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The relationship between teachers' differentiation activities and their promotion of self-regulation

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Abstract

Differentiation and promoting self-regulation are two topics which are considered complex to implement by teachers. A gap in the literature exists about the relation between these two topics. This study investigated if there was a relationship between teachers' differentiation activities, and their promotion of self-regulation in the classroom. In total, 16 fourth, fifth, and sixth grade teachers, from seven primary schools located in the eastern part of the Netherlands participated in this study. All participants were observed during a math lesson on their differentiation activities and their promotion of self-regulation. Results showed a strong positive correlation between teachers' differentiation activities and their promotion of self-regulation. Even though there was a big variation in scores on promoting self-regulation, the results confirm earlier research about the rarity of explicit strategy instruction. The low scores can be explained by a possible lack of knowledge about the topic of promoting self-regulation, but also by a lack of using all three types of strategies, originating from the three layered model of self-regulation. This study found that the relationship between differentiation and promoting self-regulation is that by promoting self-regulation, more opportunities (e.g., more time) can be created to differentiate. This fills up the gap in the literature about the connection between these two variables, and can also be practicably value for teachers and teacher educators who can use this knowledge and implement this in their lessons.

Keywords: differentiation, primary school teachers, promoting self-regulation, explicit strategy instruction.

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Introduction

The main goal of Dutch primary schools is to prepare students for today's society and their future. Furthermore, it is the task of the school to stimulate students' talents, and get the maximum out of them every day (Inspectie van het Onderwijs, 2019).

In order to get the best out of students and thereby stimulate their talents, two things come to mind. First of all, teachers have the task to meet all students' learning needs so students can develop themselves maximally (Vrancken & Tromp, 2013). Teaching in a way that meets the cognitive needs of students, increases the opportunity to develop their talents (Eysink, Hulsbeek, & Gijlers, 2017). A well-known approach to meet all these needs, is using differentiation during lessons (van Geel et al., 2018). Differentiated instruction can be defined as a strategy whereby the teacher provides several instructional approaches to students in order to variate in interest, readiness, or learning profiles (Tomlinson et al., 2003). Differentiation can be seen as a complex teaching skill (Deunk, Dolaard, Smale-Jacobse, & Bosker, 2015; van Geel et al., 2018). The Dutch inspectorate has shown that the majority of teachers insufficiently adapt their instruction to the different needs of students. Also, most of the novice teachers do not feel confident enough to implement this task (Inspectie van het Onderwijs, 2016).

Secondly, an effective strategy regarding students' talent development is offering autonomy and freedom in the learning process (Wolfensberger, 2012). Fostering students' autonomy can result in perceived competence, intrinsic motivation, and a higher academic performance (Reeve, Jang, Carrell, Jeon & Barch, 2004). According to Vergeer (2001), an important prerequisite to improve the autonomy of students is to let them regulate their learning process by developing (meta)cognitive skills, emotional skills, and strategies (i.e., self-regulation). Self-regulation can be described as a proactive process, which enables people to monitor their thoughts and behaviour (Zimmerman, 2008). To make students more self-regulated learners, self-regulatory skills have to be practised during their time at school (Kistner et al., 2010). During this time, the responsibility of the teacher is to foster students' self-regulated learning behaviour (Kistner et al., 2010). This self-regulated learning behaviour can be achieved by promoting self-regulation during their lessons. However, a very limited amount of teachers implement this in their lessons in an effective way (Dignath & Büttner, 2008).

In sum, it can be concluded that both differentiation and self-regulation are important to get the most out of students, but are complex to implement by teachers. Differentiation and the promotion of self-regulation can be applied simultaneously and might even be related (van Geel et al., 2018). In their research, they state that promoting self-regulation can be seen as a part of differentiated instruction. Also, it is a logical thought that differentiation and promoting self-regulation are related. When, for instance, a teacher uses differentiation by giving an extended instruction to low-achievers, it is very useful that other students can regulate their own learning process without disturbing the teacher and asking for help. So, if teachers promote self-regulation more, which results in students with a high level of autonomy, the teacher can spend more time on differentiation.

Despite the abovementioned indications, a gap in the literature exists when it comes to the relationship between teachers' use of differentiation and their promotion of self-regulation. Knowing that there is a relationship can be helpful for teachers in how to design and structure their lessons. It may improve their skills regarding differentiation and promoting self-regulation as well. Therefore, this study aims to investigate the relation between teachers' differentiation activities and their promotion of self-regulation in the classroom.

1. Theoretical Framework

1.1 Differentiation

In Dutch primary schools, below-average, average, and gifted learners are grouped in one class. This results in a large variety of ability levels in classes (Eysink et al., 2017). In order to meet all these different ability levels, including specific learning needs, teachers should differentiate their instruction (Tomlinson & Allen, 2000; van Dijk, Eysink, & de Jong, 2016; van Geel et al., 2018). There are several definitions of differentiated instruction, but often it is described as making adaptations in aspects of the instruction to match students' specific learning needs (Bosker, 2005; George, 2005; Parsons et al., 2018).

Teachers can differentiate through varying their teaching methods, and thus aim to construct the optimal learning experience for students (Tomlinson, 2000). In addition, van Geel et al. (2018) state that the key to successful differentiation is not solely using strategies during instruction, but the adaptation of teaching to the identified needs of the students. By adapting the instruction to the learning needs of students, a more effective learning process along with increasing results can be achieved (Suprayogi, Valcke, & Godwin, 2017; Eysink et al., 2017). Another benefit of differentiation is that this engages students more in activities, which also enhances the learning process (Heacox, 2002).

Teachers can choose to differentiate on several aspects, for instance cognitive level or interests. Tomlinson (2000) distinguishes four classroom elements on which teachers can at least apply differentiation: (1) content (e.g., using reading materials of different levels), (2) process (e.g., task time), (3) products (e.g., giving students the opportunity of how to express obtained knowledge by for instance writing a letter or creating a video), and (4) learning environment (e.g., creating different working spaces). Eysink, Hulsbeek, and Gijlers (2016) state in their research that the teacher should always take on the role of the coach when cognitive differences between students are taken into account. The coaching role can be helpful when differentiation on the process is applied. For instance, when a teacher differentiates on the process, he/she can apply coaching by giving feedback to students on different levels. In this example, low achievers can get more directive feedback, so the teacher provides the solution quicker than he/she would do with high achievers. High achievers, on the other hand, can get more process-based feedback and hints to get to the answer.

A popular strategy that can be applied during differentiation is ability grouping. This means that students with the same abilities/talents are grouped during learning. In primary schools, the most used form is within-class homogeneous ability grouping (Deunk, Smale-Jacobse, de Boer, Doolaard, & Bosker, 2018). When within-class homogeneous ability grouping is applied, homogeneous groups are formed within the heterogeneous class. These homogeneous groups are often based on students' cognitive level. In most cases, three groups arise: low-ability, medium-ability, and high-ability students. Some researches state that within-class homogeneous ability grouping can have negative effects on the performance of low-ability students, and a more positive effect on the performance of medium and high-ability students (e.g., Lou et al., 1996). Deunk et al. (2018) conclude in their research that grouping can create a context for differentiated instruction, but this alone is not enough. It needs to be ensured that teachers indeed offer this differentiated instruction.

The way that teachers apply differentiation depends if they strive for convergence or divergence (Bosker, 2005). Teachers who strive for convergence focus on helping their students in reaching a basic level of performance. This means that teachers spend their extra time to help low-ability students reaching a minimum performance level. However, in this case high-ability students do not get extra attention from their teacher, since they already reached their minimum performance level (Deunk et al., 2018). On the contrary, teachers who strive for divergence focus on all students with the goal of reaching their highest potential. The attention from the teacher will therefore be equally divided among all students. The majority of teachers uses an approach that combines both convergent and divergent goals (Denessen, 2017). An example of this is trying to reach a minimum goal with low-ability students while high-ability students get the opportunity to expand their knowledge (Denessen, 2017).

Overall, differentiating is seen as a complex teaching skill (Eysink et al., 2017; Keuning et al., 2017; Parsons et al., 2018; van Geel et al., 2018), which the majority of the teachers do not fully master (Inspectie van het Onderwijs, 2016). As an example, Tomlinson (2000) states that the most essential factor in differentiation is that teachers' instruction and curriculum is of a high-quality level. Not only teaching skills but also practical problems play an important part during differentiation. The challenge for most teachers is the need to reflect throughout the whole day on the quality of the differentiation Tomlinson (2000). Other challenges are lack of skills, large class size, and limited preparation time (Nicolae, 2014; Inspectie van het onderwijs, 2016).

Regarding differentiation activities and the promotion of self-regulation on which this research is focussed, another research was found that claims that there is a connection between the two. Keuning et al. (2017) and van Geel et al. (2018) conducted a cognitive task analysis, which focussed on the actions of teachers during their differentiation. A differentiation skill hierarchy was created in which the teaching skills needed for differentiation are described. They have distinguished four phases of differentiation: (1) *Preparing lesson period*, (2) *Preparing the lesson*, (3) *Enacting the lesson*, and (4) *Evaluating the lesson*. To demonstrate the possible relationship between differentiation and promoting self-regulation, it is relevant to zoom in at the third phase (*enacting the lesson*). Within all four phases, several skills concerning differentiation were categorized (e.g. determine didactical approach, analysing). The skills regarding the ''enacting the lesson'' phase are: Introducing the lesson, providing adapted instruction, stimulating self-regulation, and ending the lesson. According to van Geel et al. (2018) these four skills belonging to the third phase, have a temporal relationship and can be conducted simultaneously or subsequently. In the hierarchy, ''*Stimulating self-regulation''* is seen as a skill that is needed during differentiated instruction. This raises the question whether applying differentiation automatically means the stimulation of self-regulation as well.

This research about differentiation and promoting self-regulation focuses mainly on the instruction of the teacher, and since these skills have a temporal relation according to the research of van Geel et al. (2018) it is plausible that there is a relation between the two. The topic (promotion of) self-regulation will be described in the next paragraph to explore its relationship with differentiation.

1.1 Self-regulated learning

A widely known definition of self-regulated learning is the one from Schunk and Zimmerman (1994). They describe self-regulation as systematically self-generated thoughts, actions, and feelings, which can help people with reaching their goals. Research has shown that self-regulated learning can result in an enhancement of the academic achievement of students (Zimmerman & Schunk, 2001; Kistner et al., 2010). In addition, self-regulated learning is important to maintain lifelong learning (Dignath, Büttner & Langfeld, 2008). A popular model to describe the process of self-regulated learning is the one from Boekaerts (1999) (see Figure 1). This three-layer model represents the metacognitive, cognitive, and motivational components of self-regulation. The inner layer of the model represents the cognitive regulation and takes care of learning activities referring to information processing. The middle layer represents the metacognitive regulation. This layer focusses both on the learning process and the learner's skills and knowledge to understand and monitor their cognitive processes.

The outer layer shows the motivational regulation, representing the learning process embedded into the ''self'', and the learners' expectations, goals, and needs, which affect the use and development of cognitive and metacognitive skills. All three layers interact during the learning process (Boekaerts, 1999). Each component is necessary, but not sufficient for self-regulation. For instance, students that have cognitive skills but are not motivated to use these, do not achieve the same academic level as students who have both the skills and are motivated (Schraw, Crippen, & Hartley, 2006).

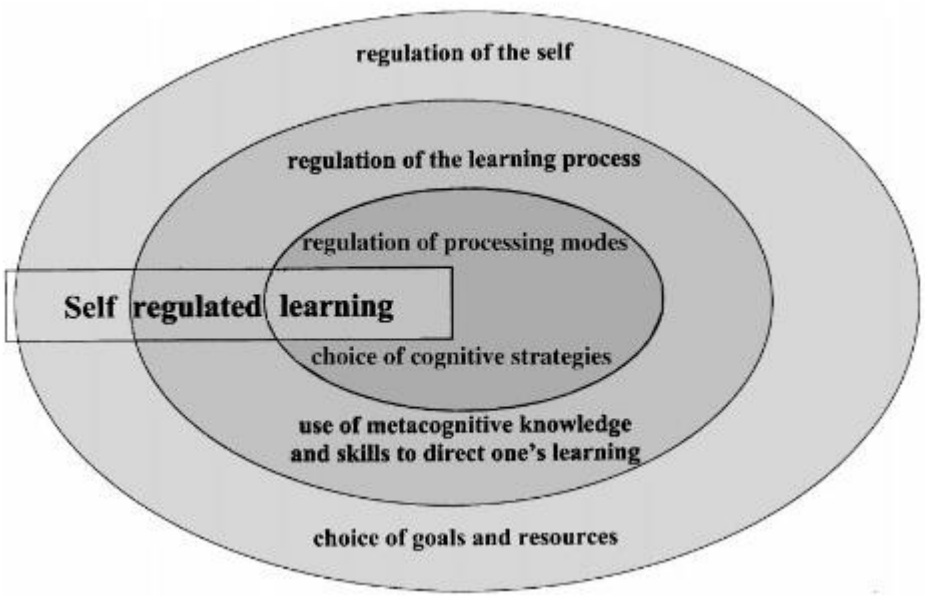

Figure 1. The three-layered model of self-regulated learning (Boekaerts, 1999)

Furthermore, there are self-regulated learning strategies that can be used during a lesson/instruction. According to Broadbent and Poon (2015), self-regulated learning strategies affect learning outcomes by helping learners to retain and acquire knowledge in a way that is structured. These strategies are part of the SRL process which can be thought to students to put into real world practice. In the traditional learning environment, self-regulated learning strategies predict high academic achievement (Zimmerman, 1989). The learning strategies can be classified according to the three layers of the three-layered model of self-regulated learning (Kistner et al., 2010). The strategies belonging to the inner layer (cognitive) are: organisation, elaboration, and problem solving. Cognitive strategies help learners to acquire knowledge by retaining information. For instance, the strategy ''problem solving'' helps students by developing a deeper level of understanding (Schraw et al., 2006). Strategies which play an important role in the middle layer (metacognition) are: planning, monitoring and evaluating the learning process, and metacognition II (i.e., metacognitive reflection, reasoning about one's learning).

Metacognitive strategies include knowledge about why and when to use certain strategies. Students who have a high level of metacognitive knowledge are better able to assess a learning situation and selecting the best strategy in that situation (Schraw et al., 2006). For instance, the strategy ''planning'' involves the selection of the most appropriate strategy, and ''monitoring'' refers to the self-testing skill which is needed to control learning. Lastly, strategies belonging to the outer layer (motivational regulation) are: causal attribution (i.e., self-efficacy ''I can do that'', a positive attitude towards learning), action control (i.e., activities to motivate for instance relaxation exercises), resource management (i.e., bringing in other resources that stimulate learning, for instance collaborating with others), and feedback. According to McCombs and Marzano (1990), motivation strategies are essential in stimulating students to use both cognitive and metacognitive strategies. ''Causal attribution'' for instance, is related to students self-efficacy. Teachers who teach with a higher level of self-efficacy set higher goals and standards for students, and so give them more autonomy, resulting in a higher academic achievement (Goddard, Hoy, & Hoy, 2000).

The distinction between cognitive and metacognitive strategies is that cognitive strategies can be seen as an indication of metacognitive activity (Dignath, Büttner & Veenman, 2008). For example, if a student decides to engage in a cognitive activity to organize his learning, this derives from a metacognitive decision. In other words, thoughts about thoughts. In addition, Flavell (1976) states that cognitive strategies facilitate learning whereas metacognitive strategies intend to monitor the learning process. When for instance a cognitive strategy is applied, such as asking questions, this can become metacognitive when the goal of this strategy is to use it to monitor knowledge. In conclusion, metacognitive activities cannot occur without cognitive activity (Dignath et al., 2008).

1.3 Promoting self-regulated learning

The majority of students lack self-regulatory skills, and therefore need support to improve these (Dignath & Büttner, 2018). If the goal is to enhance the use of these self-regulatory skills by students, teachers have the task to foster their students' behaviour when it comes to self-regulation (Kistner et al., 2010; Dignath & Büttner, 2018). Furthermore, it is shown that training in self-regulated learning can improve students' learning outcomes (Dignath & Büttner, 2008; Dignath et al., 2008; Masui & De Corte, 2005; Schunk & Ertmer, 2000). Regarding the promotion of self-regulated learning, two learning approaches can be distinguished: *direct* promotion and *indirect* promotion (Kistner et al., 2010).

A *direct* promotion of self-regulated learning focusses on teaching learning strategies (e.g., problem-solving) and can be divided into *implicit*, and *explicit* instruction.
An example of an *implicit* instruction is a teacher who is using modelling of a strategy during the lesson. In this example, the teacher applies the strategy, but he does not mention its benefits or give an explanation for it (Dignath & Büttner, 2008). In contrast, when an *explicit* strategy is instructed, the teacher will show how to apply a strategy and also explains it. For instance, the teacher again uses modelling to show the strategy, but he also tells his students about the benefits of using this strategy (e.g., ''this is the best strategy, because now you can divide the exercise in small steps, so you will make less mistakes''). Using explicit instruction especially benefits low ability students, because they will then understand the reasoning behind a strategy use, where these students struggle with the most. Research has shown that teachers rarely use explicit instruction in their lessons (Dignath & Büttner, 2018; Kistner et al., 2010; Vandevelde, Vandenbussche & van Keer, 2012). However, the research from Kistner et al. (2010) also shows that students whose teachers explicitly explained the majority of strategies, had a better understanding of the content after the lesson. On the other hand, when strategies had been applied in an implicit way, students did not enhance their performance. The majority of the researchers in self-regulated learning suggests using a 'scaffolding' method when strategy use is taught (Dignath & Büttner, 2018). With this method, teachers will model the strategy as long as needed (thinking out loud about the strategy use), until the students can self-regulate their learning. First, it will be regulated by the teacher, then through modelling and guidance, and lastly by reflecting on feedback (Perry, Hutchinson, & Thauberger, 2008).

Besides direct promotion, *indirect* promotion of self-regulation can also be applied by teachers. When the goal is to promote self-regulation indirectly, teachers can arrange a learning environment which supports self-regulated learning (Otto, 2010). These learning environments allow students to practice and apply their obtained strategies and knowledge (Kistner et al, 2010; Zimmerman & Bandura, 1994). Dignath, Büttner, and Veenman (2008) describe four elements that can be implemented in the class to arrange a learning environment that fosters students' skills regarding self-regulation (based on the research of De Corte et al. 2004).

The first element is creating an environment in which students can cooperate. Cooperative learning includes learning arrangements in a way that students can work in small groups or pairs. The role of the teacher is hereby to stimulate mutual support among the students, intending to solve a problem as a group successfully, with a minimum of help from the teacher. During cooperative learning, students use self-regulated learning strategies. The strategy monitoring, belonging to the middle layer of the three-layered model of self-regulation (metacognition), plays an important role.

Students need to speak out loud about the things they are doing, and therefore need to consider if their approach will work for a specific situation.
This will stimulate students to use their metacognitive knowledge. Also the strategy feedback will be used during cooperative learning, belonging to the outer circle of the model from Boekaerts (1999) (motivation). Because students need to solve a problem as a group, they need to give each other feedback (and reflect on their own thinking) on their problem solving strategies.

The second element is to create an autonomous learning environment to make sure that students participate in planning and choosing their own activities, and so decide themselves about their learning process. This intrinsically motivates students and fosters self-direction in their learning process (Deci & Ryan, 1993), which is related to the outer circle of the model from Boekaerts (1999). Examples of how to implement self-direction in the learning environment are, for instance, project work or working with schedules. When looking at the self-regulated learning strategies, the strategy planning is an important factor in creating this autonomous environment. Letting students decide in their own activities and planning, provokes the use of this strategy because students now need to think about their own learning process.

The third element is implement constructivist learning principles. A constructivist learning environment motivates students in understanding as well as 'learning about learning'. Learning needs to take place through active construction, so new knowledge can be connected to previous knowledge (Bada & Olusegun, 2015). This can be achieved by providing less structured, complex, or open assignments/problems that require reasoning of the problem to be undertaken. These problems will first of all stimulate students to think about their cognitive knowledge in order to solve the problem. However, not only cognitive knowledge will be used, but also metacognitive knowledge, because students need to consider the best approach for their problem.

The fourth element is fostering transfer. Learning content can always be associated with the context from which it was originally retrieved. Sometimes it can be difficult for students to apply new knowledge in a different context (e.g., applying a reading strategy in a written mathematical problem in order to find the right strategy to use). According to Dignath et al. (2008), learning needs to take place in different contexts so students can apply their obtained knowledge and connect this to the authentic context (e.g., measuring ingredients to bake a cake to stimulate the use of knowledge about for instance the metric system). Using different contexts stimulates students to use their cognitive knowledge, but they also need to think about how to use their knowledge in a new setting (which stimulates their metacognitive activity).

Moreover, Dignath and Büttner (2018), state that a classroom which indirectly supports self-regulation is based on constructivist perspective of learning, which shares the idea that students construct their own knowledge. This is in line with the research of De Corte et al. (2004), who also have described that one of the methods to indirectly promote self-regulation is by applying constructivist learning principles during the lesson. Since this research aims to explore the relationship between promoting self-regulation and differentiation, the research of Suprayogi et al. (2017), is interesting. They have concluded that there is a significant association between the implementation of differentiated instruction and constructivist teaching beliefs. This makes it plausible that teachers who indirectly promote self-regulation through a constructivists learning environment, also use more differentiation in their lesson.

To conclude, Dignath and Büttner (2018) state that the majority of researchers agree that a combination of direct and indirect promotion is the most effective in regard to the development of self-regulated learners. In addition, Paris and Paris (2001) argue that merely using direct promotion may be too abstract for students. On the other hand, merely using indirect promotion does not provide students with enough guidance in choosing the right or most effective strategy.

2 Research questions

Based on the literature of differentiation and self-regulation, the following research question and sub-questions have been composed:
What is the relationship between teachers' differentiation activities (concerning content, task, process, learning environment) and their promotion of self-regulation (direct and indirect) in the classroom?

Sub-questions:

1. *What is the relationship between teachers' differentiation activities (content, task, process, learning environment) and their direct promotion of self-regulation?*

It is expected that teachers who show a high score on differentiation, also show a high score in their direct promotion (i.e., explicit instruction) of self-regulation, since the research of van Geel et al. (2018) indicates that there is a relation between providing adapted instruction and promoting self-regulation.

2. *What is the relationship between teachers' differentiation activities (content, task, process, learning environment) and their indirect promotion of self-regulation?*

It is expected that teachers who show a high score of differentiation, also show a high score in their indirect promotion of self-regulation, since a significant association was found between differentiation activities of the teacher and constructivist teaching beliefs (on which a learning environment fostering self-regulation is based).

3 Method

3.1 Research design

This research has a qualitative design. Two main variables were measured: differentiation, and self-regulation. Self-regulation consists of two separate parts, namely direct promotion (implicit/explicit instruction) and indirect promotion (learning environment/context). All variables were measured through observations during a regular math lesson.

3.2 Participants

In total, 16 fourth, fifth, and sixth grade teachers, from seven primary schools located in the eastern part of the Netherlands participated in this study. The participants consisted of five males and eleven females. The age ranged from 22 to 55 years old, with a mean age of 32.37 years old (SD = 10.87). Consent was given by all participants to film, observe, and use their data for this study.

3.3 Materials

3.3.1 STIP observation instrument

Differentiation was measured by the STIP instrument (Eysink et al., 2017) (see Appendix A), based on the Classroom Observation Scale-Revised (COS-R, VanTassel, & Baska, 2003), and the Classroom Practises Inventory (Heacox, 2002). The instrument measured the degree of differentiation used by teachers in their class and consisted of the components: (1) a lesson description, (2) a teacher observation, and (3) an interview with the teacher.

In the lesson description, the lesson method and organisation were described, along with the number of students participating in the lesson, and the topic of the lesson. In addition, questions and remarks from students and the teacher could be noted, along with unexpected student behaviour.

The observation list contained a total of 32 items in four main categories: (a) differentiation in content (seven items, e.g., 'The teacher offers learning content based on students learning needs'), (b) differentiation in task (six items, e.g., 'The teacher provides low ability students with content appealing for memorising, understanding and applying, and focuses on fact knowledge'), (c) differentiation in process (eleven items, e.g., 'The teacher groups students based on their ability or interests'), and (d) learning environment (eight items, e.g., 'The teacher has high expectations from the students'). The items were coded with '0' when the action was not observed and a '1' when the action was observed during the lesson. The sum of the sores was computed to obtain teachers' differentiation scores, with a maximum of 32. A second coder scored 10% of the data. The interrater reliability coefficient reached .78 (Cohen's kappa).

The interview in the STIP instrument existed of nine questions concerning the executed lesson. Because of the organisational component, the decision was made not to do an interview but to send a questionnaire. The questionnaire can be helpful to gain insight in the reasoning behind teachers' behaviour and decisions made during the lesson. In addition, personal data from the participants were asked in the questionnaire, such as: date of birth, teaching experience, and accomplished degrees.

3.3.2 Observation instrument self-regulation

To measure teachers' promotion of self-regulation in the class, the instrument developed by Dignath et al. (2008) was used. The instrument exists of two observations, one for direct promotion (see Appendix B), and one for indirect promotion of self-regulation (see Appendix C). The main goal of the first observation (direct) was to identify the type of strategy instruction used by the teacher. The observation units were one minute. Each minute, the video was stopped and the following things were coded.

First of all, during the observation, a distinction was made between explicit and implicit instruction. During an explicit instruction, the teacher mentions the word ''strategy'', the name of the strategy, or the description of the strategy in his or her instruction. Also, the teacher tells his students why he uses a certain strategy. The intention and reason why the instruction was offered at a certain moment has to be clear. An implicit instruction means that a procedure is explained, without mentioning the strategy. In an implicit instruction it is not clear if the teacher has the intention to teach a certain strategy and the teacher does not give any reflection about using the strategy. So, dependent on the type of instruction the teacher uses (explicit or implicit), this was coded with X in the observation scheme.

Secondly, when an explicit instruction was observed, the way in which the explicit instruction was given had to be coded. A distinction was made between three categories: (1) mentioning the benefit of a strategy (i.e., teacher explains why students need to use a certain strategy and explains advantages), (2) transfer (i.e., teacher mentions that the applied strategy can be used in other contexts), and (3) metacognition level II (i.e., teacher provides students with information about metacognition and self-regulation, or activates reflecting of their own learning behaviour). The applied strategy was coded with X.

Third, the type of strategy that was instructed by the teacher had to be coded. The first letter of all strategies used within the minute was placed with the corresponding phase: before, during or after learning. In table 1, the different strategies are explained with the corresponding phase.

The second part of the instrument existed of an observation for the learning environment (indirect). The observation focused on four aspects (which included nine items in total), describing the learning environment. The four main aspects were: (1) cooperative learning (e.g., 'Teacher uses cooperative learning forms in class', 'Teacher makes sure that students work together'), (2) self-direction (e.g., 'Teacher allows students to take responsibility by giving them freedom in their decision-making'), (3) constructivist learning principles (e.g., 'Teacher activates students prior knowledge, integrates new knowledge and gives complex problems which can be handled in different ways'), and (4) fostering transfer (e.g., 'Teacher mentions that the learning content can be used in different contexts'). A rating scale was used to code the items. The scale went from 1 to 4, from ''never observable'' to ''mainly observable''. A second coder scored 10% of the data. The interrater reliability coefficient reached .80 (Cohen's kappa).

Table 1

Self-regulating strategies with description and examples.

Strategy	**Description and examples**
	Before learning
Organization	Everything regarding organizing the learning content in such a way that a structure arises, which makes the process of information storage easier. For example, teacher and students create a scheme to process the lesson content, so a more clear overview is created.
Planning	Every systematic activity regarding planning. Often at the start of the lesson, for example when the teacher discusses what students can do when their work is finished.
	During learning
Elaboration	Activating prior knowledge, summarizing important information, drawing conclusions, applying learned knowledge.
Problem-solving	All (meta)cognitive processes related to information processing. For example, applying reading skills to understand texts or applying problem-solving strategies in math class.
Resource-management	Everything concerning bringing in other resources. For instance collaboration with others. Or arranging the learning environment so it supports learning (digital devices).
Action Control	Activities to motivate yourself, such as: concentration activities, rewarding when a goal is achieved, or relaxation exercises.
	After learning
Monitoring and evaluation	Monitoring the learning process. Such as keeping track of the learning goals, asking yourself questions to check understanding and regulate the learning process.
Causal Attribution	Having a positive attitude towards the learning process (i.e. self-efficacy, self-instruction).
Feedback	Talking with students about for example, the learning process/content.
Metacognition Level II	Metacognitive reflection about metacognition. Teacher provides students with information about metacognition and self-regulation, or activates reflection on their own learning behaviour.

3.4 Procedure

The experiment consisted of one session of approximately 50 minutes. The teacher gave a regular math class which included an instruction. The overall goal of the research was communicated to the participants before the observation started. The participants were not informed about the specific topic of the observation, since it was expected that this could influence their teacher behaviour and therefore the reliability of this research. Because two observations had to be conducted which was not possible to do at the same time, the lesson was also recorded on video. The video-devices were set up in the back of the class before the lesson started. During the teacher observation, the observer was sitting in the back of the class, observing the lesson with the use of the STIP instrument. The self-regulation observation scheme was filled in after the class with help of the video observation. Afterwards, the teachers received an online questionnaire, which they had to fill in and send back.

3.5 Analysis

Teachers could score on the four categories of differentiation. The total score was calculated by taking the sum of scores from all four elements. Descriptive statistics (e.g., Mean, SD) were used to analyse teachers' scores on differentiation. Also, relative scores were calculated, by dividing the mean scores of the elements by the maximum score that could be achieved per element. This was done to see what teachers' scores were compared to the maximum achievable score and so gain insight in the scores on the different elements, which might give an explanation for the final results.

To gain insight in the direct promotion of self-regulation, teachers' implicit and explicit strategy instructions were counted. Teachers' scores on direct promotion was calculated by counting the amount of explicit instructions. These scores were converted into percentages since the lessons differed in time. Descriptive statistics were used to analyse these results. The explicit instructions were divided among the three categories and presented in a frequency table. All the strategies shown in table 1 can be divided (according to the theory) into three types (cognitive strategies, metacognitive strategies, and motivational strategies) as already shown in the theoretical framework. In the results, we will also analyse teachers strategies on those three types.

On each item within the indirect promotion observation scheme, teachers could score from 1 to 4. The total score was calculated by taking the sum of all scores per item. Furthermore, descriptive statistics were used to analyse teachers' scores on the indirect promotion of self-regulation. In this case, relative scores were also calculated to see if there was a difference in scores on the four aspects.

Pearson correlations were conducted to examine the relation between differentiation and the promotion of self-regulation. Teachers' total scores on differentiation and direct and indirect promotion were used, and also correlations between the scores on the separate categories from differentiation and indirect promotion of self-regulation were calculated.

4 Results

In this chapter, all results will be described. First, the results regarding teachers' scores on differentiation will be discussed. Secondly, teachers' scores on the promotion of self-regulation (direct as well as indirect) will be discussed. Finally, correlational measures will be analysed to determine coherence between teachers' differentiation activities and their promotion of self-regulation.

4.1 Differentiation

To give a general overview of teachers' scores on differentiation, all data regarding differentiation will be presented in the table below. Table 2 shows teachers' mean scores on the four elements of differentiation, as well as the total mean score, the relative scores, and the minimum and maximum scores.

Table 2

Mean scores, relative scores, standard deviations, and minimum and maximum scores on the elements of differentiation and the total differentiation score (n = 16).

Differentiation scores	Mean	*SD*	Relative scores	Min.	Max.
Content (max. 7)	2.63	1.99	0.37	0.00	6.00
Task (max. 6)	1.81	1.32	0.30	0.00	4.00
Process (max. 11)	5.31	2.41	0.48	0.00	9.00
Learning environment (max. 8)	4.81	1.64	0.60	0.00	7.00
Total score (max. 32)	14.56	5.55	0.45	6.00	26.00

Relatively, teachers scored the highest on the element learning environment and the lowest on the element task. The low score was caused by the fact that the maximum score within the element task was 4. The reason for this was that no participants scored on the following two items within task regarding the stimulation of creative thinking: *''Explicitly mentions that weird solutions are not that weird''*, & *Teacher: ''You can figure that out, we will look into that tomorrow, in response to today's' lesson''.*

4.2 Self-regulation

4.2.1 Direct promotion of self-regulation

Table 3 shows the mean scores of the implicit and explicit instructions. The percentages show the amount of time that teachers used implicit and explicit instruction during their lesson.

Table 3

Mean scores, standard deviations, and minimum and maximum scores on self-regulation (counted and percentages).

Scores on instructions	Mean	*SD*	Min	Max	Mean (%)	*SD*	Min (%)	Max (%)
Implicit instruction	20.87	7.34	11.00	34.00	94.73	6.61	76.90	100.00
Explicit instruction	1.18	1.37	0.00	4.00	5.27	6.61	0.00	23.10

Table 4

Frequencies of the three categories of explicit instructions.

Category	Frequency
Mentioning benefit of strategy	13
Metacognition II	6
Transfer	0
Total	19

Table 4 shows the frequencies of explicit instructions with the corresponding category. A total of 19 explicit instructions were coded. Out of these 19 instructions, 13 were conducted through mentioning the benefit of the strategy. Examples of this are: ''*Always start at the total score, otherwise you will get a very complex sum''*, *''First you take the sum of those two numbers, in this way your sum will get a lot easier''.*

Furthermore, six of the explicit instructions were conducted through metacognition II. An example of this type of instruction that was mentioned was: *''A lot of you still make this mistake, so pay attention to this and be careful with adding the zero's into your answer.''* None of the explicit instructions was conducted through transfer.

To see whether there was a coherence between the type of explicit instruction and teachers' scores on explicit instruction, a Pearson test was conducted. The test showed that there was no significant correlation ($r(8) = .55$, $n = 9$, $p = .124$) between the total score of explicit instruction and the strategy: mentioning the benefit of a strategy.

However, the second Pearson test showed a very strong correlation between teachers' total score of explicit instruction and their use of the strategy: metacognition II ($r(8) = .95$, $n = 9$, $p = <.001$). Which means that, the higher teachers scored on explicit strategy instruction, the more they used the strategy metacognition II in their lesson.

Because there was a big group of participants who did not use explicit instruction at all, the decision was made to split up the group of participants in two groups and compare their results. It was expected that this could help explain the rest of the results. The first group are the participants who did use an explicit instruction at least once (''Explicit users'', 9 participants). The second group are the participants who did not use an explicit instruction at all (''Non-explicit users'', 7 participants). Table 5 shows the mean scores (%) in strategy use of both groups.

Table 5

Mean scores (%) of used strategies during instruction of explicit users (n = 9), and non-explicit users (n=7).

Type of strategy	Explicit users (%)	*SD*	Non explicit users (%)	*SD*
Cognitive strategies	93.44		92.04	
Organisation	4.24	5.31	2.76	3.58
Elaboration	29.01	12.17	34.73	20.77
Problem solving	60.21	15.39	54.54	24.57
Metacognitive strategies	13.98		8.31	
Planning	9.11	7.26	7.21	7.42
Monitoring and evaluating	1.94	2.50	1.09	2.90
Metacognition II	2.93	4.01	0.00	0.00
Motivational strategies	8.17		11.24	
Resource management	1.25	2.68	4.30	8.66
Causal attribution	.39	1.19	1.07	2.56
Feedback	6.04	4.59	5.84	8.15
Action control	.48	1.44	0.00	0.00

Out of all the strategies, problem solving and elaboration are the two most used strategies during the lessons in both groups. If we compare this to the three layered model of self-regulated learning (Boekaerts, 1999), it shows that teachers mostly focus on the cognitive part (organisation, elaboration, problem solving).

The Mann-Whitney U tests was conducted to analyse whether there is a difference in strategy instruction between the explicit and the non-explicit users. The test was conducted for all ten strategies as well as the three main categories (cognitive, metacognitive, and motivational). No difference was found between the explicit and non-explicit users in strategy use. (Cognitive strategies: U = 23.00, z = -.900, p = .408, Metacognitive strategies: U = 27.00, z = -.483, p = .681, Motivational strategies: U = 23.00, z = -.902, p = .408, Organisation: U = 27.50, z = -.453, p = .651, Elaboration: U= 29.00, z = -.265, p = .791, Problem solving: U = 31.00, z = -.053, p = .958, Planning: U = 27.50, z = -.427, p = .670, Monitoring and evaluating: U = 24.00, z = -.965, p = .334, Metacognition II: U = 17.50, z = -1.947, p = .052), Resource management: U = 28.50, z = -.417, p = .677, Causal attribution: U = 30.00, z = -.276, p = .783, Feedback: U = 25.00, z = -.698, p = .485, Action control: U = 28.00, z = -.882, p = .378.

Also, a Pearson test was conducted to see whether there was coherence between the type of strategy (cognitive, metacognitive, and motivational) and teachers' scores on direct promotion (i.e., explicit instruction). It was expected that these results could help explain the difference in explicit instruction use between the two groups. Table 6 shows correlations between the three types of strategies and explicit instruction.

Table 6

Correlations between types of strategies and explicit instruction.

Type of strategy	Explicit instruction
Cognitive strategies	.004
Metacognitive strategies	.510*
Motivational strategies	-.026

Note.

* $p < .05$, two tailed.

The only significant correlation found was between metacognitive strategies and explicit instruction, meaning that the more teachers use explicit instruction, the more they use metacognitive strategies.

4.2.2 Indirect promotion of self-regulation

Table 7 shows teachers' mean scores, standard deviations, relative scores, and minimum and maximum scores on the four elements of the indirect promotion of self-regulation, and the total score.

Table 7

Mean scores, standard deviations, relative scores, and maximum and minimum scores on indirect promotion of self-regulation.

Scores on indirect promotion	Mean	*SD*	Relative scores	Min.	Max.
Cooperation (max. 8)	3.25	1.84	4.06	2.00	7.00
Constructivism (max. 12)	7.44	1.86	6.20	4.00	11.00
Self-direction (max. 8)	3.06	1.24	3.82	2.00	5.00
Transfer (max.8)	3.50	1.15	4.37	2.00	6.00
Total score (max. 36)	17.25	3.92	-	12.00	25.00

Relatively, participants had the highest mean score on constructivism. The lowest mean score was found on self-direction. The reason for this low score was probably that the maximum score on self-direct was only 5 out of the 8.

To see if there were differences in scores within indirect promotion of self-regulation, the group again was split up in explicit users and non-explicit users. Table 8 shows the mean, standard deviations, and minimum and maximum scores of the two groups on the indirect promotion of self-regulation.

Table 8

Mean, standard deviations, and minimum and maximum scores of explicit users and non-explicit users on indirect promotion.

	Mean explicit users	*SD*	Min	Max	Mean non explicit users	*SD*	Min	Max
Cooperation	3.33	1.80	2.00	7.00	3.14	2.03	2.00	7.00
Constructivism	8.67	1.32	7.00	11.00	5.85	1.06	4.00	7.00
Self-direct	3.67	1.32	2.00	5.00	2.28	.48	2.00	3.00
Transfer	4.33	.86	3.00	6.00	2.57	.53	2.00	3.00
Total score	19.89	3.05	15.00	25.00	13.85	1.46	12.00	16.00

The explicit users group scores higher on the total score (U = 1.50, z = -3.202, p = .001), constructivism (U = 2.00, z = -3.167, p = .002), self-direct (U = 13.50, z = -2.051, p = .040), and transfer (U = 4.00, z = -3.024, p = .002). There was no significant difference on the element cooperation (U = 28.50, z = -.366, p = .714).

4.3 Relationship between differentiation and self-regulation

To research if there was a relationship between differentiation and the promotion of self-regulation, Pearson correlations have been conducted. Table 9 shows the correlations between teachers' direct promotion of self-regulation, indirect promotion of self-regulation, and teachers' total scores on differentiation.

Table 9

Correlations between direct promotion, indirect promotion, and the scores on differentiation.

	1.	2.	3.
1. Direct promotion (explicit)	-		
2. Indirect promotion	.80**	-	
3. Differentiation	.89**	.87**	-

Note.

* $p < .05$, two tailed.

** $p < .01$, two tailed.

First of all, the Pearson-correlation showed a strong, positive correlation between teachers' total scores on differentiation activities and their direct promotion of self-regulation, which was statistically significant ($r(15) = .89$, *p = <.01).* A scatterplot summarizes the results (Appendix D, figure 2). Therefore, it can be concluded that there is a relationship between teachers' differentiation activities and their direct promotion (i.e., explicit instruction) of self-regulation.

Also, a strong positive correlation between teachers' total scores on differentiation activities and their indirect promotion of self-regulation was shown, which was statistically significant ($r(15) = .87$, *n = 16, p = <.01).* A scatterplot summarizes the results (Appendix D, figure 3). Therefore, it can be concluded that there is a relationship between teachers' differentiation activities and their indirect promotion of self-regulation.

Correlational analyses were conducted for the elements on which teachers could score within differentiation and within indirect promotion of self-regulation, and the total score of direct promotion. It was expected that this could help explain the relation. Table 10 shows the correlations between teachers' scores on direct promotion, the elements within indirect promotion, and the elements within differentiation.

Table 10

Correlations between direct promotion, the elements of indirect promotion, and the elements of differentiation.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Direct promotion	-								
2. Cooperation	.46	-							
3. Constructivism	.56*	-.13	-						
4. Self-direct	.52*	.25	.53*	-					
5. Transfer	.51*	-.12	.66**	.21	-				
6. Content	.67**	.37	.58*	.71**	.28	-			
7. Task	.75**	.56*	.52*	.82**	.28	.75**	-		
8. Process	.61**	.19	.39	.26	.65**	.27	.47	-	
9. Learning environment	.66**	.14	.37	.40	.44	.26	.41	.41	-

Note.

* *p < .05.*

** *p <.01.*

Direct promotion correlates with all sub-elements except for cooperation (indirect promotion). The differentiation elements do however show a stronger correlation with direct promotion than the elements of indirect promotion. Task and content are the two elements of differentiation that did show a correlation with some of the sub-elements of indirect promotion. Process and Learning environment did not show any correlation with the sub-elements of indirect promotion, except for transfer and process. Within the four elements of differentiation, the only correlation found, was between task and content.

To get more insight in the relationship between differentiation and the promotion of self-regulation, the explicit and non-explicit users were compared. Table 11 shows the mean, standard deviations, and minimum and maximum score on differentiation of the two groups.

Table 11

Mean, standard deviations, minimum and maximum scores of explicit users and non-explicit users on differentiation.

	Mean explicit users	*SD*	Min	Max	Mean non explicit users	*SD*	Min	Max
Content	3.44	2.29	0.00	6.00	1.57	.78	1.00	3.00
Task	2.56	1.23	1.00	4.00	.85	.69	0.00	2.00
Process	6.77	1.64	4.00	9.00	3.42	1.90	0.00	6.00
Learning environment	5.56	1.23	3.00	7.00	3.85	1.67	1.00	6.00
Total score	18.33	4.06	13.00	26.00	9.71	2.49	6.00	12.00

There are some big differences in scores between these two groups, such as the total score. The minimum score is 13 in the explicit users group. This means that all participants who had a score of 12 or lower on differentiation, did not use any explicit instruction. Too see whether these differences in scores are significant, the Mann-Whitney U test was conducted for the total score as well as for the four elements of differentiation. The explicit users scored higher on the total score ($U = 1.50$, $z = -3.204$, $p = .001$), task ($U = 7.50$, $z = -2.639$, $p = .008$), process ($U = 4.50$, $z = -2.897$, $p = .004$), and learning environment ($U = 12.50$, $z = -2.065$, $p = .039$). There was no significant difference on the element content ($U = 16.00$, $z = -1.685$, $p = .092$).

5 Discussion and conclusion

The aim of this study was to investigate the relationship between teachers' differentiation activities and their promotion of self-regulation in the classroom. In order to determine if there was a relationship and what that relationship entailed, observations were used to measure the amount of differentiation and (direct and indirect) promotion of self-regulation that teachers applied in their (math) lesson. The observation could have had an influence on teachers behaviour which might have led to a more positive image than normally (e.g., more preparation time). However, all teachers used the method they used daily and they were not aware of the specific topic on which the observation was focussed.

The first hypothesis was that it was expected that teachers who scored high on differentiation, also had a high score in their direct promotion (i.e., explicit instruction) of self-regulation. This hypothesis is confirmed by the results of this research. Although we were aware of the small sample size, a strong positive correlation was found between differentiation and direct promotion (i.e., explicit instruction) of self-regulation. These results partly correspond with the results of the research of van Geel et al. (2018). They conducted a cognitive task analysis to capture the complexity of differentiated instruction. This task analysis resulted in a differentiation skill hierarchy which describes the required knowledge, and factors influencing differentiation. One of the factors that was mentioned by their expert group (i.e., 'good differentiators') was the promotion of self-regulation, meaning that this can be seen as one of the factors that influences, and is required for differentiation. What this research adds on top of the research of van Geel et al. (2018) is that it shows that teachers who are good in differentiation, not only consider promoting self-regulation as an important factor during differentiation, but use it in their daily practise in an effective way (i.e., explicit instruction). It also showed that teachers who do not use differentiation on such a high level, promote self-regulation in their lesson less effective (i.e., implicit instruction). Since a strong positive correlation was found, it is indeed plausible to say that promoting self-regulation is an important factor of differentiation.

Another explanation for the found relationship is the following argument. A large class size is often mentioned by teachers' when the question is asked why they do not differentiate (Inspectie van het Onderwijs, 2016). What became obvious from the observations was that teachers mostly used homogeneous grouping based on cognitive level in order to differentiate. However, the large class size makes it difficult for teachers to divide their attention equally among all students. Vergeer (2001) states that self-regulation helps students by improving their autonomy. It is a logical thought that differentiation becomes easier for the teacher when students have a high level of autonomy.

They can regulate their own learning process, decide for themselves which strategies to use, which results in the teacher having more time to give for instance extended instruction, or give instruction based on the specific learning needs of students. This could be an explanation for the fact that teachers who promote self-regulation effectively, which results in more autonomous students, also use more differentiation in their lesson (and vice versa for teachers who do not, or less effectively promote self-regulation). This can also declare the fact that teachers who had a score of 12 or lower on differentiation, did not use explicit strategy instruction once. Because the extra time for differentiation that teachers could create by promoting self-regulation, was not necessary, simply because they barely differentiated. The results of the research of van Geel et al. (2018) who consider promoting self-regulation as a factor of differentiation, the relationship found in this research, and the abovementioned arguments makes it plausible to say that the degree to which teachers promote self-regulation, influences the degree to which teachers differentiate. For future research it would be interesting to investigate if teachers with students who have a high level of autonomy indeed use more differentiation in their lessons.

Even though teachers' scores on direct promotion positively correlated with their scores on differentiation, the scores on direct promotion cannot be considered ''high''. The results revealed that in general, teachers scored very low on the direct promotion of self-regulation. This is in line with research of Kistner et al. (2010) who showed in their research that teachers' strategy instruction is rare. They showed that teachers spend (on average) only 15% of their instruction time on explicit instruction. In this research, however the percentage was even lower (5,27%). After the observations, the majority of the participants asked what the focus of the observation was. When it was told that it was about differentiation and promoting self-regulation, most teachers had no idea how to execute the promotion of self-regulation, or even what it was. Therefore, a possible explanation for the low scores on direct promotion could be that teachers are not aware of the importance of strategy instruction in an explicit way, or how to conduct this effectively. In addition, Dignath-van Ewijk and van der Werf (2012) found in their research that when the question was asked to teachers how they could enhance their students self-regulation, mainly characteristics of constructivist learning environments were mentioned, and not strategy instruction. To clarify teachers' thoughts and assumptions about self-regulated learning strategies, future research could exist of interviews with teachers about their knowledge of this topic, and teachers observing for example videos of other teachers' strategy instruction to see what their thoughts are. This can for instance lead to a training with the goal to enhance teachers' image and knowledge of explicit strategy instruction (and therefore promoting self-regulation).

Another explanation for teachers' low scores on explicit instruction could be that the amount of strategy use per category differed a lot. Teachers mostly focussed on cognitive strategies (organisation, elaboration, problem solving), and did not focus as much on motivational strategies (causal attribution, action control, resource management, feedback) and metacognitive strategies (planning, monitoring & evaluating, metacognition II). The low frequency of metacognitive and motivational strategies is consistent with the results of other observation studies (Kistner et al., 2010; Dignath & Büttner, 2017). Using cognitive strategies can be seen more as the ''obvious'' instruction, as it is more about retaining information. Metacognitive and motivational strategies however, require from the teacher to take a step further and focus more on the learning process instead of just recalling information. So, both metacognitive and motivational strategies can be seen as more complex. This could be a reason for the big difference in type of strategy use. Schraw, Crippen, and Hartley (2006) stated that each component of the three layered model of Boekaerts (1999) is necessary, but not sufficient when used alone for self-regulation. Boekaerts (1999) states that each component lacks something that the others have. So, it could be that because teachers did not focus as much as needed on metacognitive and motivational strategies, the way they promoted self-regulation was less effective, which explains there low scores.

In the second hypothesis it was expected that teachers who scored high on differentiation also scored high on their indirect promotion of self-regulation. The results confirm this hypothesis, since a strong positive correlation was found between differentiation and indirect promotion of self-regulation. Dignath and Büttner (2008) and De Corte et al. (2004) stated that a classroom which indirectly supports self-regulation is based on a constructivist perspective of learning. Suprayogi et al. (2017) found a significant association between differentiation activities of the teacher and constructivist teaching beliefs in their research. This is in line with the results from this research since a high score on differentiation correlated with a high score on indirect promotion of self-regulation (which is based on constructivist learning perspectives).

An explanation for the strong correlation could be that the autonomy of students (created by teachers through promoting self-regulation) could have had an influence on the degree to which teachers use differentiation. The more autonomous students are, the more time teachers can spend on for instance extended instruction. By promoting self-regulation indirectly, the context will be created to do this. So, by creating a context which provokes self-regulation, boundary conditions can be created to differentiate. For instance cooperation assignment so the teacher has to spend less time on instruction and can focus more on meeting specific learning needs (e.g., adapting an assignment for low-ability students, or give them extended instruction).

The purpose of this study was to examine the relationship between teachers' differentiation activities and their promotion of self-regulation in the classroom. Both topics are considered complex by teachers to implicate in lessons. Lots of studies have been conducted about differentiation and self-regulation solely, however very little information was known about the two topics combined. The results of the present study confirms earlier research about the rarity of explicit instruction, but also indicates that teachers knowledge and image of this topic can have an influence on their teaching behaviour. The study shows that there is a relationship between teachers' differentiation activities and their promotion of self-regulation (direct as well as indirect), and therefore contributes to the theoretical field. Promoting self-regulation can be seen as an important influencing factor of differentiation and also to enhance students autonomy. A lack of metacognitive and motivational strategy use can be seen as an cause for their low scores on direct promotion, since it is important to use all three aspects of the three layered model of self-regulation. The combination of all types of strategies will create more self-regulated learners. Consequently, in educational practice, teachers should spend more time on explicit strategy instruction (of all types) to promote self-regulation and enhance students autonomy, and therefore create more opportunities for differentiation. This knowledge can be used by teachers and teacher educators to implement in their lessons, and make the implementation of differentiation less complex while students become more autonomous.

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7 Appendices

Appendix A: STIP observation instrument

STIP

Observatielijst voor in de klas

Observator		Datum	
School		Meetmoment	1 / 2 / 3 / 4
Leerkracht		Starttijd les	

		Eindtijd les	
Aantal leerlingen groep		Aantal jongens	
		Aantal meisjes	
Gebruikte methode		Onderwerp van de les	
Opstelling in de groep	0 Tafels los van elkaar in rijen en kolommen 0 Tafels in groepjes 0 Tafels in tweetallen naast elkaar 0 Anders, namelijk…….. Maak een foto!		

- Lees voorafgaand aan de observatie dit hele instrument goed door, zodat je weet wat er van je verwacht wordt, waar je op moet letten en hoe je dit moet scoren.
- Zorg dat je voldoende vragenlijsten voor leerling en leerkracht mee hebt.
- Vraag of je in de les een geluidsopname mag maken. Dan kun je later dat wat gezegd wordt nogmaals beluisteren.

Als je op school aankomt…

- Vraag naar de betreffende leerkracht van groep.
- Stel jezelf voor aan de leerkracht van de groep en vertel dat je komt voor de observatie van de afgesproken Natuur en techniekles (hetzij een reguliere, hetzij een STIP).
- Bespreek met de leerkracht waar je het beste kunt gaan zitten in de groep. Je wilt een plek waar je de hele ruimte goed kunt overzien en waar je de leerkracht goed kunt verstaan. Overleg of het goed is dat je af en toe ook rond loopt.
- Vraag of het goed is dat je een geluidsopname maakt. Dictafoon-app in je telefoon.
- Vraag of de leerkracht na afloop van de les de vragenlijsten voor de leerlingen wil laten invullen en ook de vragenlijst voor de leerkracht. Geef de vragenlijsten gelijk aan de leerkracht.
- Vul vooraf zoveel mogelijk de algemene informatie op het voorblad in. Maak ook een foto van het lokaal met je mobiele telefoon.
- Vul tijdens de observatie eerst de lesbeschrijving in. Noteer wat er gebeurt en welke interacties plaatsvinden.
- Vul na de observatie, bijvoorbeeld als de leerlingen en leerkracht de vragenlijst invullen (max. 15 minuten) op basis van je lesbeschrijving en de audio-opname de leerkrachtobservatie in.
- Neem de ingevulde vragenlijsten, samen met het ingevulde observatieformulier mee.

De lesbeschrijving

Wat gebeurt er in de les? (methoden/organisatie)	*Minuten*	*Vragen of opmerkingen (specifieke quotes)*		*Andere observaties (noteer hier ook het aantal leerlingen dat antwoord mag geven of dat betrokken is bij de vraag).*
		Leerkracht	*Leerling*	

Onverwacht leerlinggedrag dat geobserveerd is.				

De lesbeschrijving (vervolg)

Wat gebeurt er in de les? (methoden/organisatie)	*Minuten*	*Vragen of opmerkingen (specifieke quotes)*		*Andere observaties (noteer hier ook het aantal leerlingen dat antwoord mag geven of dat betrokken is bij de vraag).*
		Leerkracht	*Leerling*	

Onverwacht leerlinggedrag dat geobserveerd is.				

Vragen voor leerkracht na observatie

Bespreek de volgende vragen met de leerkracht NADAT je de observatie hebt afgerond. Dit duurt ongeveer 15 minuten.

Vraag	*Antwoord leerkracht*
1. Hoe heeft u besloten wat u in deze les ging doen? Welke beslissingen heeft u daarin gemaakt? Heeft u gebruik gemaakt van een uitgeschreven lesplan voor deze les? zo ja, graag kopie meenemen	
2. Wat was het doel van de les? Wat moesten de kinderen leren?	
3. Had u de voorkennis van de leerlingen in kaart gebracht? Zo ja, op welke manier?	
4. Op welke manier heeft u rekening gehouden met verschillen tussen leerlingen?	
5. Wat waren de doelen van de voorgaande les bij deze groep? Waar sloot deze les op aan?	
6. Welke inhoud gaat u in de volgende les behandelen? Welke doelen streeft u dan na?	

7. Gaat u de kinderen huiswerk of extra of ander werk geven naar aanleiding van deze les?	
8. Hoe bepaalt u of de leerlingen de doelen van deze les bereikt hebben?	
9. Zijn er aspecten van de les die u nog wilt verduidelijken voordat we deze observatie afronden?	

Leerkrachtobservatie

Differentiatie in inhoud *Leerlingen van verschillende competentieniveaus werken aan verschillende inhouden (met inherente complexiteit).*	***Score*** *0 = komt niet voor* *1= komt voor*	***Voorbeeld(en)***
De leerkracht:		
1. Bepaalt wat leerlingen al over de te behandelen leerinhoud weten. *Vraagt expliciet naar de voorkennis over dit onderwerp: wat weet je er al van? Helpt voorkennis activeren.*		
2. Biedt leerlingen leerinhouden aan die zijn afgestemd op hun leerbehoeften. • *Concrete leerinhouden voor de moeilijk lerende leerlingen: bijvoorbeeld de schijf van 5, of de limonadefabriek.* • *Meer abstracte leerinhouden voor de slimmere leerlingen: bijvoorbeeld fotosynthese of het ontstaan van dag en nacht.*		
3. Laat leerlingen relaties tussen behandelde leerinhoud en andere leergebieden zien of ontdekken al naar gelang hun leerbehoeften. • *De leerkracht geeft aan waar de leerinhoud nog meer mee te maken kan hebben of aan welke andere onderwerpen/ leerinhouden deze leerinhoud gekoppeld kan worden.* • *De leerkracht biedt ruimte aan leerlingen om te ontdekken waar de behandelde leerinhoud nog meer mee te maken kan hebben of aan welke andere onderwerpen/leerinhouden deze leerinhoud gekoppeld kan worden ('zijpaden' uitdiepen).*		

4. Maakt gebruik van verschillende bronnen die zijn afgestemd op de leerbehoeften van de leerlingen. • *De leerkracht heeft voor moeilijk lezende of lerende leerlingen makkelijkere teksten ingezet.* • *De leerkracht heeft voor de makkelijk lezende of lerende leerling moeilijkere teksten ingezet.*		
Opmerkingen:		

Differentiatie in taak *Leerlingen van verschillende competentieniveaus werken aan andere typen taken (van meer lagere naar meer hogere orde denkvaardigheden stimulerend)*	***Score*** *0 = komt niet voor* *1= komt voor*	***Voorbeeld(en)***
De leerkracht:		
5. Zorgt voor verschillende opdrachten die afgestemd zijn op de leerbehoeften van de leerlingen. • *Hij geeft moeilijk lerende leerlingen bijvoorbeeld vooral opdrachten die een beroep doen op herinneren, begrijpen en toepassen. Stelt vragen die ingaan op feitenkennis (wat is….?), oorzaak-gevolg relaties (wat was eerst….?) of het toepassen van het geleerde (laat eens zien hoe je dit uitrekent….?).*		

• *Hij geeft makkelijk lerende leerlingen bijvoorbeeld vooral opdrachten die een beroep doen op het analyseren, evalueren en creëren bij leerlingen. Stelt vragen waarbij leerlingen zaken met elkaar moeten vergelijken, waarbij ze hun mening moeten geven en onderbouwen of waarbij ze gevraagd wordt iets nieuws te bedenken.*		
6. Stimuleert het creatief denken bij leerlingen op hun eigen niveau. • *Neemt geen genoegen met de eerst genoemde ingevingen, vraagt meer van de leerlingen.* • *Stelt vragen als: zou je dat ook anders kunnen bekijken? Hoe zou die of die daar tegenaan kijken? Denkt iedereen daar hetzelfde over?* • *Zegt expliciet dat gekke oplossingen soms helemaal zo gek nog niet zijn… bijv. de aarde is rond was een heel gekke uitspraak toen men dacht dat de aarde plat was… totdat het tegendeel werd bewezen.* • *Zegt bijvoorbeeld: zoek dat maar eens op of zoek dat maar eens uit… komen we er morgen op terug…naar aanleiding van opdrachten die de leerlingen doen.*		
Opmerkingen:		

Differentiatie in proces *Verschillende competentieniveaus krijgen verschillende procesondersteuning (meer directief, versus meer coachend).*	***Score*** *0 = komt niet voor* *1= komt voor*	***Voorbeeld(en)***
De leerkracht		
7. Groepeert leerlingen op basis van hun mogelijkheden of interesses • *Laat bijvoorbeeld leerlingen die nog niet veel over het onderwerp weten samenwerken in een heterogene groep (niveau of interesse) of laat leerlingen die al veel over het onderwerp weten samenwerken in een homogene groep (niveau of interesse)*		
8. Laat leerlingen de leerinhoud ontdekken op een wijze die past bij hun voorkennis (qua instructietijd en type opdrachten). • *Biedt leerlingen die moeilijk leren uitgebreid instructie bij het onderwerp en opdrachten die de leerling helpen zich de stof eigen te maken.* • *Laat leerlingen die makkelijk leren de ruimte om de leerstof zelf te ontdekken met behulp van een korte instructie en gestructureerde opdrachten (dus qua instructietijd en opdrachten).*		
9. Legt leerinhoud op verschillende manieren uit zodat centrale begrippen goed worden overgebracht. • *Werkt bij leerlingen die nog niet veel van het onderwerp weten of het moeilijk vinden met veel voorbeelden, vergelijkingen en kleine stapjes.* • *Biedt leerlingen die al veel weten of makkelijk leren meer ruimte voor verbinding, neemt grotere stappen, laat sneller los.*		
10. Gebruikt verschillende manieren van feedback geven al naar gelang wat de leerling nodig heeft. • *Geeft bij de moeilijk lerende leerlingen meer directieve feedback, zoekt meer naar voorbeelden, geeft misschien ook de oplossing.*		

• *Geeft de makkelijk lerende leerlingen meer procesmatige feedback: laat leerlingen zaken zelf uitzoeken, geeft hints, maar geen oplossing.*		
11. Stimuleert op verschillende manieren de leerlingen om kritisch te denken. • *Stelt vragen als: Hoe zou jij dat aanpakken? Hoe zou jij dat oplossen? Hoe zou jij dat testen/uitproberen? Is dat voor iedereen een probleem denk je? Wat vind je daar van?* • *Stelt vragen als: als je … en … met elkaar vergelijkt… wat zou dan … zijn? Welke oplossing zou meer mensen helpen?* • *Stelt vragen waarin leerlingen moeten synthetiseren, hun gevonden resultaten omzetten naar een theorie. Wat betekent dat voor…. ? Kun je nu ook iets concluderen over….. ?* • *Stelt vragen als: kun je in het kort aangeven wat nu precies het probleem is en welke oplossing je uiteindelijk het beste vindt?*		
Opmerkingen:		

Leeromgeving *De leeromgeving is de setting waar het leren van de leerlingen plaatsvindt. Deze setting heeft een fysieke en psychologische component.*	***Score*** *0 = komt niet voor* *1= komt voor*	***Voorbeeld(en)***
De leerkracht		
12. Heeft de tafels zo opgesteld dat het uitnodigt tot groepswerk. *De tafels staan in groepjes opgesteld.*		
13. Zorgt voor een goede voorbereiding van de les <u>waardoor er weinig tijd verloren gaat aan organisatie en klassenmanagement</u>. *De les is goed voorbereid, materialen zijn al beschikbaar, leerlingen weten wat er van hen verwacht wordt.*		

14. Accepteert de gevoelens van leerlingen op een positieve manier. *Is positief naar alle leerlingen*		
15. Moedigt leerlingen aan. *Neemt geen genoegen met eerste antwoord, vraagt door/verder, geeft zelf ook aanvullende voorbeelden of interpretaties.*		
16. Accepteert of gebruikt de ideeën die leerlingen inbrengen. *Waardeert de inbreng van de verschillende leerlingen*		
17. Heeft hoge verwachtingen van de leerlingen. *Laat de leerlingen op een positieve manier merken dat hij <u>verwacht</u> dat de leerlingen ver zullen komen bij een taak of opdracht (Dat kunnen jullie.., dat halen jullie wel…., ik verwacht dat jullie…..) .*		
18. Betrekt leerlingen bij het plannen, monitoren en vaststellen van hun leren of het geleerde. *Stelt leerlingen vragen die erop gericht zijn om hen zelf te laten nadenken over planning of volgen van het leren.*		
19. Reflecteert met de leerlingen op het geleerde. *Vraagt leerlingen wat het betekent wat ze geleerd hebben, vraagt of ze kunnen reproduceren wat er geleerd is, vraagt of het doel bereikt is van de les, vraagt wat ze nog niet weten, waar nog vragen liggen.*		
Opmerkingen:		

Appendix B: observation instrument self-regulation (strategy instruction)

Observant: _____ Leerkracht:_____ School: _____

Datum: _____ Land:_____ Groep: _____

Type Strategie:

Voor het leren		**Tijdens het leren**		**Na het leren**	
Organisatie	**O**	Elaboratie	**E**	Monitoren en Evalueren	**M**
Planning	**P**	Probleem oplossen	**P**	Oorzakelijke attributie	**O**
		Hulpbronnen inzetten	**H**	Feedback	**F**
		Sturen van actie	**S**	Metacognitie level II	**M^2**

Tijd	**Type Strategie**	**Meta Cognitie Level II**	**Voordeel v.e. strategie uitleggen**	**Transfer naar andere domeinen**	**Expliciete instructie v.d. leerkracht**	**Impliciete instructie v.d. leerkracht**	**OPMERKINGEN**
0:00-1:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
1:00-2:00	VOOR						
	TIJDENS						

	NA						
	ALGEMEEN						
Tijd	**Type Strategie**	**Meta Cognitie Level II**	**Voordeel v.e. strategie uitleggen**	**Transfer naar andere domeinen**	**Expliciete instructie v.d. leerkracht**	**Impliciete instructie v.d. leerkracht**	**OPMERKINGEN**
2:00-3:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
3:00-4:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
4:00-5:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
5:00-6:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						

6:00-7:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
Tijd	**Type Strategie**	**Meta Cognitie Level II**	**Voordeel v.e. strategie uitleggen**	**Transfer naar andere domeinen**	**Expliciete instructie v.d. leerkracht**	**Impliciete instructie v.d. leerkracht**	**OPMERKINGEN**
7:00-8:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
8:00-9:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
9:00-10:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						
10:00-11:00	VOOR						
	TIJDENS						

	NA						
	ALGEMEEN						
11:00-12:00	VOOR						
	TIJDENS						
	NA						
	ALGEMEEN						

Appendix C: observation instrument promoting self-regulation (learning environment)

	SCHOOL: **GROEP:**	**LEERKRACHT:**				
	Datum:	**Rating**	**1**	**2**	**3**	**4**
	COOPERATIEF LEREN					
1	De leerkracht gebruikt vormen van coöperatief leren tijdens de lessen	- Als leerlingen samenwerken - Zo ja, hoe vaak (Kwantiteit)				
2	De leerkracht zorgt ervoor dat leerlingen daadwerkelijk samen werken en grijpt in indien nodig	- Als de leerkracht leerlingen activeert om samen te werken - Als de leerkracht bij de leerlingen kijkt terwijl ze werken - Als de leerkracht hulp biedt als het nodig is - (Kwaliteit)				
	CONSTRUCTIVISTISCH LEREN					
3	De leerkracht wijst leerlingen op het activeren van voorkennis en het integreren van nieuwe kennis	- **Hoe vaak** en **hoe duidelijk** is dit te observeren?				
4	De leerkracht integreert nieuwe kennis in een betekenisvolle context en/of introduceert nieuwe kennis door het bewust creëren van een cognitief conflict	- In welke mate doet de leerkracht dit?				

5	De leerkracht geeft complexe en/of open en/of weinig gestructureerde problemen die op verschillende manieren aangepakt kunnen worden en/of waarbij verschillende oplossingen mogelijk zijn.	- **Hoe vaak** en **hoe duidelijk** is dit te observeren?				
	ZELFSTURING					
6	De leerkracht geeft ruimte aan leerlingen om verantwoordelijkheid te nemen voor het structureren van hun eigen leren door hen enige mate van beslissingsvrijheid te geven.	- Hoeveel verantwoordelijkheid krijgen de leerlingen?				
7	Er is een balans tussen zelfsturend leren van de leerling en leerkracht gestuurd leren.	- In welke mate is dit van toepassing?				
	TRANSFER					
8	Leren is geïntegreerd in een authentieke en levensechte context.	- In welke mate is dit van toepassing?				
9	De leerkracht benadrukt/belicht de leerinhoud in diverse contexten en/of diverse manieren om naar een probleem te kijken	- In welke mate is dit van toepassing?				

Appendix D: Scatterplots

Figure 2 Scatterplot differentiation and direct promotion of self-regulation.

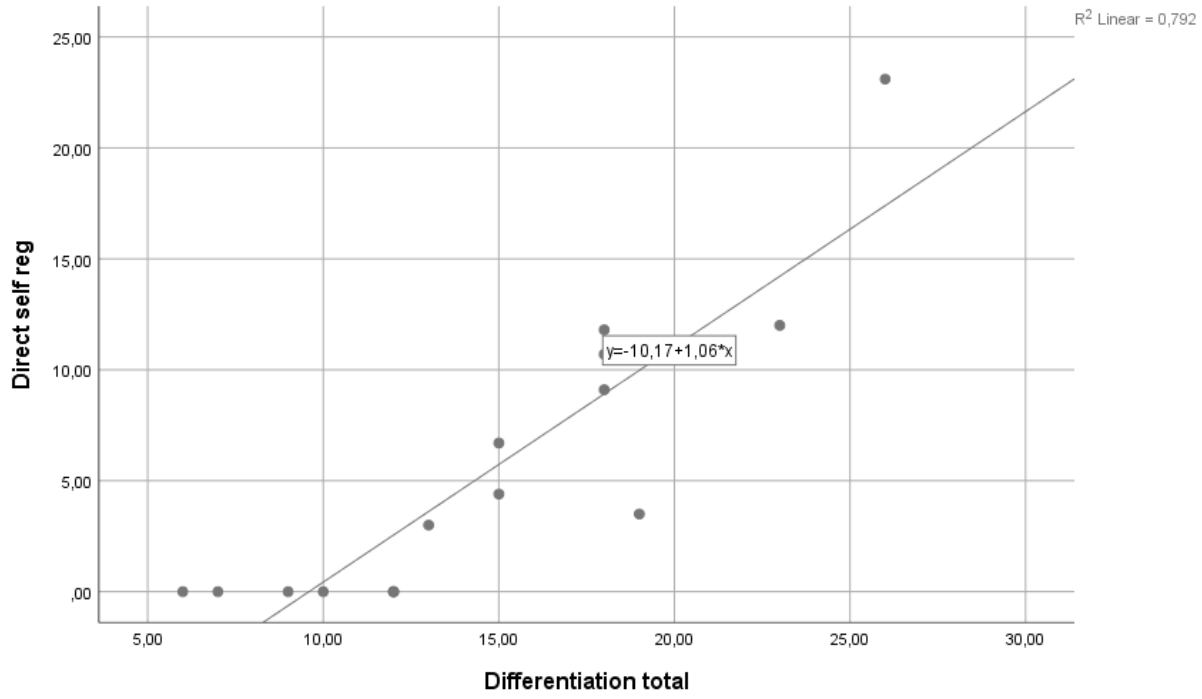

Figure 3 Scatterplot differentiation and indirect promotion of self-regulation.