain topics and others may prefer to listen or acquire knowledge by manipulating objects associated with the content. In addition, teachers should enable flexible grouping, so students can choose to work alone, in pairs or in groups (Chamberlin & Powers, 2010; Goddard et al., 2010; Kanevsky, 2011; Landrum & McDuffie, 2010; Santangelo & Tomlinson, 2012; Smit & Humpert, 2012; Watts-Taffe et al., 2012). Santangelo and Tomlinson (2012) and Chamberlin and Powers (2010) argue that sometimes, groups will comprise students with similar interests or learning profile characteristics, and other times they will include students with diverse interests or learning profile characteristics.

In order to differentiate ***the product***, Smit and Humpert (2012) argue that teachers must allow students to develop varied products. Product assignment are typically performance oriented and should facilitate the ability of students to critically think about, apply, and demonstrate what they have learned (Santangelo & Tomlinson, 2012). Because students have other needs and other possibilities, teachers are able to develop diverse product assignments. These product assignments can differ in difficulty, size, but also in form. In addition, teachers can replace some of their tests or other traditional assessments with alternative products (Chamberlin & Powers, 2010). Instead of written tests, teachers can allow students to demonstrate their learning through presentations or play. This gives teachers the opportunity to select appropriate assignments and tests for every student.

Furthermore, learning activities must be structured to allow students to work at their own pace, because the same pace for all students is likely to be too easy for some students and too difficult for others (Houtveen & Van de Grift, 2001; Kanevsky, 2011; Tomlinson et al.,2003). Classrooms in which time is used flexibly, would likely better serve the full range of students. However, many teachers fail to adapt the pace of instruction in response to the needs of students (Kanevsky, 2011; Little, 2010).

2.2.6 Differentiation with respect to below-average students and above-average students

When teachers have thought about the possibilities for differentiation, and teaching and learning activities and instructional materials have been adjusted, the teachers have taken into account the differences between students. Then, the implementation begins and the actual learning process of students can start. During the learning process, students often work in different instruction groups (Tomlinson et al, 2003; Watts-Taffe et al., 2012). The teacher has to know how to provide instruction and support to all this groups. However, the same students must not always sit together in the same group. It is assumed that below-average students do not benefit when they always work together with students with equal abilities (Houtveen & Van de Grift, 2001, Roy et al., 2013). According to Houtveen and Van de Grift (2001), groups that consist of below-

average students are not stimulated to perform optimally, because often less ambitious objectives are set for these students. Teachers develop low expectations for below-average students. Furthermore, below-average students cannot be motivated by high achieving students, and positive role models are not available when below-average students are always in the same group. This does not mean that below-average students must not sit together, however, they have to get the opportunity to work with other students as well.

Reis et al. (2011) state that teachers can use diverse strategies when they differentiate instruction for below-average students. Most important is that teachers guide below-average students through learning. Teachers can do this by acting as role models (Smit & Humpert, 2012; Watts-Taffe et al, 2012). Smit and Humpert (2012) argue that modeling serves to share with students not only what the teacher thinks regarding the content to be learned but also to engage the teacher in the process of communication and collaborative learning. When teachers act as role models, they show below-average students which strategies have to be used in specific situations. In addition, they explain all the steps of the strategies and show the results of the strategies. Through this structure, below-average students understand the learning content better.

Providing instruction for above-average students is very different from providing instruction for below-average students (Fletcher & Speirs-Neumeister, 2012). Above-average students should have opportunities for personal and academic growth, but do not receive that very often. Figg, Rogers, McCormick and Low (2012) state that above-average students only engage in learning when the curriculum is adapted to their needs. If that does not happen, they are not motivated, which can lead to underachievement (McCoach, Rambo & Welsh, 2013; McCoach & Siegle, 2003). According to Rubenstein and Siegle (2012), motivating above-average students is most challenging for teachers, but not impossible.

Little (2010) defined several activities that teachers can implement that describe appropriately differentiated curriculum for above-average students. Above-average students often learn more early and more quickly than other students (Kanevsky, 2011). This means they need less time to learn contents, particularly when they face material that is relatively straightforward and simple. If above-average students are not put to work sooner and they have to wait, they will probably be bored, which can affect their achievement (Coleman, 2001). That is why ability grouping does work with above-average students (Roy et al., 2011). When above-average students can work together, they learn at paces similar to their own.

According to Kanevsky (2011), enabling students to select their preferred ways of learning is ideal for above-average students to motivate them and to decrease bored feelings. Teachers can do this by explaining several strategies and showing advantages and disadvantages of the strategies. Then, students can choose the strategy that suits them most. It promotes senses of ownership for above-average students, which is important in maintaining positive attitudes toward school learning and intrinsic motivation. However, Chamberlin and Powers (2010) emphasize that teachers cannot and should not always give answer to the preferences of students. They need to develop many learning strategies, including strategies they do not like (Kanevsky, 2011; Little, 2010).

Coleman (2001) and Little (2010) emphasize that above-average students need limited repetition of previously mastered content and greater complexity in the organization of content. Teachers can do this through compacting (Kanevsky, 2011; Reis et al., 2011). Compacting allows teachers to modify the

curriculum and eliminate previously mastered work for above average students. When students do face content they already mastered, they have limited opportunities to develop themselves in the school setting and that does not truly provide these students with possibilities to learn (Little, 2010). However, the teacher has to ensure that students have the support they need to engage effectively with the content. Even for above-average students, a curriculum that is too challenging does not motivate. If students feel that a course or curriculum is outside their capabilities, the learning experience may be frustrating. Kanevsky (2011) states that students then often decide to do nothing, otherwise others will see their disabilities.

Coleman (2001) defines more ways to address the needs of above-average students. Teachers can provide enrichment by allowing more depth and exploration within the content area for above-average students. They can also provide novelty by creating learning opportunities that generally are not included in the curriculum. Teachers must develop some good questions for exploration for students, but most of all, they must encourage students to ask their own questions (Little, 2010).

According to Chamberlin and Powers (2010) and Smit and Humpert (2012), the teachers and students collaborate in the learning process. They both share responsibility for teaching and learning (Kanevsky, 2011; Santangelo & Tomlinson, 2012). This means that the teacher must support the learning of above-average students and below-average students by monitoring them and providing descriptive feedback during the learning process. The students are encouraged to direct their own learning processes, while the teacher diagnoses learning difficulties. In providing feedback, the teacher coaches the students, redirecting their learning, supplying hints, suggesting learning strategies and reflecting on the perceptions of students of their learning processes. Through this, teachers can differentiate and provide extra support or extra challenge during the learning process of students.

2.2.7 Summative evaluations and sustainability of differentiated instruction

Even when teachers have identified the different needs of students and when activities have been modified, teachers should engage in reflection about how to make the classroom more meaningful and relevant for all students (Gettinger & Stoiber, 2012; Goddard et al., 2010; Little, 2010). Advocating for greater diversity and providing attention to culture in the curriculum and in curricular materials selected for classroom use stays important. Therefore, according to Watts-Taffe et al. (2012), teachers should evaluate the progress of students and consider their changing interests to keep the classroom flexible after differentiated instruction is implemented. That is why teachers must provide summative evaluations (McTighe &Brown, 2005). Summative evaluations refer to the assessment of the learning and summarize the development of students at particular times. Wiliam (2011) states that with summative evaluations, teachers try to monitor and report student progress by investigating whether students meet the learning objectives. This enables teachers to determine which students made progress and which students still need extra support. It makes summative evaluations the key for future differentiation.

Eventually, teachers are responsible for the success of each student and differentiated instruction helps in increasing the learning of students (Santangelo & Tomlinson, 2012). This is why the sustainability of differentiated instruction is important. To maintain differentiation in the classroom, teachers always have

to build on their learning environment (Kanevsky, 2011). In addition, they have to develop routines to support differentiation. This includes developing classroom systems that allow children to work in small peer groups and independently while the teacher provides targeted instruction to other groups of students (Watts-Taffe et al., 2012). That indicates that teachers must demonstrate flexibility with classroom routines and resources they already know (Santangelo & Tomlinson, 2012). Goddard (2010) claim that in classrooms where differentiated instruction is optimized, teachers design opportunities for success and provide scaffolding when students are being pushed to learn new content and skills. In the optimal differentiated classroom, assessment is ongoing and continuously informs instruction (Chamberlin & Powers, 2010). Furthermore, teachers must keep in mind that they do not have to differentiate instruction during every class.

The following table shows the most important components of differentiated instruction and the potential activities of teachers to put those components into practice:

Table 1. Providing differentiated instruction.

Components of differentiated instruction	*Activities of the teacher*
Process	- The teacher enables flexible grouping - The teacher allows all students to work at their own pace - The teacher allows below-average students to use auxiliary materials - The teacher provides extra support/challenge to students, based on their progress during the lesson
Product	- The teacher makes differences between students in the complexity of tasks - The teacher makes differences between students in the number of tasks
Content	- The teacher sets minimum goals for all students - The teacher ensures that the learning materials are adjusted to the level and development of each student - The teacher expresses different expectations for students with different abilities - The teacher provides above-average students with content with more depth - The teacher provides below-average students with content with more structure

2.3 Limiting and promoting factors in providing differentiated instruction

2.3.1 Learning environment

Providing effective differentiated instruction can be difficult (Watts-Taffe et al., 2012). Teachers face several challenges when implementing differentiated instruction (Houtveen & Van de Grift, 2001; Inspectie van het Onderwijs, 2013). There are several preconditions for differentiation. The learning environment has to be safe and stimulating for students (Santangelo & Tomlinson, 2012). The learning environment consists of the routines, procedures, and physical arrangement of the classroom, as well as the overall tone or mood that

exists among and between the students and teacher. Effective differentiated learning environments are characterized by flexibility and are carefully constructed to support the need of each student for affirmation, contribution, power, purpose, and challenge. Chamberlin and Powers (2010) emphasize that teachers can vary the classroom environment in regard to seating arrangements, accessible placement of materials and resources, but also taking care of lighting, different group settings and the noise level.

2.3.2 Skills and attitudes for providing differentiated instruction

As class sizes and the diversity among students increase, and resources diminish, many barriers to differentiation have surfaced (Kanevsky, 2011). Relatively few teachers are making changes in their classroom and the modifications being made involve only minor adjustments to the core curriculum which are deemed insufficient to maintain developmentally appropriate level of challenge. However, appropriate education requires that the general education classroom teacher possess skills that were once the purview of the special education teacher alone (Dee, 2010). Those skills include adapting instruction and making modifications to content, process and product for students. That often represents foreboding challenges for teachers. That is why implementing differentiated instruction can be very daunting for teachers. It requires new ways of thinking about curriculum and instruction (Tobin & Tippett, 2013). Unianu (2012) argues that teachers with more experience are more convinced that they are capable to adapt the educational activity in order to take into consideration the needs of all students. This could be explained by more professional experiences and more types of students which have learned under their careful supervision. Furthermore, teachers who work with children with different ethnical backgrounds are more open to the idea of inclusion than those who do not work with such categories of children.

Santangelo and Tomlinson (2012) claim that effective differentiation is grounded in attitudes of teachers. Teachers have to understand, but also appreciate the unique needs of students. Some teachers do not provide differentiated instruction, because they believe there is no need to differentiate (Goodnough, 2010; Santangelo & Tomlinson, 2012). There are also teachers who do not differentiate, because they do not know how to do so (Santangelo & Tomlinson, 2012).

2.3.3 The principal

Many teachers are generally unable to overcome the powerful influence exerted by systemic factors such as standardized schedules and use of class time, inflexible routines and management strategies what results in low differentiation (Santangelo & Tomlinson, 2012). It implies that teachers need help and support. However, teachers do not always get support for differentiation (Goddard et al., 2010; Reis et al., 2011). According to Roy et al. (2013), teachers are more likely to use differentiated instruction when school climate and resources are adequate. Therefore, principals have to provide teachers with sufficient support and encouragement (Goddard et al., 2010; Houtveen & Van de Grift, 2001; Poon-McBrayer & Wong, 2013; Unianu, 2012). Principals are very important in the process of implementing differentiated instruction. The principal has to guide teachers, because otherwise teachers cannot be expected to implement differentiated instruction (Houtveen & Van de Grift, 2001; Smit & Humpert, 2012). Principals can guide teachers by

checking the progress of the implementation and by helping teachers when they face problems during the implementation.

The principal must also have visions about differentiated instruction, because then, the principal knows how to plan and evaluate differentiated instruction (Smit and Humpert, 2012). That is crucial for effective differentiated instruction within the school. Although classroom teachers assume primary responsibility for their classes, the monitoring of student progress should be guided by the principal (Houtveen & Van de Grift, 2001). Principals can do this by discussing and evaluating individual student performances, including the concerns of teachers about behavior and achievement of students. Furthermore, partnership between the principal and teachers is the key to effective implementation of differentiated instruction. Partnership can only result from relationships with mutual trust and respect. Goddard et al. (2010) state that partnership between the principal and teachers arises when teachers get support and when they are able to enact differentiation at their own pace. The support of the principal is the key to the willingness of teachers to differentiate instruction. When teachers feel comfortable in discussing instruction with their principal, teachers are more likely to report that differentiated instruction occurs in their schools.

2.3.4 Teacher education programs

Opportunities for training and the availability of material resources are also facilitators for creating inclusive environments and using effective instructional practices (Smit & Humpert, 2012). Many teachers lack the time, knowledge, training, flexibility, and resources to plan for differentiated instruction or to use effective strategies (Goddard et al,, 2010; Smit & Humpert, 2012; Watts-Taffe et al., 2012). They are discomfort with the process of differentiation and have difficulty managing differentiated activities (Lavensky, 2011; Watts-Taffe et al., 2012). If teachers have not been trained in differentiated instruction, they often use strategies that require less preparation or tailored instruction. Therefore, teachers are not able to meet the needs of all students (Watts-Taffe et al., 2012).

Houtveen and Van de Grift (2001) claim that differentiated instruction tends to stop at identifying possible problems through tests and analyzing these problems. Those problems can be the underachievement of certain students or misconceptions of students about specific topics. After this point, very little action takes place. This is because the majority of teachers lack relevant strategies and knowledge to effectively overcome the problems of their students (Santangelo & Tomlinson, 2012). Therefore, teacher education programs must prepare teachers to meet the needs of all students by teaching the skills to make appropriate lesson adaptations, accommodations and modifications, because preparation has an impact on teacher attitudes and confidence in working in inclusive settings (Dee, 2010; Gettinger & Stoiber, 2012). However, this remains challenging for teacher programs (Goodnough, 2010). Smit and Humpert (2012) state that many education programs lack in preparing teachers for teaching in diverse classrooms. Teachers do not learn to select their own grouping format, nor do they purposefully group students based on readiness, interest, or learning profile. Furthermore, the use of continual and varied assessments is essential for effective differentiation, but education programs seem to ignore this. That suggests that teachers have little opportunity to experience how assessment data can and should serve as the core from which decisions about

differentiation are made. Because of this lack of training, teachers often continue to use the same practices, rather than incorporating strategies for differentiated instruction, because most teachers think it is difficult to use those strategies in practice (Dee, 2010). In addition, many teachers do not include differentiated instruction into their lesson plans. It is not necessary to plan differentiated instruction, but it helps teachers to organize it (Houtveen & Van de Grift, 2001; Watts-Taffe et al., 2012).

Even now differentiated instruction gets more and more attention and teachers try to implement differentiated instruction in their classrooms (Houtveen & Van de Grift, 2001), the quality of differentiation remains debatable. This is because Goodnough (2010) states that many teachers lack confidence to differentiate, even after structured learning, in their ability to teach for diversity. Chamberlin and Powers (2010) emphasize that teachers have to use space, time and materials flexibly to suit the needs of various learners when they are able to provide effective differentiated instruction.

2.4 Research questions

It appeared that providing differentiated instruction consists of many activities. Teachers have to recognize differences between students and have to identify the nature of these differences. After differences between students have been identified, teachers should be able to formulate meaningful goals in terms of what students need to learn next. There are lots of opportunities for teachers to differentiate in order to meet the needs of students. When activities and instructions have been modified, teachers must engage in reflection about how to make the classroom more meaningful and relevant for all students for the sustainability of differentiated instruction in the classroom. Teachers can do this through summative evaluations, because then, they try to monitor and report student progress by investigating whether students meet the learning objectives.

Many factors limit and promote the provision of differentiated instruction. The learning environment has to be safe and stimulating for students, otherwise differentiation is not possible. Many teachers lack the time, knowledge, training, flexibility, and resources to plan for differentiated instruction or to use effective strategies. In addition, effective differentiation is grounded in attitudes and skills of teachers. Teachers also need help and support from principals during the implementation of differentiated instruction.

This knowledge makes it possible to identify the extent of differentiated instruction provided by teachers in primary school classrooms and makes it possible to formulate several research questions.
As stated before, the main research question is:
‘’To what extent does differentiated instruction have effect on student mathematics achievement in primary school classrooms?’’
The hypothesis is that students who receive more differentiated instruction from their teachers have higher mathematics achievement, because it is assumed that differentiated instruction will contribute to the learning of students (Goodnough, 2010; Hayes & Deyhle, 2001; Reis et al., 2011).
The following sub questions have been formulated:
1. To what extent do teachers vary the extent of differentiated instruction between different groups of students?

The hypothesis is that below-average students receive more differentiated instruction, because the Dutch inspectorate claims that teachers in the Netherlands often only focus on how to help below-average students, failing to address the needs of other students (Inspectie van het Onderwijs, 2011). Above-average students seem to get too little challenge, because many teachers are unaware of the possibilities they have to differentiate their instruction for above-average students (Inspectie van het Onderwijs, 2013; Tomlinson et al., 2003). Teachers often do know the possibilities of differentiated instruction, however, experience difficulty in providing education for diverse students (Visscher, Dijkstra and Karsten, 2012).

2. Which aspects of differentiated instruction influence student mathematics achievement most?

The hypothesis is that providing below-average students with extra instructional support, and providing above-average students with extra challenge have the strongest influence on student mathematics achievement. Meeting the needs of students often results in different instruction groups (Tomlinson et al, 2003; Watts-Taffe et al., 2012). When teachers divide students in different groups, they are more able to provide instruction and learning content that fits the needs of the students, which probably has positive effects on student achievement. Other aspects of differentiated instruction, while just as important, are more global, and therefore, are likely to have less effect on student mathematics achievement.

3. METHOD

In this chapter, the method of the study is presented. It includes the kind of research that was chosen, how respondents were selected, which instruments were used, which procedures were taken to collect data and how data was analyzed.

3.1 Research description

The research questions were answered by means of quantitative research. The units of analysis were twenty-four primary school teachers in the Netherlands. They have been observed multiple times by several observers with the purpose to measure the differentiated instruction in their mathematics lessons to determine what effect this has on average mathematics achievement of their students. Hill, Charalambous and Kraft (2012) state that observations are useful for teacher evaluation, because observations provide opportunities to analyze many acts of teachers.

In this study, student mathematics achievement has been expressed in terms of ability scores on CITO students monitoring system (SMS) tests. In the Netherlands, almost all primary schools use CITO SMS test to determine the achievement of their students. The CITO SMS test results can be put on one and the same ability scale. Through these tests, teachers get information about the progress of students (CITO, 2013). In addition, teachers gain insight into the results of the education they provide.

3.2 Respondents

Twenty-four primary school teachers in the Netherlands participated in this study. The schools of these teachers were located throughout the Netherlands. The teachers have been selected by non-random sampling (Onwuegbuzie & Leech, 2007), because the schools of the teachers are all affiliated with the Focus-project. Schools have volunteered to take part in that project. These schools were selected for this study, because Focus trains the schools in the achievement-oriented approach and thus in providing differentiated instruction *(*Visscher, Peters & Staman, 2010). To promote variation between participating schools, strong, average and weak achievement-oriented approach schools were selected. This selection was made by Focus staff who already worked two years with the schools. Based on this working experience, the schools were categorized.

Within the schools, teachers and students have been selected by homogeneous sampling (Onwuegbuzie & Leech, 2007). This kind of sampling involves sampling individuals, groups or settings because they all possess similar characteristics or attributes. Participants were selected for the study based on membership of a subgroup or unit that has specific characteristics. For this study, teachers and students in grade 4 of the schools have been selected. Teachers have lots of opportunities to differentiate in grade 4. In addition, students in grade 4 are still very young, which means that they can learn relatively quickly and therefore, differentiated instruction has probably much influence on them.

Table 2 presents the characteristics of the teachers and students. To keep the teachers anonymous, they were coded from 1 till 27. Originally, twenty-seven teachers were participating in the study, however, three teachers dropped out due to different circumstances. That is why teachers 3, 4 and 18 are missing in the

data. The socioeconomic status (SES) of the classroom has been described as the total percentage of students with student weight. The weighting system in primary education in the Netherlands determines the amount of money schools receive to buy and develop educational materials for their students. The amount of money schools receive, is based on the educational level of the parents and the postcode area of the school.

Table 2. Participating schools

Teacher	**Combination group**	**Size of the class**	**Total percentage of students with student weight**
1	Yes	10	15,2
2	No	22	6,4
5	Yes	14	41,5
6	No	21	10,5
7	Yes	12	25,6
8	Yes	17	9,6
9	No	29	39,9
10	No	24	36,2
11	Yes	23	15,6
12	No	26	19,9
13	No	21	20,5
14	No	24	9,0
15	No	12	61,5
16	No	26	3,3
17	Yes	10	14,5
19	No	17	3,8
20	No	22	27,9
21	No	15	62,2
22	Yes	9	1,8
23	Yes	18	5,1
24	Yes	13	4,2
25	No	24	69,1
26	No	23	4,8
27	No	24	43,1

3.3 Instrumentation

3.3.1 Observation instrument

To determine whether the teachers, trained in the achievement-oriented approach, implement differentiated instruction into their classrooms, they were observed several times. According to Dooley (2001), observations are very suitable for measuring the degree of implementation. The lessons observed were all videotaped. This had the advantage that the lessons could be viewed more often and details could be observed better.

The observation instrument can be found in the appendix. For the construction of the observation instrument, two methods were used. First, the theoretical framework provided important aspects that teachers should exhibit when implementing differentiated instruction. The process, product and content of learning were identified as components of differentiated instruction. However, not all aspects of providing differentiated instruction can be classified under these components. For example, there are some activities that teachers have to do if they want to provide differentiated instruction, before they actually start the lesson and start to adapt. These activities cannot be observed by means of lesson observations. That is why they were not included in the observation instrument. In addition, it appeared that teachers have to differentiate in line with the interests and motivation of students. However, motivation is difficult to observe, because it is mostly unknown what students motivates. Therefore, these aspects of differentiated instruction were not included in the instrument. Some, indirect aspects of differentiated instruction were included, like reflecting on and evaluating the learning of students. These aspects are important, because they form the basis for future differentiation.

Second, the ICALT observation instrument from Van de Grift (2007) formed the basis of the new instrument. ICALT means 'International Comparative Analysis of Learning and Teaching' and within this project several inspectorates of education of multiple counties were involved (Inspectie van het Onderwijs, 2009). For the construction of the ICALT observation instrument, two methods were used to identify the indicators of good teaching and learning. The first was studying research that has been done on the quality of teaching. The second was making consensus-seeking discussions between the several inspectorates. Through the ICALT observation instrument, teachers were observed on several aspects, including differentiating instruction and processing differences. The component 'differentiating instruction and processing differences' was adapted for the new instrument. This part of the ICALT observation instrument can be found in the appendix. This resulted in developing several items for observing the teachers. For every item, several examples of' good practice have been formulated. These examples of good practice helped to focus on the practice of the teachers while making the observations.

The items have been scored as follows:

- (1) predominantly weak
- (2) more weaknesses than strengths
- (3) more strengths than weaknesses
- (4) predominantly strong.

Scores 1 and 2 are insufficient, scores 3 and 4 are sufficient. When the teachers showed no examples of good

practice on specific items, score 1 had to be given. When teachers showed some examples of good practice, but did not perform very well yet on specific items, score 2 was appropriate. When teachers mastered specific items, but still had much room for improvement, score 3 had to been given. Score 4 does not mean that teachers perfectly demonstrate the indicator, even if teachers could improve somewhat on specific aspects, score 4 was possible. The advantage of four scores is that it is not possible to score in the middle. The instrument was made in Dutch, because all observers who used the instrument were from the Netherlands.

The instrument was used by three observers. All observers have evaluated the same lessons of the same teachers three times, so every teacher was observed nine times in total. This is necessary, because accurate observation ratings require two or more lessons and two or more observers (MET project, 2013). Beforehand, the observers received guidelines regarding how to use the observation instrument and how to score the items. This instruction can be found in the third appendix. After all teachers had been evaluated once, the scores of the three observers were compared. When scores varied very much, the differences were discussed, just as how to score teachers in future lesson observations. All observers were already familiar with scoring teachers and had knowledge of the achievement-oriented approach and differentiation.

3.3.2 Validity and reliability of the observation instrument

It is important that the observation instrument is valid (Nieveen, 1999). This means that the instrument really measures what it claims to measure. There are several ways to reach validity. First, the observation instrument was developed on basis of the theoretical framework presented in this thesis. Important aspects of differentiated instruction were identified, and translated into items for the observation instrument. Table 3 shows the link between the theoretical background and the observation instrument

Table 3. Link between theoretical background and observation instrument

Differentiation activities in the theoretical framework	**Item in the observation instrument**
- The teacher sets minimum goals for all students - The teacher expresses different expectations for students with different abilities	The teacher adjusts the learning objectives/expectations to relevant differences between students
- The teacher enables flexible grouping - The teacher ensures that the learning materials are adjusted to the level and development of all students	The teacher takes the differences among students into account with the organization of the learning environment
- The teacher makes differences between students in the complexity of tasks - The teacher makes differences between students in the number of tasks - The teacher allows below-average students to use auxiliary materials	The teacher adjusts the processing of the learning content to relevant differences between students

- The teacher allows all students to work at their own pace	The teacher adjusts the pace for processing the learning content to relevant differences between students
- The teacher provides below-average students with content with more structure	The teacher provides below-average students with extra instructional support
- The teacher provides above-average students with content with more depth	The teacher provides above-average students with extra challenge during instruction
- The teacher provides extra support/challenge to students, based on their progress during the lesson	The teacher evaluates the learning of students

In addition, the internal consistency of the observation instrument was measured using Cronbach's alpha. Cronbach's alpha can be used as an estimate for the reliability of the instrument. For this instrument, Cronbach's alpha was 0,56, which means that the internal consistency is just below the acceptable level of 0,60. So, there is no strong correlation between all the items of the instrument. Deleting specific items of the instrument did not improve the alpha. To determine whether there were more underlying factors within the observation instrument, the factor analysis was conducted. Through that analysis, two factors were extracted. However, the internal consistency between those two factors was 0,35, which was even lower. There can be several explanations found for the alpha. First, the number of items is very low, which can deflate the alpha. Second, alpha is most appropriately used when the items measure different substantive areas within single constructs. In this study, not all items of the instrument are directly connected to differentiated instruction. For example, the first item says that the teacher has to adjust the learning objectives and expectations on relevant differences among students. The teacher can do this by formulating minimum goals for all students. In fact, this is no differentiation, but the main condition for differentiation. Therefore, it was important that this item was included in the instrument.

To determine whether the observations of the three observers were consistent, the correlation between the observations was calculated using Pearson's correlation coefficient. Table 4 presents the correlations.

Table 4. Pearson's correlation coefficient between the observations of the observers

Observers	**Pearson Correlation**	**Sig.**
1 – 2	,93	,001*
1 – 3	,81	,014**
2 – 3	,88	,004*

** Significant when p<0,01 **Significant when p<0,05*

Table 3 shows that the ratings of the teachers between all observers were strongly positively correlated, and that the correlations are significant.

3.4 Procedures of data collection

CITO SMS mathematics test results for the beginning of the school year 2013/2014 and information about participants have been collected by Focus Staff, prior to this study. The CITO SMS mathematics test results for the middle of the school year 2013/4014 were collected, during the study. Other data of participants were also collected by Focus staff, prior to this study.

Data from the teachers, to measure whether they implement differentiated instruction or not, were collected by means of the observation instrument, developed for this study. Some of the lessons to be observed already had occurred before this study started, and other lessons occurred during the study. All lessons were videotaped by Focus staff.

3.5 Data analysis

To analyse the data obtained with the observation instrument, statistical analyses using IBM SPSS Statistics were employed. In order to answer the main question, the multi-level analysis was used to analyze the data. Multi-level analysis can be used in order to investigate whether independent variables are associated with dependent variables, but when data are not independent of each other. Mathematics achievement of students may depend upon the classroom in which they are, and the school to which they go. Through multi-level analysis, these factors are taken into account. The independent variable in this study was the degree of differentiated instruction provided by the teachers, while the average CITO SMS mathematics test result of students in the middle of the school year 2013/2014 was the main dependent variable. Whether the teachers educated combination lesson groups or not, the SES of the students in classrooms, the CITO SMS mathematics test results of the students at the beginning of the school year 2013/2014, and the size of the class functioned as control variables, and were added step wisely to the analysis. These control variables were chosen, because they ought to influence student mathematics achievement.

To answer the first sub question ‘’To what extent do teachers vary the extent of differentiated instruction between different groups of students?’’, the scores on items 5 and 6 from the observation instrument were used. Item 5 reads: ‘’The teacher provides below average students extra support in the instruction’’, while item 6 reads: ‘’The teacher provides above average students extra challenge in the instruction’’. By means of the t-test, it was tested whether the scores of teachers on the items 5 and 6 significantly differed from each other and, if so, in which direction.

Multi-level analysis was also used to answer the second sub question ‘’Which aspects of differentiated instruction influence student mathematics achievement most?’’. The independent variables were the scores on the separate items, while the average CITO SMS mathematics test result of students was the dependent variable.

Table 5. Link between questions and instrument

Questions	Instruments	Data	Data analysis
Main question: To what extent does differentiated instruction go together with more student mathematics achievement growth in primary school classrooms?	Observation instrument CITO SMS test	Scores of teachers on providing differentiated instruction CITO SMS test results of students from the beginning of the year and from the middle of the year Size of the class Combination group or not The socioeconomic status of the students	Multi-level analysis
Sub questions:			
1. To what extent do teachers vary the extent of differentiated instruction between different groups of students?	Items 5 and 6 of the observation instrument	Scores on items 5 and 6 of the observation instrument Size of the class Combination group or not The socioeconomic status of the students	T-test
2. Which aspects of differentiated instruction influence student mathematics achievement most?	Observation instrument CITO SMS test	Separate scores per item CITO SMS test results of students from the beginning of the year and from the middle of the year. Size of the class Combination group or not The socioeconomic status of the students	Multi-level analyses

4. RESULTS

In this chapter, the results of the different analyses for every research question are presented and the hypotheses are tested.

4.1 To what extent does differentiated instruction has effect student mathematics achievement in primary school classrooms?

Table 6 shows the CITO SMS mathematic test results of the students at the beginning of the school year and in the middle of the school year. The national average CITO SMS test results of students in grade 4 for mathematics at the beginning of the school year is ’44,0’ and in the middle of the school year ’50,0’ (CITO, 2013). In this study, the mean CITO SMS test result for mathematics at the beginning of the school year of the students was ‘45,6’, which is just above the national average. The mean CITO SMS test result for mathematics in the middle of the school year of the students was ’51,5’, which is also above the national average.

Table 6. CITO SMS test results of the students in grade 4 at the beginning of the school year 2013/2014 and in the middle of the school year 2013/2014

Teacher	CITO SMS mathematics test results of the students in grade 4 at the beginning of the school year 2013/2014	CITO SMS mathematics test results of the students in grade 4 in the middle of the school year 2013/2014
1	58,0	61,9
2	57,1	58,4
5	39,9	52,4
6	45,0	54,6
7	52,9	52,3
8	48,1	54,6
9	47,8	51,0
10	47,7	50,3
11	41,3	50,0
12	50,3	51,1
13	45,4	55,7
14	46,4	53,4
15	23,6	39,7
16	46,2	44,7
17	41,3	51,0
19	45,9	51,0
20	55,3	67,1

21	38,3	31,3
22	48,0	62,5
23	50,0	61,1
24	52,7	52,3
25	32,8	48,1
26	47,7	45,6
27	33,7	35,4
Mean	45,6	51,5
SD	8,0	8,2

Table 7 shows the scores of the teachers for providing differentiated instruction. These scores are averages of nine observations of three observers in total. There are no major differences between the scores of teachers in terms of their differentiation, but what is most notable is that almost all teachers scored generally low on differentiation.

After adjusting the scores, most teachers have the mean score 2 ‘more weaknesses than strengths’. Only two teachers have received the mean score 3 ‘more strengths than weaknesses’, for providing differentiated instruction. Together, the teachers had the mean score of ‘2,23’ for providing differentiated instruction with a standard deviation of ‘0,23’.

There are large variations in the mean scores of teachers between the items. The mean score of teachers on items 4, 6 and 7 differ very much from the mean score on the other items. Teachers scored relatively low on item 4 ‘’ The teacher adjusts the pace for processing the learning content to relevant differences between students’’, and item 6 ‘’The teacher provides above average students extra challenge in the instruction’’, and relatively high on item 7 ‘’The teacher evaluates the learning of students’’ in comparison with the scores for the other items of the observation instrument.

Table 7. Scores of teachers on providing differentiated instruction

Teacher	**Average score indicator 1 ‘adjusting the learning objectives’**	**Average score indicator 2 ‘learning environment’**	**Average score indicator 3 ‘adjusting the processing’**	**Average score indicator 4 ‘adjusting the pace’**	**Average score indicator 5 ‘support below-average students**	**Average score indicator 6 ‘challenge above-average students**	**Average score indicator 7 ‘evaluating learning**	**Average score differentiation**
1	2,78	1,89	2,45	3,22	2,44	1,00	3,11	2,41
2	1,78	2,44	2,11	1,89	2,33	1,11	3,22	2,13
5	2,11	2,22	2,67	2,00	2,67	1,33	3,00	2,29
6	2,11	2,22	2,78	2,00	2,55	2,44	3,67	2,54
7	2,00	2,00	1,33	1,22	2,34	1,00	3,11	1,86

8	2,11	2,22	2,78	2,22	2,11	1,44	3,33	2,32
9	3,06	2,33	2,72	1,33	2,67	1,33	2,44	2,27
10	2,11	2,22	2,44	1,66	2,11	1,22	2,11	1,98
11	1,56	2,22	2,78	1,00	1,11	1,22	3,56	1,92
12	1,78	2,44	2,89	2,11	2,78	1,33	2,44	2,44
13	1,78	2,00	2,22	1,11	1,89	1,11	2,78	1,84
14	2,45	2,22	2,11	1,56	2,89	1,33	3,33	2,27
15	2,00	2,11	1,33	2,33	2,44	1,00	3,33	2,08
16	2,55	2,00	2,22	1,67	2,78	1,22	2,33	2,26
17	2,22	2,52	1,78	3,00	2,33	1,00	3,44	2,33
19	2,00	1,89	2,33	2,44	2,33	1,00	3,33	2,19
20	3,22	2,89	2,89	2,33	2,78	1,45	3,89	2,78
21	2,45	2,67	2,56	1,89	2,78	1,00	3,22	2,37
22	2,11	2,00	1,55	2,00	1,67	1,11	3,00	1,92
23	2,44	1,89	2,56	1,44	2,00	1,22	3,11	2,10
24	2,11	2,44	2,78	2,00	2,33	1,22	3,67	2,36
25	2,33	2,45	2,33	1,67	2,89	1,33	3,56	2,37
26	2,11	2,11	2,89	2,67	2,44	1,67	3,22	2,44
27	2,33	3,00	2,22	1,11	2,33	1,22	3,56	2,25
Mean	2,23	2,27	2,36	1,91	2,37	1,26	3,16	2,23
SD	0,39	0,30	0,47	0,58	0,42	0,30	0,46	0,23

Table 8 summarizes tables 6 and 7 and shows an overview of the average score of teachers on differentiation, and the average growth in CITO SMS mathematics test results of the students. It was expected that these data were positively related.

Table 8. Overview of the average score of teachers on differentiation and the CITO SMS mathematics test results of the students in grade 4 in the middle of the school year

Teacher	**Average score of teachers on differentiation**	**CITO SMS mathematics test results of the students in grade 4 in the middle of the school year 2013/2014**
1	2,41	61,9
2	2,13	58,4
5	2,29	52,4
6	2,54	54,6
7	1,86	52,3

8	2,32	54,6
9	2,27	51,0
10	1,98	50,3
11	1,92	50,0
12	2,44	51,1
13	1,84	55,7
14	2,27	53,4
15	2,08	39,7
16	2,11	44,7
17	2,33	51,0
19	2,19	51,0
20	2,78	67,1
21	2,37	31,3
22	1,92	62,5
23	2,09	61,1
24	2,36	52,3
25	2,37	48,1
26	2,44	45,6
27	2,25	35,4
Mean	2,23	51,5
SD	0,23	8,2

Table 9 shows the outcomes of the multi-level analysis that was conducted to answer the main research question. The following abbreviations are used for the variables: differentiated instruction (DI), CITO SMS test results of students at the beginning of the year (CITO), combination group (CG), size of the class (SC), socioeconomic status (SES).

Table 9. Results of multi-level analysis: *The effect of differentiated instruction on student achievement*

	Model 1			**Model 2**			**Model 3**			**Model 4**		
Variable	*B*	*t*	*Sig.*	*B*	*t*	*Sig.*	*B*	*t*	*Sig.*	*B*	*t*	*Sig.*
DI	-,023	-,146	,162*	,036	,228	,822*	,035	,217	,831*	,046	,274	,787*
CITO	,711	4,581	,000*	,650	4,123	,001*	,653	3,912	,001*	,599	2,676	,015*
CG				-,226	-1,1408	,175*	-,216	-,952	,353*	-,019	-,086	,933*
SC							-,014	-,065	,949*	-,201	-,856	,403*
SES										-,083	-,374	,713*
R2	,502			,547			,547			,550		

** Significant when p<0,01*

Results are significant when the p-value is lower than 0,10. The results of the multi-level analysis show that the Beta-coefficient of differentiated instruction initially is negative, but when more control variables are added, the Beta-coefficient is positive, which means that the more the teacher differentiates, the higher the mathematics achievement of the students is. However, this results could be due to chance, because differentiated instruction has no statistically significant effect on mathematics achievement. Looking at the coefficient of determination, fifty-five percent of the variation in student mathematics achievement can be explained by the independent variables. To determine whether the control variables had statistically significant effects on student mathematics achievement, the multi-level analysis was conducted several times, within each analysis one of the control variables as the independent variable. Results show that only the CITO SMS test results of students at the beginning of the school year have significant effect on student mathematics achievement. The Beta-coefficient of the CITO SMS test results of the students at the beginning of the school year is also positive, which means that the higher the CITO SMS test results of the students at the beginning of the school year are, the higher the results will be in the middle of the year. The B-coefficient of the other control variables are all negative, meaning that they are all associated with less student mathematics achievement. However, this results can also be due to chance, for none of these control variable have statistically significant effect on student mathematics achievement. The results indicate that the hypothesis for the main question, that differentiation has effect on student mathematics achievement, must be rejected.

4.2 To what extent do teachers vary the extent of differentiated instruction between different groups of students?

To determine whether teachers varied the extent of differentiated instruction between different groups of students, the scores of teachers on items 5 and 6 of the observation instrument were used. Item 5 reads: ‘’The teacher provides below-average students extra support’’, while item 6 reads: ‘’The

teacher provides above-average students extra challenge''. Table 6 shows that almost all teachers considerably provided more differentiated instruction to below-average students than to above-average students. The average score on item 5 ''The teacher provides below-average students extra support'' of all teachers was '2,37', while the average score on item 6 ''The teacher provides above-average students extra challenge'' was '1,26'.

It was expected that below-average students would receive more differentiated instruction than above-average students. The t-test was conducted to determine whether the differences in the amount of provided differentiated instruction were significant. However, for using the t-test, the data must have a normal distribution. This was investigated by performing the Kolmogorov-Smirnov test. The Kolmogorov–Smirnov test is a nonparametric test of the equality of continuous, one-dimensional probability distributions. When the p-value of the data is higher than the significance level of 0,05, it can be assumed that the data have a normal distribution. In this study, the p-value of the data was 0,20, which meant that the data had a normal distribution and the t-test could be used.

The t-test provided the following data: t = 11,60; p = 0,00. The p-value of 0,00 is below the significance level of 0,05. This means that the hypothesis is confirmed. Like expected, the teachers varied the extent of differentiated instruction between different groups of students, providing below-average students with more differentiation than above-average students.

4.3 Which aspects of differentiated instruction influence student mathematics achievement most?

To determine which aspects of differentiated instruction had most influence on student mathematics achievement, the separate scores of teachers per item were examined and linked to student mathematics achievement through multi-level analysis. It was expected that providing below-average students with extra support and providing above-average students with extra challenge had the most influence on student mathematics achievement. This means that item 5 ″The teacher provides below-average students extra support'' and item 6 ''The teacher provides above-average students extra challenge'', were supposed to have most influence on student mathematics achievement. Table 10 shows the results of the multi-level analysis.

Table 10. Results of multi-level analysis: *The influence of different aspects of differentiated instruction on student mathematics achievement*

Independent variable	**B**	**T**	**Sig.**
Item 1: The teacher adjusts the learning objectives/expectations to relevant differences between students	,118	,573	,574
Item 2: The teacher takes the differences among students into account with the organization of the learning environment	-,200	-,935	,363

Item 3: The teacher adjust the processing of the learning content on relevant differences between students	-,218	-,798	,436
Item 4: The teacher adjusts the pace for processing the learning content on relevant differences between students	,047	,159	,876
Item 5: The teacher provides below-average students extra instructional support	-,197	-,776	,448
Item 6: The teacher provides above-average students extra challenge in the instruction	,208	,983	,339
Item 7: The teacher evaluates the learning of students during the processing of the learning content	,281	1,077	,430

Dependent variable: Student mathematics achievement

Items 6 and 7 have the largest positive Beta-coefficients, which would mean that providing above-average students extra challenge and evaluating the learning of students during the processing of the learning content, have the most influence on student mathematics achievement. However, this results can be due to chance, for none of the items have statistically significant effect on student mathematics achievement The same applies to items 1 and 4, for both items have positive Beta-coefficients, which would mean that the more the teacher adjusts the learning objectives/expectations to relevant differences between students and the more the teacher adjusts the pace for processing the learning content on relevant differences between students, the higher student mathematics achievement is, but no statistically significant effect is found for that. Item 2 ‘’The teacher takes the differences among students into account with the organization of the learning environment’’, item 3 ‘’The teacher adjust the processing of the learning content on relevant differences between students’’, and item 5 ‘’The teacher provides below-average students extra support in the instruction’’ have negative Beta-coefficients, meaning that those aspects decrease student mathematics achievement when implemented by the teachers, but that result can also be due to chance. These results indicate that the hypothesis is not confirmed.

5. CONCLUSION

In this chapter, the main research question and the sub questions will be answered on the basis of the results.

5.1 Main question

Although differentiation is widely acknowledged to be an important instructional approach for all students, because differentiated instruction is expected to improve the learning of each student, there is little known about the precise relationship between differentiation and learning of students. This study examined to what extent differentiated instruction goes together with more student mathematics achievement in primary school classrooms. Results showed that differentiated instruction has no significant effect on student mathematics achievement, which is against expectations. The Beta-coefficient of differentiated instruction was positive, which means that the more the teacher differentiates, the higher the student mathematics achievement is, however, that might be due to chance. This result may be due to the low variation between the extent of differentiated instruction provided by teachers. The teachers scored an average '2,23' for providing differentiated instruction with the standard deviation of '0,23'. On a scale of 1 to 4, this means that the teachers had the adjusted mean score '2', which indicates that the teachers showed more weaknesses than strengths on providing differentiated instruction. This low variation is remarkable, because the Dutch Inspectorate discovered that there are significant differences in the extent to which teachers in primary education possess general teaching skills, and the more complex differentiation skill (Inspectie van het Onderwijs, 2013).

In addition, whether the teachers taught combination groups or not, the average SES of the students in a classroom, and the size of the class also did not have significant effects on student mathematic achievement. Results showed that only the CITO test results of students at the beginning of the school year have significant effect on student mathematics achievement. The Beta-coefficient of the other control variables, combination groups, size of the class, and the percentage of student weight, are all negative. This means that these variables have a negative influence on student mathematics achievement, however, the results were not statistically significant.

5.2 Sub questions

Another aim of this study was to determine whether teachers varied the extent of differentiated instruction between different groups of students. Results showed that below-average students received more differentiated instruction than above-average students from teachers. This is in line with expectations, meaning that the hypothesis for this question was confirmed. Several explanations can be given for this result.

It was striking that almost no teacher provided differentiated instruction for above-average students. Above-average students only received limited opportunities to start to work after the basic instruction, while this is very important, because they needed less time to learn subject matter content

in comparison with other students. Above-average students were sometimes provided with more difficult tasks, but most of the time they only received little instruction about those tasks. Teachers explained the tasks, but did not ask challenging questions to the students. In addition, teachers rarely offered above-average students multiple learning strategies.

Although the teachers provided significantly more differentiated instruction for below-average students than for above-average students, most teachers did not provide below-average students with sufficient extra support. In many cases, below-average did not receive more time for the processing of the learning content. Furthermore, teachers did not function as role models for below-average students during extra instruction time, and they did not show below-average students which strategies have to be used in specific situations. Many teachers developed the extra instruction for below-average students as repetition of the basic instruction.

The results of this study indicate that it is possible that many teachers are unaware of the possibilities they have to differentiate their instruction for above-average students, for most teachers did not show their differentiation skills. Teachers did provide below-average students with differentiated instruction, however, many teachers have lots of opportunities improve the quality of that instruction.

The last aim of this study was to investigate which aspects of differentiated instruction had most influence on student mathematics achievement. Results showed that providing above-average students extra challenge and evaluating the learning of students during the processing of the learning content, had the strongest positive influence on student mathematics achievement, for the Beta-coefficients of those factors were the largest. This means that the more the teachers challenges above-average students, and the more the teachers evaluates the learning of the students, the higher the student mathematics achievement is. However, these associations were not statistically significant, so these finding may be due to chance. The same can be said for adjusting the learning objectives/expectations to relevant differences between students, and for adjusting the pace for processing the learning content on relevant differences between students.

Taking the differences among students into account with the organization of the learning environment, adjusting the processing of the learning content on relevant differences between students, and providing below-average students extra instructional support, even had a negative relationship with student mathematics achievement. However, no statically significant effects were found, so these findings can also be due to chance.

It is possible that the nature of the aspects of the observation instrument influenced the results. Adjusting the processing of the learning content on relevant differences between students, and providing below-average students extra instructional support, are both aimed at below-average students. If teachers want to adjust the processing of the learning content on relevant differences between students, they should let below-average students collaborate with above-average students.

Below-average students benefit from this, because below-average students need to be motivated by high achieving students, however, above-average students do not benefit from it, because then, they cannot learn at their own pace.

When teachers provide below-average students extra instructional support, they often do not meet the needs of the other students, because they are only focused on helping below-average students. In addition, the quality of the extra instructional support for below-average students is often questionable, because many teachers do not know how to develop such support for below-average students. Therefore, it is possible that mainly providing differentiated instruction for below-average students may have negative influence on average student mathematics achievement.

It appeared that differentiated instruction has no significant effect on student mathematics achievement, which is against expectations. Results also showed that teachers provided below-average significant more differentiated instruction than above-average students, although the quality of the extra instruction support for below-average students is often questionable. In addition, not all aspects of differentiated instruction had equal effect on student mathematics achievement. Providing above-average students extra challenge and evaluating the learning of students during the processing of the learning content, had the strongest positive influence on student mathematics achievement. Adjusting the learning objectives/expectations to relevant differences between students, and adjusting the pace for processing the learning content on relevant differences between students are also associated with more student mathematics achievement. In contradiction, it seemed that taking differences among students into account for the organization of the learning environment, adjusting the processing of the learning content on relevant differences between students, and providing below-average students extra instructional support, had a negative influence on student mathematics achievement, meaning that teachers should not only focus on providing below-average students with differentiated instruction. However, no statistically significant effects were found, so these results can be due to chance.

6. DISCUSSION

In this chapter, some limitations of this study are described and recommendations for further research will be given.

6.1 Limitations of this study

6.1.1 Observation instrument

The instrumentation had some limitations. The observations did not give insight in underlying motivations, thoughts and ideas of the teachers who were observed, making it difficult to determine why some decisions were made regarding the extent of differentiated instruction. This would have been valuable for the measurement of differentiated instruction as provided by the teachers, because then, several sides behind the actions of teachers are discussed. This creates the question whether observations alone are suitable for the measurement of differentiation.

The Cronbach's alpha of the instrument was 0,56. It means that the internal consistency of the instrument was just below an acceptable level of 0,60, which indicates that not all items really measure the same construct. This may have to do with the nature of the items, for some represented indirect aspects of differentiated instruction. Through the theoretical framework, it became clear that teachers have to formulate minimum goals for all students. This is actually no differentiation, but one of the conditions for differentiated instruction. That is why these aspects where included in the instrument.

The average scores of the teachers on the various items of the observation instrument varied very much. Although almost all aspects of differentiated instruction were implemented too little during the lessons of the teachers, most of the teachers did evaluate the learning of students during the processing of the learning content. In addition, teachers scored relatively low on adjusting the pace for processing the learning content on relevant differences between students, and on providing above-average students extra challenge in comparison with the scores on other aspects of differentiated instruction. The reason for this large variation between scores on different aspects of differentiated instruction may have been due to the difficulty of the aspects. It appeared that many teachers face problems in providing extra challenge for below-average students, which is maybe also the reason why most teachers do not adjust the pace for processing the learning content on relevant differences between students, because then, teachers have to put above-average students to work after the basis instruction, what often did not happen. Teachers are more familiar with evaluating the learning of students, which is probably the reason why they received relatively high scores on this aspect of differentiated instruction, because evaluating the learning of students is one of the main parts in teacher education programs (Ruys et al., 2013).

In comparison with the instrument for ranking and rating the use of differentiated instruction strategies of Roy et al. (2013), the instrument in this study was missing some very important aspects of differentiated instruction. It did not include evaluating the effectiveness of teaching adjustments, using data of students to make decisions about teaching adjustments, using alternative materials to match

abilities of students, adapting evaluations to match abilities of students, adapting the lesson plan format, assessing rate of improvement of low achievers frequently, and planning different assignments to match abilities of students. These aspects were not included, because it was not possible to observe them all in the classroom. Therefore, the link between theory and the items of the instrument did not fully correspond. The instrument of Roy et al. (2013) is meant to be used by teacher, so they can evaluate their own practices in and outside the classroom regarding differentiation. Because these aspects were not in the instrument, some information was missing that is important for determining the degree of differentiation provided by the teachers. These limitations indicate that some good theoretical framework and definition of the differentiation concept is necessary before differentiated instruction can measured validly.

6.1.2 Data collection

Some limitations can be found in the data collection. The low variation between the teachers on differentiation may have been influenced by the way the data was collected. The conducted evaluations of teacher behavior were quite strict, making it difficult for teachers to obtain sufficient scores on providing differentiated instruction. This may be due to the scoring system of the observation instrument. There were four scores that could be given to the teachers by the observers on each aspect of differentiated instruction, making it impossible for teachers to receive an average score. Scores 1 and 2 were insufficient, while scores 3 and 4 where sufficient, which means that the judgment of the observers is either negative or positive with no other possibility. That has probably led to the low scores of the teachers on differentiation.

Another possible reason for the low variation between teachers may have been the selection of the schools that was made by Focus staff. Focus staff selected strong, average and weak achievement-oriented approach schools to promote variation between the schools. This was done after Focus staff had worked two years with the schools. However, this selection tells nothing about individual teachers within schools. If schools are selected as weak achievement-oriented schools, there is still much variation in the abilities of teachers within those schools. Individual teachers were not investigated, so it may be that there was little variation between teachers selected for this study with regard to their abilities to work through the achievement-oriented way, which might have influenced the scores of teachers on providing differentiated instruction.

For this study, only students from grade 4 participated. This was done, because teachers have lots of opportunities to differentiate in grade 4. In addition, students in grade 4 are still very young, which means that they can learn relatively quickly and therefore, differentiated instruction has probably much influence on them. However, is it possible that more variation would have been found when teachers who teach in other grades also had been included in this study, because then, it may be possible to create more diversity between the participants.

Some lessons of teachers which were used for this study, were actually not appropriate for

inclusion. This is because there is no need to differentiate in every lesson (Chamberlin & Powers, 2010). For example, lessons in which students have to learn through investigation or in which they have to make tests. So sometimes, teachers were given low scores on providing differentiated instruction, even though they were not able to perform differently. This had negative influences on overall scores of teachers on differentiation, for the scores between several lessons of the same teachers could be very different sometimes.

Although all lessons were videotaped, not all actions by the teachers were registered by the camera, so some information may have been lost. In addition, despite that the observations took place in the primary schools of the teachers, and they were ensured that the results of those observations will only be used for research of the University of Twente, the teachers might have behaved differently than usually (Dooley, 2001). It could have been that the teachers were nervous or that they felt embarrassed. This may have affected their actions and may have had negative influences on the results of the study. Furthermore, not all lessons were videotaped that well, making it sometimes very difficult to observe the teachers reliably, for the audio of the camera sometimes did not work.

6.2 Recommendations for future research

This study demonstrated the results did not show an effect between differentiated instruction and student mathematics achievement in primary school classrooms, which may have been caused by various factors. This conclusion, as well as the limitations of this study, suggests interesting possibilities for future research. First of all, in future research, to increase variation between teachers on providing differentiated instruction, the scoring system of the observation instrument has to be changed. This will make it more easy for teachers to achieve sufficient scores on providing differentiated instruction. This can be done by creating more variation in the scoring system. Because the internal consistency of the instrument was just below the appropriate level, the instrument should be adjusted for future research in order to ensure that all the items of the observation instrument actually measure the amount of differentiated instruction provided by teachers.

Further research should also focus on how teachers actually understand, engage with, and respond to diversity in the classroom, because it turned out that many teachers still face problems in providing differentiated instruction. Therefore, research on the thoughts of teachers regarding differentiated instruction is needed. Through such research it is possible to ask teachers whether they think it is difficult to provide differentiated instruction, and why they think it is difficult to provide differentiated instruction. This will complete the observations, because then, more and other information about differentiated instruction becomes clear. When thoughts of teachers are identified, it is possible to determine why teachers do not provide differentiation or make certain decisions regarding differentiation in their classroom, which is useful to remove the problems the teachers face in providing differentiated instruction. It also important to investigate whether teachers implement other aspects of differentiated instruction, like whether teachers use data of students to make decisions

about teaching adjustments or whether teachers adapt the lesson plan format, because those aspects are essential for providing differentiated instruction. In that way, the degree of differentiated instruction provided by teachers can be better determined, for it seemed that only observations are not appropriate to measure differentiation.

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APPENDIX 1

OBSERVATIE-INSTRUMENT voor afstemmen van instructie en verwerking op verschillen

School:	Datum:
Groep:	Aantal leerlingen:
Leerkracht:	Vak:

Score[1] 1= overwegend zwak; 2= meer zwak dan sterk; 3= meer sterk dan zwak; 4= overwegend sterk.

Geobserveerd[2] 0= nee, dat heb ik niet waargenomen; 2= ja, dat heb ik waargenomen

Indicator: De leerkracht…		Score[1]	Voorbeelden van goede praktijk: De leerkracht…	Geobserveerd[2]
1.	…stemt de leerdoelen/verwachtingen af op relevante verschillen tussen leerlingen	1 2 3 4	…stelt bij aanvang van de les minimumleerdoelen voor alle leerlingen	0 1
			…spreekt voor de verwerking van de leerinhoud verschillende verwachtingen uit voor leerlingen met verschillende niveaus	0 1
2.	…houdt in de organisatie van de leeromgeving rekening met verschillen tussen leerlingen	1 2 3 4	…zorgt ervoor dat benedengemiddelde leerlingen kunnen samenwerken met bovengemiddelde leerlingen	0 1
			…zorgt ervoor dat de lesmaterialen zijn afgestemd op het niveau en de ontwikkeling van alle leerlingen	0 1
3.	…stemt de verwerking van de leerinhoud af op relevante verschillen tussen leerlingen	1 2 3 4	…maakt tussen leerlingen verschil in de complexiteit van de opdrachten	0 1
			…maakt tussen leerlingen verschil in het aantal opdrachten	0 1
			…laat leerlingen die dat nodig hebben hulpmaterialen gebruiken	0 1
4.	…stemt de tijd voor de verwerking van de leerinhoud af op relevante verschillen tussen leerlingen	1 2 3 4	…geeft benedengemiddelde leerlingen extra tijd voor de verwerking van de opdrachten	0 1
			…zet bovengemiddelde leerlingen na de basisinstructie aan het werk.	0 1
5.	…biedt benedengemiddelde	1 2 3 4	…geeft, naast de basisinstructie,	0 1

	leerlingen extra ondersteuning in de instructie		extra instructie aan benedengemiddelde leerlingen	
			…vertelt benedengemiddelde leerlingen expliciet welke strategie gebruikt moet worden	0 1
			…legt aan benedengemiddelde leerlingen de stappen uit van de strategie die gebruikt moet worden	0 1
			…laat beneden gemiddelde leerlingen de uitkomsten van de gebruikte strategie zien	0 1
6.	…biedt bovengemiddelde leerlingen extra uitdaging in de instructie	1 2 3 4	…geeft bovengemiddelde leerlingen aanvullende instructie over de verrijkingsstof	0 1
			…stelt uitdagende vragen aan bovengemiddelde leerlingen	0 1
			…leert bovengemiddelde leerlingen meerdere strategieën aan	0 1
			…bespreekt met bovengemiddelde leerlingen de voor- en nadelen van strategieën	0 1
			…geeft bovengemiddelde leerlingen de gelegenheid om hun eigen strategie te kiezen	0 1
7.	…evalueert tijdens de verwerking van de leerinhoud het leren van de leerlingen	1 2 3 4	…controleert de voortgang van leerlingen tijdens de verwerking van de opdrachten	0 1
			…biedt extra ondersteuning/uitdaging aan leerlingen op basis van de controle op de voortgang	0 1

APPENDIX II

Part of the ICALT observation instrument

Score[1] 1= overwegend zwak; 2= meer zwak dan sterk; 3= meer sterk dan zwak; 4= overwegend sterk.
Geobserveerd[2] 0= nee, dat heb ik niet waargenomen; 2= ja, dat heb ik waargenomen

Indicator: De leerkracht…		Score[1]	Voorbeelden van goede praktijk: De leerkracht…	Geobserveerd[2]
Afstemmen van instructie en verwerking op verschillen				
23	…gaat na of de lesdoelen werden bereikt	1 2 3 4	…gaat na of de doelen van de les zijn bereikt	0 1
			…gaat na wat de prestaties van de leerlingen zijn	0 1
24	…bidet zwakke leerlingen extra leer- en instructietijd	1 2 3 4	…geeft zwakke leerlingen extra leertijd	0 1
			…geeft zwakke leerlingen extra instructietijd	0 1
			…geeft zwakke leerlingen extra oefeningen	0 1
			…geeft zwakke leerlingen ‘voor’- of ‘na’-instructie	0 1
25	…stemt de instructie af op relevante verschillen tussen leerlingen	1 2 3 4	…zet leerlingen die minder instructie aan groepjes of individuele leerlingen	0 1
			…geeft aanvullende instructie aan groepjes of individuele leerlingen	0 1
			…richt zich niet alleen op de middenmoot	0 1
26	…stemt de verwerking van de leerstof af op relevante verschillen tussen leerlingen	1 2 3 4	…maakt tussen leerlingen verschil in de omvang van opdrachten	0 1
			…geeft niet alle leerlingen dezelfde tijd voor de opdracht	0 1
			…laat sommige leerlingen gebruik maken van hulpmaterialen	0 1

APPENDIX III

Instruction for observers about the observation instrument

Scoren van de indicatoren

Indicator 1:

- Score 1 wanneer geen voorbeelden van goede praktijk te zien zijn.
- Score 2/3 wanneer er één voorbeeld van goede praktijk te zien is. Waar ligt het verschil? Geeft de leerkracht alleen aan wat de leerlingen gaan doen in de les, bijvoorbeeld: ‘’Vandaag gaan we rekenen met breuken’’, dan is score 2 van toepassing. Formuleert de leerkracht dit daadwerkelijk als doel, bijvoorbeeld: ‘’Vandaag gaan jullie leren om breuken om te zetten in kommagetallen en percentages’’, dan is score 3 van toepassing.
- Score 4 wanneer beide voorbeelden van goede praktijk te zien zijn

Indicator 2:

- Score 1 wanneer er geen voorbeelden van goede praktijk te zien zijn
- Score 2 wanneer alleen het volgende voorbeeld van goede praktijk te zien is: ‘’…zorgt ervoor dat de lesmaterialen zijn afgestemd op het niveau en de ontwikkeling van alle leerlingen’’
- Score 3 wanneer alleen het volgende voorbeeld van goede praktijk te zien is: ‘’…zorgt ervoor dat benedengemiddelde leerlingen kunnen samenwerken met bovengemiddelde leerlingen’’
- Score 4 wanneer er twee voorbeelden van goede praktijk te zien zijn

Indicator 3:

- Score 1 wanneer er geen voorbeelden van goede praktijk te zien zijn
- Score 2 wanneer er één voorbeeld van goede praktijk te zien is
- Score 3 wanneer er twee voorbeelden van goede praktijk te zien zijn
- Score 4 wanneer er drie voorbeelden van goede praktijk te zien zijn

Indicator 4:

- Score 1 wanneer er geen voorbeelden van goede praktijk te zien zijn
- Score 2 wanneer alleen het volgende voorbeeld van goede praktijk te zien is: ‘’…geeft benedengemiddelde leerlingen extra tijd voor de verwerking van de opdrachten’’
- Score 3 wanneer alleen het volgende voorbeeld van goede praktijk te zien is: ‘’…zet bovengemiddelde leerlingen na de basisinstructie aan het werk’’
- Score 4 wanneer er twee voorbeelden van goede praktijk te zien zijn

Indicator 5:

- Score 1 wanneer er geen voorbeelden van goede praktijk te zien zijn
- Score 2 wanneer er één voorbeeld van goede praktijk te zien is of wanneer er twee voorbeelden van goede praktijk te zien zijn
- Score 3 wanneer er drie voorbeelden van goede praktijk te zien zijn
- Score 4 wanneer er vier voorbeelden van goede praktijk te zien

Indicator 6:

- Score 1 wanneer er geen voorbeelden van goede praktijk te zien zijn
- Score 2 wanneer er één voorbeeld van goede praktijk te zien is of wanneer er twee voorbeelden van goede praktijk te zien zijn
- Score 3 wanneer er drie of vier voorbeelden van goede praktijk te zien zijn
- Score 4 wanneer er vijf voorbeelden van goede praktijk te zien zijn

Indicator 7:

- Score 1 wanneer geen voorbeelden van goede praktijk te zien zijn
- Score 2 wanneer het volgende voorbeeld van goede praktijk te zien is: ‘’…controleert de voortgang van leerlingen tijdens de verwerking van de opdrachten’’, maar de leerkracht alleen de voortgang van benedengemiddelde leerlingen controleert.
- Score 3 wanneer het volgende voorbeeld van goede praktijk te zien is: ‘’…controleert de voortgang van leerlingen tijdens de verwerking van de opdrachten’’, en dat doet bij benedengemiddelde leerlingen en bovengemiddelde leerlingen.
- Score 4 wanneer er twee goede voorbeelden van praktijk te zien zijn.

APPENDIX IV

Instrument from Roy et al. (2013)

Table 5. Ranking and ratings of use of differentiated instruction strategies

		Frequency					
	Strategies	Mean	1	2	3	4	5
1.	Adjust the amount of work required in accordance with student's capabilities	3.82	2	6	26	39	26
2.	Provide weaker students with additional aids or tools (e.g. study guide)	3.72	2	10	24	42	21
3.	Evaluate the effectiveness of teaching adjustments (e.g. monitor subsequent achievement and progress	3.64	4	13	22	38	23
4.	Use students' data to make decisions about teaching adjustments	3.61	8	9	23	32	26
5.	Analyse data about students' academic progress	3.58	1	16	32	26	25
6.	Modify goals and expectations for students with difficulties	3.49	4	18	25	33	21
7.	Use alternative materials to math students' abilities (e.g. books below and beyond grade level)	3.30	10	16	29	23	22
8.	Plan different assignments to math students' abilities	3.27	3	25	30	23	18
9.	Adapt evaluations to math students' abilities (e.g. adjust grading)	3.12	11	22	28	19	18
10.	Assess low achievers' rate of improvement frequently	3.02	10	23	31	25	10
11.	Vary the complexity of assignments to math students' abilities (e.g. make judgments about a text or summarise, recognize the main themes)	2.97	12	23	30	26	9
12.	Adapt the lesson plan format (e.g. present information in a different sequence, give more explanations)	2.63	18	28	33	14	7

Note: 1 = never, 5 = very frequently.