Chapter 35
How Do Dutch Teachers Implement Differentiation In Primary Mathematics Education?

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Abstract Adapting education to students' diverse educational needs is widely recognised as an important, but also complex aspect of effective teaching. In this chapter, we provide insight into how Dutch primary school teachers implement differentiation based on students' current mathematics achievement level. We review evidence from four independent samples in which the same teacher self-assessment questionnaire was administered (*N* = 907 teachers in total), supplemented with qualitative data from various perspectives: external observers, students, and teachers. Based on these sources of information, we identify the following general patterns. Teachers generally implement achievement-based differentiation at least to some extent. That is, student achievement is monitored, and efforts are taken to adapt instruction or practice to students' current achievement level. This is often organised using within-class homogeneous achievement groups. While low-achieving students regularly receive additional instruction, specific instruction for high-achieving students is uncommon. Refined, qualitative strategies to diagnose students' individual educational needs and to adapt education to these individual needs are also used relatively infrequently. These relatively infrequently used strategies point to areas for improvement. Furthermore, the flexibility of within-class achievement groups seems to vary and deserves more attention in future research and practice.

Keywords Differentiation · Implementation · Mathematics education · Adaptive teaching · Formative assessment

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1 Introduction

Adapting education to students' diverse educational needs is widely recognised as an important, but also complex aspect of effective teaching (Kyriakides et al., 2009; Parsons et al., 2018). Implementing differentiation requires specific attitudes, knowledge, and skills, and concerns about suboptimal implementation of differentiation have been raised (Hertberg-Davis, 2009; Inspectorate of Education, 2012, 2018; Schumm et al., 2000; Van Geel et al., 2018; Vogt & Rogalla, 2009). Knowledge about how teachers currently adapt education to students' diverse educational needs is the first step towards promoting effective differentiation. In this chapter, we focus on the research question: How do Dutch primary school teachers implement differentiation based on students' current mathematics achievement level? Specifically, which strategies are used relatively frequently and infrequently? To answer this question, we looked for general patterns in data from four independent studies that investigated differentiation practices in Dutch primary mathematics education using various quantitative and qualitative measures.

1.1 Theoretical Background

In this chapter, we focus on differentiation based on students' current level of knowledge and skills (also called readiness-based or cognitive differentiation), defined as 'an approach by which teaching is varied and adapted to match students' abilities using systematic procedures for academic progress monitoring and data-based decision-making' (Roy et al., 2013, p.1187). According to this definition, teachers should monitor students' academic progress to identify students' educational needs and then adapt instruction to these needs.

To specify *how* educational needs should be determined and *how* instruction should be adapted in the context of primary mathematics education, a previous study sought consensus among experts in the field of differentiation and mathematics education (Prast et al., 2015). This resulted in the cycle of differentiation depicted in Fig. 35.1.

Organisationally, this model assumes the use of flexible homogeneous within-class achievement groups (Tieso, 2003). The term 'achievement grouping' rather than 'ability grouping' is used since students should be grouped flexibly based on their current level of knowledge and skills rather than on (presumably fixed) academic ability. These achievement groups (typically a low-achieving, average-achieving and high-achieving group) should be used part of the time to cater specifically to the educational needs of the different subgroups, besides whole-class activities where possible and individualised adaptations where necessary. Note, however, that the steps of the cycle of differentiation could also be organised in a different way.

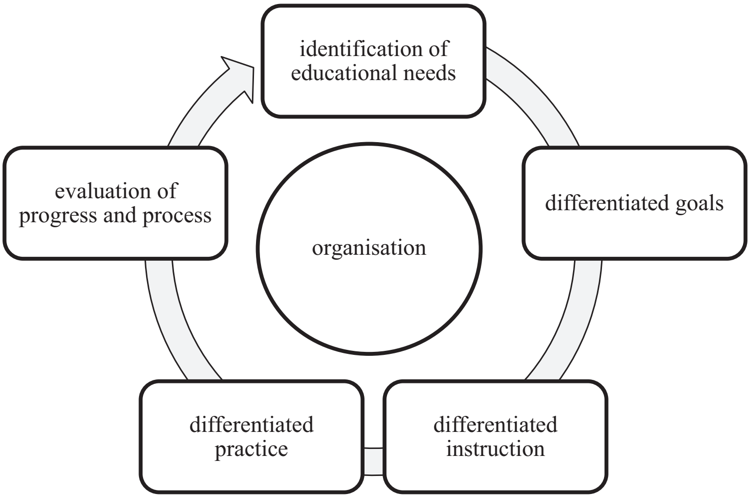

Fig. 35.1 Cycle of differentiation (Prast et al., 2015)

The first step in the cycle of differentiation is the identification of educational needs. Information from various sources, including formal and informal assessments, should be used to assign students to achievement groups, to change these groups when necessary, and to gather more refined information about students' educational needs (Prast et al., 2015; Van Geel et al., 2018). In the second step, the teacher should set challenging but realistic goals, which may be the same (convergent differentiation) or different (divergent differentiation) for the different subgroups (Blok, 2004; Prast et al., 2015; Van Geel et al., 2018). Third, the teacher should differentiate instruction through broad whole-class instruction engaging students of diverse achievement levels, tailored subgroup instruction, and individual adaptations (Bosker et al., 2021; Prast et al., 2015). Effective instructional approaches for low-achieving students in mathematics include direct explicit instruction and adapting the level of abstraction (e.g., starting at a more concrete level by working with manipulatives) (Gersten et al., 2009; Van Groenestijn et al., 2011). High-achieving students may need less instruction to reach the general goals for the whole class, but these students also need instruction and feedback (VanTassel-Baska & Stambaugh, 2005). This may include subgroup instruction that stimulates higher-order thinking and reflection on various possible ways of solving a challenging problem (Prast et al., 2015; Rogers, 2007). Fourth, the practice tasks should be differentiated. For the low-achieving subgroup, the most crucial tasks towards mastery of the goals should be selected. For the high-achieving subgroup, the regular material should be compacted and supplemented with challenging enrichment tasks (Rogers, 2007; VanTassel-Baska & Wood, 2010). Fifth and finally, the teacher should use a range of formal and informal assessments to evaluate whether the students have met the goals and whether the applied adaptations of instruction and practice had the desired effect (Prast et al., 2015). This phase can also be used to reflect on the learning process with the students (Van Geel et al., 2018). The evaluation phase informs the teacher about students' current achievement level and about instructional approaches that work for these students, completing the cycle and serving as new input for the identification of educational needs.

1.2 The Dutch Context

Meelissen et al. (2020) provide a brief overview of the Dutch educational system and the primary mathematics curriculum. Dutch primary school classes typically include students with a broad range of academic ability and achievement levels. To the extent possible, students with special educational needs are included in regular education. Separate special education schools exist for students with more severe problems. Since the enactment of a new law about inclusive education in 2014, regular education teachers perceive an increased need for differentiation (Ledoux et al., 2020).

Traditionally, Dutch students performed well on international comparative studies about mathematics achievement, but the Netherlands are losing their leading position (KNAW, 2009; Mullis et al., 2020). Moreover, while relatively many Dutch students reach at least a basic level of mathematics achievement, relatively few Dutch students perform excellently (Inspectorate of Education, 2021; Meelissen et al., 2020). Concerns about this have spurred the following developments. First, benchmarks (reference levels) have been established to specify what knowledge and skills students should have obtained at the end of primary school (Meelissen et al., 2020). A distinction is made between fundamental goals, which should be reached by 85% of the students, and striving goals, which should be reached by 65% of the students. In the Netherlands, the mathematics curriculum is primarily determined by the textbooks on which teachers rely heavily (Van Zanten & van den Heuvel-Panhuizen, 2017). Most mathematics textbooks have been adapted to work towards these benchmarks, and typically provide differentiated practice tasks at two or three levels. In the last three grades of primary school, the lowest-level tasks prepare students for the fundamental goals rather than the striving goals, which means that students get differentiated opportunities-to-learn. Second, the crucial role of the teacher in promoting students' mathematics achievement has been acknowledged (KNAW, 2009). Third, the government has started to promote data-based decision-making to increase student achievement (Doolaard, 2013a, b; Visscher, 2015). Data-based decision making is closely related to differentiation, especially to its progress monitoring component.

Taken together, these developments have underlined teachers' important role in monitoring students' progress and adapting instruction accordingly. However, the Dutch Inspectorate of Education has expressed concerns that many teachers do not implement differentiation optimally (Inspectorate of Education, 2012, 2018). In this chapter, we investigate how Dutch teachers implement differentiation in primary mathematics education. Specifically, we aim to identify general patterns of relatively frequently and infrequently used strategies for differentiation across various samples and sources of data.

2 Method

2.1 Overview and Participants

To answer the research questions, we combine data from four independent samples (see Table 35.1 for an overview). In each sample, the Differentiation Self-Assessment Questionnaire (DSAQ; see Sect. 2.2) was administered. Additionally, different types of data (video observations, student reports and additional teacher self-report data) were collected in the individual samples.

Sample 1 (Prast et al., 2015) consisted of 268 teachers of grade 1 through 6 who worked at schools that chose to participate in a large-scale research and professional development project about differentiation. The DSAQ was administered among all teachers at the start of the project. Sample 2 (Prast et al., 2023) consisted of 50 teachers and their students of grade 1, 3 and 5, recruited through the schools at which pre-service teacher training students did their internship. Sample 3 (Van Geel et al., 2022) included 300 teachers recruited through the network of the researchers on social media. Besides teachers of grade 1 through 6, this sample also included 48 Kindergarten teachers (in the Netherlands, two Kindergarten years are integrated in

Table 35.1 Overview of samples and measures

	Sample 1	Sample 2	Sample 3	Sample 4
Publication(s)	Prast et al. (2015), (2018)	Prast et al. (2023)	Van Geel et al. (2022)	Inspectorate of Education (2021)
Year of data collection	2012	2018	2019	2018–2019
Differentiation Self-Assessment Questionnaire (DSAQ)	268 teachers	50 teachers [a]	300 teachers [a]	289 teachers
Additional data	Video observations in a subsample of 55 teachers (the teacher of grade 3 in all participating schools and teachers of grade 1–6 in 6 schools)	Teacher self-reports of grouping practices; Student reports of differentiated activities (N = 310)	Teacher self-reports about learning to implement the strategies	A subsample of 110 of the 289 teachers were asked to fill out lesson logbooks; 65 teachers responded.

[a] Item-level DSAQ-scores were provided for this book chapter by the authors of the respective publications

primary school before students enter grade 1). Sample 4 (Inspectorate of Education, 2021) was a nationally representative sample of 289 teachers taking part in the Dutch national mathematics assessment 2018–2019. This sample consisted of 228 teachers teaching sixth grade students in regular primary education and 61 teachers teaching students at the end of special primary education. Differences between regular and special primary education teachers in the DSAQ-scores were minimal (Inspectorate of Education, 2021). In each sample most teachers were female (68–94%), which reflects the Dutch population of primary school teachers. Across samples, teachers had an average of 14–16 years of teaching experience, with a broad range from beginning teachers to very experienced teachers (range 0–44 years). Further details regarding the samples can be found in the respective publications.

2.2 Measures

The Differentiation Self-Assessment Questionnaire (DSAQ; Prast et al., 2015) was developed based on the cycle of differentiation described in Sect. 1.2. For each step in the cycle, a subscale was created comprising items representing various strategies for differentiation (e.g., 'I analyse the answers on curriculum-based tests to assess a student's educational needs'; see Tables 35.2a, 35.2b, 35.2c, 35.2d, and 35.2e). Teachers evaluate their use of the strategies on a five-point scale ranging from 'does not apply to me at all' to 'fully applies to me'. In the original validation study, which is Sample 1 in the current chapter, the DSAQ demonstrated convergent and divergent validity compared to other teacher self-assessment scales (Prast et al., 2015). The subscales had an adequate internal consistency (Cronbach's alpha between 0.69 and 0.86; see Tables 35.2a, 35.2b, 35.2c, 35.2d, and 35.2e for Cronbach's alpha in each sample). Consistent with Roy et al. (2013), the subscales loaded on two

Table 35.2a DSAQ subscale 1 statistics: reliability (Cronbach's α) and means and standard deviations (in parentheses) of subscale and individual items

DSAQ subscale / item	*Sample 1 (N = 268)* *α = .69*	*Sample 2 (N = 50)* *α = .68*	*Sample 3 (N = 300)* *α = .63*	*Sample 4 (N = 289)* *α = .74*	*Overall across Samples*
Subscale 1: Identification of educational needs	***3.64 (0.55)***	***3.97 (0.55)***	***3.94 (0.62)***	***3.83 (0.67)***	***3.82 (0.61)***
1.1 I analyse the answers on curriculum-based tests to assess a student's educational needs	4.02 (0.77)	4.20 (0.887)	4.13 (0.93)	4.15 (0.91)	4.11 (0.88)
1.2 I analyse the answers on standardised tests to assess a student's educational needs	3.49 (0.91)	4.00 (0.87)	3.98 (1.01)	3.97 (0.97)	3.83 (0.96)
1.3 I assess specific students' educational needs based on daily maths work	3.75 (0.72)	4.08 (0.72)	3.95 (0.95)	3.87 (0.89)	3.87 (0.86)
1.4 I assess specific students' educational needs based on (informal) observations during the maths lesson	3.76 (0.77)	4.20 (0.67)	4.14 (0.90)	3.78 (0.93)	3.92 (0.86)
1.5 If necessary, I conduct diagnostic conversations to analyse the educational needs of specific students	3.20 (0.90)	3.35 (1.05)	3.49 (1.21)	3.35 (1.06)	3.92 (1.07)

Scale: 1 = does not apply to me, 5 = fully applies to me
Color coding: dark green = +0.5 SD compared to overall subscale mean, light green = +0.25 SD, light red = −0.25 SD, dark red = −0.5 SD

Table 35.2b DSAQ subscale 2 statistics: reliability (Cronbach's α) and means and standard deviations (in parentheses) of subscale and individual items

DSAQ subscale / item	*Sample 1 (N = 268)*	*Sample 2 (N = 50)*	*Sample 3 (N = 300)*	*Sample 4 (N = 289)*	*Overall across Samples*
	α = .79	***α = .73***	***α = .73***	***α = .81***	
Subscale 2: Differentiated goals	***3.78 (0.55)***	***3.83 (0.67)***	***4.05 (0.66)***	***4.22 (0.67)***	***3.92 (0.63)***
2.1 I set different goals for the children, dependent on their achievement level	3.62 (0.79)	3.67 (1.02)	3.80 (1.03)	4.25 (0.93)	3.88 (0.93)
2.2 I set extra challenging goals for high-achieving students	3.57 (0.83)	3.84 (1.04)	4.21 (0.90)	4.18 (0.98)	3.99 (0.91)
2.3 I set well-considered minimum goals for very low-achieving students	3.75 (0.76)	3.78 (1.00)	3.87 (1.04)	4.20 (0.89)	3.93 (0.91)
2.4 I know the opportunities for differentiation offered by the curriculum	4.03 (0.68)	3.98 (1.00)	4.28 (0.96)	4.33 (0.81)	4.21 (0.84)
2.5 I use the opportunities the curriculum offers for differentiation for high-achieving students	3.88 (0.84)	4.08 (0.93)	3.97 (1.05)	4.18 (0.95)	4.02 (0.95)
2.6 I use the opportunities the curriculum offers for differentiation for low-achieving students	3.83 (0.82)	3.65 (1.11)	3.97 (1.05)	4.19 (0.92)	3.98 (0.95)

Table 35.2c DSAQ subscale 3 statistics: reliability (Cronbach's α) and means and standard deviations (in parentheses) of subscale and individual items

DSAQ subscale / item	*Sample 1 (N = 268)*	*Sample 2 (N = 50)*	*Sample 3 (N = 300)*	*Sample 4 (N = 289)*	*Overall across Samples*
	α = .72	***α = .70***	***α = .77***	***α = .86***	
Subscale 3: Differentiated instruction	***3.81 (0.42)***	***4.19 (0.44)***	***4.13 (0.58)***	***4.21 (0.62)***	***4.07 (0.55)***
3.1 I adapt the level of abstraction of instruction to the needs of the students	3.95 (0.55)	4.48 (0.54)	4.27 (0.76)	4.41 (0.74)	4.23 (0.69)
3.2 I adapt the modality of instruction (visual, verbal, manipulative) to the needs of the students	3.82 (0.62)	4.22 (0.68)	4.17 (0.84)	4.22 (0.78)	4.09 (0.69)
3.3 I adapt the pace of instruction to the needs of the students	3.95 (0.56)	4.34 (0.77)	4.28 (0.81)	4.40 (0.74)	4.22 (0.72)
3.4 I deliberately ask open-ended questions during whole-class instruction	3.82 (0.67)	4.20 (0.76)	4.12 (0.98)	4.24 (0.93)	4.07 (0.87)
3.5 I deliberately ask questions at various difficulty levels during whole-class instruction	3.69 (0.73)	4.16 (0.82)	4.09 (0.96)	4.08 (0.89)	3.97 (0.87)
3.6 I regularly provide low-achieving children with additional instruction (extended instruction, pre-teaching)	4.25 (0.64)	4.42 (0.70)	4.45 (0.81)	4.37 (0.83)	4.36 (0.76)
3.7 I regularly provide high-achieving students with additional instruction or guidance at their level, in a group or individually	3.20 (0.92)	3.51 (0.85)	3.58 (1.13)	3.80 (0.94)	3.53 (1.00)

Table 35.2d DSAQ subscale 4 statistics: reliability (Cronbach's α) and means and standard deviations (in parentheses) of subscale and individual items

DSAQ subscale / item	*Sample 1 (N = 268)*	*Sample 2 (N = 50)*	*Sample 3 (N = 300)*	*Sample 4 (N = 289)*	*Overall across Samples*
	α = .72	***α = .69***	***α = .80***	***α = .74***	
Subscale 4: Differentiated practice	***3.46 (0.55)***	***3.73 (0.57)***	***3.83 (0.73)***	***3.96 (0.70)***[b]	***3.66 (0.64)***[c]
4.1 I vary different types of practice during the maths lesson (e.g. individual or group work, solution spoken, written or drawn)	3.53 (0.78)	4.02 (0.74)	3.79 (1.04)	3.79 (0.92)	3.70 (0.91)[c]
4.2 I adjust different types of practice to the needs of the students in the classroom (e.g. having a specific child complete exercises on the computer because this child learns more in this way)	3.04 (0.83)	3.31 (0.95)	3.52 (1.13)	3.58 (0.95)	3.29 (1.00)[c]
4.3 I select the most important tasks for very low-achieving students	3.73 (0.73)	3.72 (0.93)	4.03 (1.01)	4.09 (0.91)	3.87 (0.89)[c]
4.4 I use curriculum compacting for high-achieving students	3.20 (1.25)	4.00 (1.14)	3.97 (1.20)	4.07 (1.16)	3.64 (1.22)[c]
4.5 I provide high-achieving students with enrichment tasks	4.00 (0.87)	4.23 (1.04)	4.37 (0.94)	4.27 (1.00)	4.20 (0.92)[c]
4.6 I also use computer programmes or maths websites in my maths lessons	3.68 (0.97)	3.92 (1.03)	3.96 (1.78)	–[a]	3.84 (1.43)[c]
4.7 I use computer programmes and/or maths websites to offer children focused practice in a skill that they do not sufficiently master	3.32 (0.96)	3.46 (1.18)	3.59 (1.31)	–[a]	3.46 (1.16)[c]
4.8 I use computer programmes and/or maths websites to offer specific children additional challenge in the maths lesson	3.15 (1.05)	3.18 (1.17)	3.44 (1.36)	–[a]	3.29 (1.22)[c]

[a]This item was not administered in Sample 4 due to overlap with other items in the questionnaire of that study

[b]The scale mean and standard deviation were computed on items 4.1 through 4.5

[c]The overall means and standard deviations were computed based on Sample 1–3

Table 35.2e DSAQ subscale 5 statistics: reliability (Cronbach's α) and means and standard deviations (in parentheses) of subscale and individual items

DSAQ subscale / item	*Sample 1 (N = 268)* α = .86	*Sample 2 (N = 50)* α = .80	*Sample 3 (N = 300)* α = .77	*Sample 4 (N = 289)* α = .80	*Overall across Samples*
Subscale 5: Evaluation of progress and process	***3.56 (0.57)***	***3.78 (0.60)***	***3.81 (0.63)***	***3.87 (0.61)***	***3.75 (0.61)***
5.1 I use scores on standardised and curriculum-based tests to evaluate whether the learning goals have been met	4.04 (0.73)	4.31 (0.74)	4.24 (0.93)	4.42 (0.82)	4.24 (0.83)
5.2 I analyse the answers on curriculum-based tests to evaluate whether the learning goals of that unit have been met	4.06 (0.72)	4.33 (0.83)	4.31 (0.91)	4.22 (0.93)	4.21 (0.86)
5.3 I regularly evaluate whether all students have met the learning goals based on their daily maths work	3.75 (0.85)	3.96 (0.86)	4.00 (0.93)	4.05 (0.91)	3.94 (0.90)
5.4 I evaluate whether all students have met the lesson goals based on (informal) observations during the maths lesson	3.45 (0.86)	3.58 (0.99)	3.94 (0.94)	3.83 (0.88)	3.74 (0.90)
5.5 I conduct diagnostic conversations to evaluate whether specific students have met the lesson goals	2.85 (0.87)	3.10 (1.09)	2.96 (1.11)	3.13 (1.00)	2.99 (1.01)
5.6 I evaluate whether the type of instruction and practice chosen by me were effective for the majority of the students in the class	3.44 (0.77)	3.72 (0.81)	3.74 (0.96)	3.78 (0.88)	3.66 (0.87)
5.7 I evaluate whether a specific type of instruction was effective for specific students	3.32 (0.80)	3.46 (0.91)	3.54 (1.00)	3.67 (0.86)	3.51 (0.90)

higher-order factors, namely progress monitoring (subscales identification of educational needs and evaluation of progress and process) and instructional adaptations (subscales differentiated goals, differentiated instruction, and differentiated practice).

A brief description of the additional data collected in the individual samples is integrated in the results section to enhance readability.

3 Results

3.1 DSAQ Results

Mean scores and pooled standard deviations across all four samples were calculated. As Tables 35.2a, 35.2b, 35.2c, 35.2d, and 35.2e show, teachers' self-assessment scores were generally quite high, with mean scores well above the midpoint of the scale for all subscales and for most items.

To investigate which strategies for differentiation had relatively high and low scores, the mean item scores were compared to the mean score for the subscale to which each item belonged, in relation to the pooled standard deviation of the subscale. Specifically, item scores were considered moderately high (light green in Tables 35.2a, 35.2b, 35.2c, 35.2d, and 35.2e) if they were at least a quarter of a standard deviation higher than the subscale mean and high (dark green) if they were at least half of a standard deviation higher than the subscale mean. Similarly, item scores were considered moderately low (light red) if they were at least a quarter of a standard deviation lower than the subscale mean and low (dark red) if they were at least half a standard deviation lower than the subscale mean. This is reported per sample as well as for the overall results aggregated across the samples.

As can be seen in Tables 35.2a, 35.2b, 35.2c, 35.2d, and 35.2e, the pattern of (moderately) low or high use was largely consistent across samples. Strategies that were classified as (moderately) high in the overall sample were not always (moderately) high compared to the subscale average of each individual sample, but they were almost never classified as (moderately) low in individual samples. The same goes for strategies that were classified as (moderately) high. Only for two items (4.4 and 4.6), the direction of effects differed between samples, with moderately low scores in Sample 1 and moderately high scores in Sample 2.

We continue to describe the overall scores across the four samples. Teachers indicated to use various sources of information to identify students' educational needs (range 3.83–4.11), with moderately high scores for the analysis of answers on curriculum-based tests, and low scores for diagnostic conversations. Regarding differentiated goals, item scores were quite homogeneous (range 3.88–4.21), with only one moderately high score for knowing the opportunities of differentiation offered by the curriculum. Within the subscale for differentiated instruction (range 3.53–4.36), there was a remarkable difference between the high score for additional instruction for low-achieving students and the low score for instruction for high-achieving students. Adapting the pace of instruction also scored moderately high. Regarding differentiated practice (range 3.29–4.20), there was substantial variability between the items. While the general use of varied types of practice was around the subscale average, the score for adjusting different types of practice to the needs of specific students was low. Selection of the most important tasks for very low-achieving students scored moderately high, and the use of enrichment tasks for high-achieving students scored high. While the general use of computer programmes was moderately high, the use of computer programmes for focused practice was moderately low and the use of computer programmes for specific challenge was low. Regarding evaluation (range 2.99–4.24), the reported use of scores on standardised and curriculum-based tests to evaluate students' progress was high, and the use of daily mathematics work was moderately high. In contrast, evaluating whether a specific type of instruction was effective for specific students scored moderately low and conducting diagnostic conversations to evaluate whether specific students have met the lesson goals scored low.

3.2 Additional Data

In each sample, additional data were collected using various measures. In this section, the most relevant results are summarised.

In a subsample of 55 teachers from Sample 1, one or two mathematics lessons per teacher were observed and scored with a systematic video observation instrument (see Prast et al., 2018, for details). The results indicated that most teachers worked systematically with achievement groups. Most teachers differentiated the practice tasks based on the suggestions in the textbook, sometimes complemented with supplementary materials. For high-achieving students, the use of challenging enrichment tasks was more common than compacting of the regular material (i.e., reducing the amount of repetitive practice). Regarding instructional attention and adaptations, the observations revealed a difference between differentiation for low-achieving and high-achieving students. Teachers regularly spent specific attention to low-achieving students, for example by providing extended instruction to a subgroup, providing explicit instruction, teaching at a lower level of abstraction, or building understanding of the concepts behind a mathematical procedure (i.e., multiplication and division). In contrast, specific instructional attention for high-achieving students was very seldomly observed. Only a few teachers ever spent more than one minute specifically with high-achieving students across the observed lessons. Some teachers did differentiate instruction for high-achieving students by allowing them to skip the whole-class instruction.

In Sample 2 (Prast et al., 2023), two types of additional data were collected: interviews with teachers about their achievement grouping practices, and student questionnaires about their perceptions of differentiated activities in mathematics lessons. In structured interviews, teachers (N = 50) were asked whether and how they used achievement groups. Most teachers indicated to use achievement grouping in some way, either fully integrated in their mathematics teaching routine to differentiate instruction and practice (n = 32, 64%) or partly (n = 14, 28%), for example using the achievement groups for subgroup instruction but not for differentiation the practice tasks. Of the teachers using achievement groups (partly or fully), most teachers reported to create and update grouping arrangements periodically based on students' achievement on curriculum-based or standardised tests. Specifically, 11 teachers (22%) reported to make new grouping arrangements twice per year, 6 teachers (12%) three to four times per year, and 15 teachers (30%) approximately every three to six weeks based on each curriculum-based test. Some of these teachers indicated that these groups could be adapted per lesson based on students' needs. Another 8 teachers (16%) indicated to work with flexible groups, created per lesson or per week based on teachers' assessment of students' educational needs, on educational software or on students' own view on whether they needed additional instruction. The remaining teachers did not change the groups (n = 1, 2%), changed grouping arrangements in a different way (n = 3, 6%) or had missing responses (n = 2, 4%).

In the student questionnaire, students of the teachers in Sample 2 were asked to rate how often they participated in various differentiated and undifferentiated activities such as whole-class instruction, subgroup instruction and working at more or less difficult tasks (see Prast et al., 2023, for details). The questionnaire was administered in written form among all students with informed consent of grade 3 and 5, and as an individual interview among randomly selected low-achieving, average-achieving and high-achieving students of grade 1. Additionally, scores on a standardised mathematics achievement test were collected. N = 310 students (21 students of grade 1, 139 students of grade 3, and 150 students of grade 5) provided data on the questionnaire and on the achievement test. The results indicated that student-reported activities were clearly differentiated by achievement level: low-achieving students more frequently reported to receive extended instruction in a subgroup or individually and to work on less difficult tasks, whereas high-achieving students more frequently reported to work at enrichment tasks. However, high-achieving students (and students of other achievement levels) rarely reported to receive subgroup instruction or individual instruction about enrichment tasks and reported to work independently significantly more often than lower-achieving students.

In Sample 3 (Van Geel et al., 2022), teachers were asked how much time and effort it took to learn to use each of the differentiation strategies included in the DSAQ. Teachers' self-reported use of the strategies correlated negatively with teachers' perceived time and effort to learn the strategies. In other words, strategies that were considered easy to learn were implemented more frequently. Additionally, teachers were asked about facilitators and barriers for learning to implement the differentiation strategies. Gaining experience and developing (unspecified) attitudes and beliefs were considered the most helpful factors, whereas limited time management and a lack of experience and were considered the most impeding ones. Interestingly, (limited) skills and knowledge gained during initial teacher training were frequently identified as facilitator *and* barrier, perhaps due to differences between teacher training institutes regarding the way in which aspiring teachers learn to differentiate. Finally, teachers with less than three years of experience were shown to score lower on the DSAQ.

In Sample 4 (Inspectorate of Education, 2021), a subsample of 65 teachers kept logbooks of one to four randomly selected mathematics lessons. To identify students' educational needs, teachers most often reported to use students' daily work (55.4% of the teachers used this at least once across the reported lessons), followed by scores on achievement tests (30.1%) and other measures (19.3%). Teachers most frequently used these data to analyse students' mistakes, to assign students to achievement groups, and to determine students' mastery of the content. Approximately one-fifth of the teachers (21.7%) did not use any data to monitor students' progress in the reported lessons. Regarding adaptations, teachers most frequently mentioned to adapt instruction (66.2%), followed by goals (33.1%) and practice (28.3%), although these categories sometimes overlapped. Frequently mentioned adaptations were shortened or extended instruction, working with homogeneous achievement groups, differentiation of the practice tasks (amount or difficulty level) and individual instruction or support. Approximately one-fifth of the teachers (21.1%) did not make any adaptations in goals, instruction, or practice across the reported lessons.

4 Conclusion and Discussion

4.1 General Patterns

The aim of the current study was to chart teachers' differentiation practices in primary mathematics by identifying relatively frequent and infrequent strategies. We integrated the findings of four different studies that had the teacher self-report questionnaire (DSAQ) in common, which was accompanied by additional, more qualitative data (videos and lesson logs) in two of these studies. We identified several general patterns of relatively frequently and infrequently reported strategies that were similar across samples and measures. The two main components of differentiation – progress monitoring and instructional adaptations (Roy et al., 2013) – are clearly implemented by most teachers at least in a basic way. Most teachers monitor students' achievement using standardised tests, curriculum-based assessments and students' daily work. These assessments are used to identify students' educational needs and frequently form the basis for creating homogeneous within-class achievement groups. Based on this assessment of students' achievement level and educational needs, instructional adaptations are made.

A typical differentiated lesson could look like this. First, the teacher provides a whole-class instruction. Sometimes, high-achieving students already start to work independently during the whole-class instruction. After the whole-class instruction, average-achieving and high-achieving students work independently at tasks provided by the textbook, which are typically differentiated at three levels. Simultaneously, the teacher provides extended instruction to a subgroup of low-achieving students. The extended instruction may be at a slower pace, at a lower level of abstraction, or more explicit than the whole-class instruction. Subsequently, all students continue to work independently, while the teacher monitors and addresses individual questions where necessary. When high-achieving students finish their regular work, they move on to enrichment tasks provided by the textbook or supplementary materials. Finally, the teacher may conclude the lesson with a whole-class wrap-up, in which the teacher reflects with the students on what they have learned.

In contrast to these frequently implemented strategies for differentiation, other strategies were less frequently reported and observed. While teachers routinely provide extended instruction to low-achieving students, teachers infrequently provide specific instruction to high-achieving students (for example, about enrichment tasks), which may signal a tendency for convergent rather than divergent differentiation. Furthermore, some of the more refined, qualitative and individually tailored strategies for differentiation are used relatively infrequently. Specifically, teachers infrequently use diagnostic conversations to gain qualitative information about students' educational needs and infrequently evaluate whether a specific instructional adaptation was effective for individual students. Furthermore, teachers do not frequently adjust the type of practice to students' needs. The use of computer programmes for additional specific practice or challenge was also relatively infrequently reported.

4.2 Limitations and Strengths

The following limitations should be considered. Selection bias may have played a role in some of the samples. Especially Sample 1 (teachers at schools that were interested in an extensive professional development programme about differentiation) and Sample 3 (teachers recruited through social media) may have included teachers with a special interest for differentiation, although this bias could go in two directions: teachers could be interested because they feel the need to improve their differentiation skills, or because they already spend a lot of attention to differentiation. Nevertheless, the pattern of relatively frequently and infrequently reported strategies was similar across samples. Moreover, the combination of the four independent samples is quite large and diverse, representing a variety of schools from multiple regions in the Netherlands, and teachers with various levels of experience.

Another limitation is the use of a teacher self-report questionnaire as the primary measure. Teachers might rate their own use of differentiation differently than external observers. Therefore, we complemented these findings with qualitative findings from different perspectives, namely external observers and students. Although the main patterns of relatively frequently and infrequently used strategies described above were largely consistent across different perspectives, the general level and quality of implementation cannot be directly compared across these measures. More observational studies, in which the quality of implementation can also be examined in more detail, would be desirable in future research.

4.3 Implications for Research and Practice

The finding that many teachers implement basic strategies for differentiation such as monitoring student progress with tests and using differentiated practice tasks provided by the mathematics textbook is in line with previous national and international studies (Inspectorate of Education, 2018; Roy et al., 2013), in which it was found that such strategies are implemented relatively frequently compared to other strategies which require more time or skills to implement. The implementation of these basic strategies for differentiation may have been further supported by the increased attention for data-based decision-making and differentiation in professional development programs, as well as by the extensive suggestions for differentiation in recent versions of mathematics textbooks. At the same time, the differences between teachers should not be overlooked: while most teachers in the current study implemented differentiation at least to some extent, the qualitative findings in Sample 3 also indicated that about 20% of the teachers did not monitor progress and did not adapt goals, instruction, or practice in any way in the reported lessons. Future research might investigate what explains these differences between teachers.

The widespread use of achievement grouping warrants more research about the way in which teachers implement this, in the Netherlands but also in other countries. Specifically, the flexibility of achievement groups should receive more attention in future research and practice. Based on the single study (Prast et al., 2023), in which this topic was examined, it seems that the flexibility of achievement groups differs substantially between teachers. Some teachers used achievement groups flexibly, deciding on a lesson-by-lesson basis which students needed additional instruction and which practice tasks would be most suitable (sometimes assisted by educational software). In this case, achievement groups are used as a means to adapt instruction and practice to students' current educational needs, as recommended (Prast et al., 2015). However, a substantial percentage of teachers used achievement groups in a less flexible way, updating them for example only twice a year after the administration of a standardised mathematics achievement test. Fixed achievement groups are problematic, because they are less responsive to changes in students' educational needs (which may also vary per topic). Moreover, when students placed in low achievement groups have limited opportunities to move to a higher achievement group, this may limit their future educational chances (Denessen, 2017; Van den Bergh, 2018). While we cannot draw strong conclusions based on the single study described in this chapter, teachers should be aware of the importance of the flexibility of achievement groups and more research into this topic is needed. Substantial differences between countries regarding the use and flexibility of achievement groups may be expected. For example, within-class achievement grouping is commonly used in the Netherlands, while other countries, including the UK, have a tradition of between-class achievement grouping (Hallam & Parsons, 2013). Such organisational factors may affect the flexibility of the achievement groups.

Areas for improvement concern the relatively infrequently used strategies for differentiation. The limited specific instructional attention for high-achieving students is consistent with a previous study and might partly explain the relatively low percentage of excellent-achieving students in the Netherlands compared to other countries (Inspectorate of Education, 2019; Mullis et al., 2020). However, concerns about limited attention for high-achieving or gifted students in general education have also been raised previously by researchers from other countries including the US (Brighton et al., 2015; Hertberg-Davis, 2009). When high-achieving students work at sufficiently challenging enrichment tasks, they also need instruction or feedback about these tasks (VanTassel-Baska & Stambaugh, 2005). Moreover, differentiation for high-achieving students could generally be more systematic and goal-directed: teachers often provide students with enrichment tasks, but a risk is that these are used to keep students occupied rather than as a means to reach a higher learning goal (Inspectorate of Education, 2019; VanTassel-Baska & Stambaugh, 2005). Another area for improvement concerns refined and qualitative strategies to diagnose students' individual educational needs and adapt instruction and practice to these. This is in line with previous international reviews, although most of the reviewed studies were carried out in the US (McKenna et al., 2015; Scott et al., 1998). While the implementation of such strategies might improve the fit of educational practices to students' individual educational needs, implementing such strategies requires substantial time and effort from the teacher. Therefore, the extent of individual differentiation that is realistic to expect from general education teachers should also be considered.

In all areas for improvement, future research could examine why these strategies are relatively infrequently used and how they could be promoted, for instance in teacher education and professionalisation. Explanatory factors could be teacher attitudes and beliefs (e.g., a fixed mindset (Dweck, 2006) as an implicit reason for using fixed achievement groups), teacher knowledge and skills (e.g., being able to provide subgroup instruction about enrichment tasks or to hold a diagnostic conversation), or time and resources (e.g., time to provide subgroup instruction to high-achieving students; available instructional materials; support from colleagues). Based on the findings in Sample 3 (Van Geel et al., 2022), each of these factors seems to be relevant. While more experienced teachers reported a higher level of implementation of differentiation, teachers also reported that attitudes, pre-service teacher education and (limited) time were important facilitators or barriers in learning to implement the strategies. In addition, future research could examine the role of the teaching context in the effectivity and suitability of the various strategies. Depending on factors such as class size, heterogeneity of achievement level, and the number of students with special educational needs in a given class, some strategies may be more effective or suitable than others. For example, in a context where most students struggle to reach the basic lesson goals, it might be a valid choice to focus all efforts on reaching these basic goals at the expense of subgroup instruction about enrichment tasks. Thus, while pre-service teacher education and professional development programs for in-service teachers should strive to provide teachers with the necessary attitudes, knowledge and skills to implement differentiation, the importance of taking into account the classroom context and providing teachers with sufficient time and resources for implementation should not be overlooked.

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