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# **Does Lesson Study contribute to activating and cognitively demanding teaching behavior? A single case study**

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## ***Abstract***

*Activating and cognitively demanding teaching behavior is problematic for many teachers in Dutch secondary education, in particular for the less experienced advanced beginners. In the context of a Professional Learning Community (PLC) for both less and more experienced teachers of mathematics, Lesson Study has been chosen as professionalization method to contribute to activating and cognitively demanding teaching behavior. In Lesson Study research, effects are mostly reported based on self-reports. In a single-case study of an advanced beginning teacher, we explore the effectiveness of Lesson Study by using a mixed-method of observations, pupil questionnaires and teacher self-reports. The results indicate small learning effects on activating teaching behavior but no effect on cognitively demanding teaching behavior.*

## **Introduction**

For one of the five teachers in Dutch secondary education activating teaching is problematic (Inspectie van het onderwijs, 2014), in particular for less experienced ('advanced beginners', Berliner, 2001) teachers (Van de Grift, Van der Wal & Toorenbeek, 2011). Activating teaching is important because pupils learn more effectively, and it is even more effective if cognitively demanding tasks are used (Hattie, 2012; Silver et al., 2009). In the present study, activating teaching behavior is investigated in connection with cognitively demanding teaching behavior in the context of mathematics lessons. We conceptualized activating and cognitively demanding teaching behavior using a two dimensional framework. The first dimension focuses on teaching behavior in relation to pupils' active participation in mathematics lessons (Ebbens, 1994), and the second dimension focuses on teaching behavior in relation to the degree of cognitive demand of mathematical activities in the lessons (Silver et al., 2009).

Activating teaching makes sure that students are actively involved in schoolwork. This is observed when the teacher is asking questions, paying attention to students' responses, giving feedback, stimulating student interaction, and instructing students to work on their own or on collaborative and co-operative tasks (Bolhuis & Voeten, 2001).

Silver et al. (2009) distinguish between low and high cognitive demanding tasks. Low cognitive demanding tasks are more focused on routine applications and known procedures. High cognitive demanding tasks require students for example to explain, to describe, to justify, to make decisions and choices, to work with several forms of representation and to be creative.

To contribute to activating and cognitively demanding teaching behavior, Lesson study has been chosen as professionalization method in the context of a Professional Learning Community (PLC) for teachers of mathematics. In this PLC, advanced beginners collaborate with more experienced teachers ('proficient' teachers, Berliner, 2001) in so-called Lesson Studies, a relatively new professionalization method in the Netherlands. Lesson Study includes professional activities such as keeping up-to-date by for example reading publications, collaborating with colleagues and reflecting on teaching experiences, activities which all have been proven to be effective for adult learners including teachers (Kooy & Van Veen, 2012). In a Lesson Study, teachers collectively design and plan a so-called research lesson in great detail according to a collaboratively determined educational goal. Next, they observe one of them who teaches the designed research lesson. Afterwards, they share their observations, revise and reteach the research lesson (Fernandez, 2002; Lewis, Perry, & Murata, 2006).

Lesson Study research shows that LS can be a powerful means for teachers to improve their teaching practice (Cheung & Wong, 2013; Xu & Pedder, 2014). However these conclusions are mostly based on self-reports in small, qualitative research, conducted in non-Dutch contexts, such as Singapore, Hong Kong, China, the USA and the UK (Cheung & Wong, 2014; Xu & Pedder, 2014).

In this study, we explore the effectiveness of Lesson Study in the Netherlands in a single-case study of an advanced beginner using a mixed-method of observations, pupil questionnaires, and teacher interviews and teacher questionnaires. The main research question is to determine whether Lesson Study contributes to teacher's activating and cognitively demanding teaching behavior in regular math lessons.

## **Methodology**

### *Context and participants*

The research takes place in the context of a three-year pilot project PLC (2014 – 2017) for mathematics launched last year by the Dutch Ministry of Education, with a group of 16 teachers of 10 secondary schools. The distribution of male and female teachers is 9 versus 7, their average age is 43 (sd=11, range=27 - 59), their average years of teaching experience are 17 (sd=11, range=3-37), 11 teachers are fully qualified, and five teachers have a grade-two qualification (i.e., qualification to teach junior forms of secondary education). Eight participants, four advanced beginners and four proficient teachers, were recruited by email for participation in the study.

Data presented in this paper are collected from September 2014 - June 2015 from one randomly chosen teacher: female, age 27, grade-two qualification, three years of teaching experience. Henceforth we call her Susan.

### *Lesson Study intervention*

In the school year 2014-2015, two Lesson Study cycles took place. Susan participated in a Lesson Study team of six persons (first cycle) and five persons (second cycle). In the second cycle, Susan also taught the second research lesson.

The general theme of the PLC is activating and cognitively demanding math education. In the Lesson Studies, teachers therefore were asked to develop activating and cognitively demanding math research lessons. Teachers were supported by two subject pedagogy teacher educators, who among other things provided literature on the theme.

### *Data collection procedure and instruments*

Our approach of data collection is to a large extent based on Smith, Baker, Hattie and Bond (2008) who describe a construct validation study of the certification system of the National Board for Professional Teaching Standards. Important instruments used in this study are classroom observations (Narrative Running Record), teacher interviews and pupil questionnaires.

For classrooms observations, multiple observation instruments exist to assess the quality of teaching behaviors (e.g. ICALT, Van de Grift, 2007). Since we aimed at a detailed description of teaching behavior to see what teachers do, we took the approach of behavioral observations to record all teacher behaviors connected to activating and cognitively demanding teaching behavior during a lesson. Because of this intensive way of data collection we chose to observe two lessons per teacher conform Bolhuis and Voeten (2001). When arranging dates for the observation with the teacher, the teacher was asked to teach math lessons as 'regular' as possible.

Prior to the classroom visit, a lesson plan form was sent to the teacher to describe how the teacher had planned for the lessons to be observed. For each observation, the observers arrived in the classroom approximately 15 min prior to the scheduled observation time to have time to set up and test the recording equipment. The video recorder was positioned so as to capture as much teacher and class activity as possible. The entire lesson, which lasted 45 to 50 minutes, was video-recorded. During the observation, Observer One completed the Narrative Running Record on activating teaching behavior, a semi-structured form for recording, at 5 min intervals of as much classroom activity and interaction as possible. Observer One focused on the teacher: what the teacher said or did and how the teacher responded to the pupils. The observer also described the whole class activity and from three randomly chosen pupils their on- or off-task behaviors that were observed. Observer Two completed the Narrative Running Record on cognitively demanding teaching behavior, a semi-structured form for recording, at 5 min intervals of the cognitive level of activities and questions. Observer Two also focused on the teacher: what the teacher said or did and how the teacher responded to the pupils in making an appeal to pupils' lower or higher cognitive activity. In this way two of Susan's lessons were observed in September 2014 in two first classes, levels Mavo (lower general secondary education) and Havo (higher general secondary education) /VWO (pre-university education) (12-13 years old). In June 2015 two lessons in the same classes were observed by one observer (Observer Two in

September 2014). Only the lesson in the HV-class has been taken under consideration, because the lesson in the M-class turned out to be not a regular math lesson.

During the last five minutes of each lesson, pupils filled out a questionnaire. This pupil questionnaire included three subscales with a four-point scale (rarely - sometimes - often - almost always) developed by the researchers to measure teacher's activating and cognitively demanding teaching behavior and pupils' own commitment (see Appendix 1). All three scales showed good reliability (activating Cronbach's  $\alpha = .72$ ; cognitively demanding Cronbach's  $\alpha = .70$ ; pupil commitment Cronbach's  $\alpha = .82$ ).

After the observation of two lessons, the observers conducted a tape-recorded interview of the teacher for approximately 20 minutes, and pictures were made of the materials used. The purpose of the teacher interview was to collect additional data related to activating and cognitively demanding teaching behavior.

Following the observations and the interview, transcripts were made of the video-taped lessons. Also transcripts were made of the post-observation interviews. All artifacts of the observation were assembled as a casebook 'Teacher observations' including the two lesson plans, the Narrative Running Record forms, and transcripts of the observed lessons and interviews.

After each Lesson Study cycle, teachers filled out an evaluative questionnaire including some questions about learning effects. After the second Lesson Study cycle an interview by telephone took place to collect additional data related to learning effects. Also transcripts were made of this post Lesson Study-interview. Together with the self-reported learning effects in the evaluative teacher questionnaire after each Lesson Study cycle, these artifacts formed the casebook 'Teacher self-report learning effects'.

Since teachers were interested in getting feedback on their teaching performances, the observers filled out the ICALT observation instrument (Van de Grift, 2007) to evaluate teachers' general teaching effectiveness. Based on these ICALT results, teachers were sent short general and descriptive feedback.

#### *Scoring system of the casebook 'Teacher observations'*

For the two dimensions of activating and cognitively demanding teaching behavior, an analysis instrument has been constructed including 25 activating teaching behaviors (based on Ebbens and Ettekoven, 2013) and 13 cognitively demanding teaching behaviors (based on Silver et al., 2009) connected to three teacher roles of instructor, question asker and coach (see Appendix 2). Furthermore, for each of the two dimensions a separate detailed scoring rubric was developed, based on a three-point scale (Schoenfeld, 2013) (see Appendices 3 and 4). Level 1 describes performances that are characteristic for low performing teachers for that dimension, and level 3 describes performances that are characteristic for high performing teachers for that dimension. Level 2 describes average performances on that dimension. Also for the observations of the whole class activity and of the on- or off-task behaviors from three randomly chosen pupils a scoring rubric was developed (see Appendix 5).

Each lesson was divided and coded into stages (introduction, instruction, etc., Ebbens & Ettekoven, 2013). For each lesson stage the indicators for activating and cognitively demanding teaching behavior were added. Each lesson stage subsequently was scored on activating and cognitively demanding teaching behavior and whole class activity. Finally, an average score for all three dimensions per lesson was calculated.

#### *Data analysis procedure of the casebook 'Teacher self-report learning effects'*

Based on the questions about learning effects in the evaluative questionnaire and the interview after the second Lesson Study cycle, a survey was made of the learning experiences, moments and subjects and the eventual impact on teaching practice.

#### *Data analysis procedure of the pupil questionnaire*

To gain insight into how pupils think of the activating and cognitively demanding teaching behavior of their teacher and of their own commitment during the lesson, we computed the mean scores and standard deviations for Susan's pupils at two moments, in September 2014 and June 2015.

## **Results**

### *Teacher observations*

Table 1 presents the results of the classroom observations. The degree of activating teaching behavior increased on average .40: it was below average in September 2014, and slightly above average in June 2015. Pupils' participation (Active class) was above average in September 2014, and was scored higher, near high performance in June 2015. The difference in activation between the two moments is illustrated as follows: In the September lesson Susan asks her pupils to draw a triangle with given length of the three sides. She does not give an indication of the time available for the activity. When she observes (after six minutes) that most pupils have finished the task or could not find an answer she decides to explain the task to the class. In the June lesson Susan activates the pupils by splitting up the lesson in small activities, like measuring the angles of pie-chart and calculating the percentages of each sector of the pie-chart. A characteristic statement in this lesson is: "*What I want from you, and you now get five minutes, is that you measure all angles of the pie-chart. Five minutes.*"

The degree of cognitive demand of most activities is very low both in September and in June. Most tasks and activities were routine tasks, such as measuring angles, or calculating percentages, or were made as such, and focused on memorizing.

**Table 1.** Observations

	<i>1hv Sept 2014</i>	<i>1m Sept 2014</i>	<i>1hv June 2015</i>
Activating teaching behavior	1,71	1,80	2,15
Active class	2,32	2,19	2,70
Cognitively demanding teaching behavior	1,06	1,13	1,09

*Teacher self-report*

Table 2 presents the results of the evaluative questionnaire. After the first and second Lesson study cycles, Susan indicates increased knowledge of instruction, increased ability to observe pupils and increased understanding of pupils' thinking and learning. After the second lesson study cycle, Susan adds improved quality of lessons.

In the interview, Susan reports learning experiences in two domains. The first is the use of math language, and the second is the domain of lesson organization: time, pace and structure of the lesson. About the latter Susan says:

*“I now increase the pace of my lessons. I notice that I urge the pupils by reminding that an activity should be completed in five minutes. Previously I was more relaxed, waiting for the moment pupils finished an activity. The pace of the lessons was more guided by the pupils. [...]. Now, I'm just, um, more structured.”*

An important learning moment for Susan was her giving the research lesson: *“When I gave the research lesson, I experienced the importance of using correct math language”*.

As effects on her lessons, Susan reports that she is trying now to be more precise in using mathematical language and to organize more variation and pace for the pupils, and to remove lazy moments from her lessons. Susan says she now is more consciously preparing and reflecting on her lessons and experimenting with other approaches.

**Table 2.** Results of the evaluative questionnaire

	<i>After LS-cycle 1</i>	<i>After LS-cycle 2</i>
Increased knowledge of subject matter	2	3
Increased knowledge of instruction	4	5
Increased ability to observe pupils	5	4
Increased understanding of pupils' thinking and learning	4	5
Stronger connection of daily practice to long-term goals	2	n.a.
Improved quality of lessons	3	5
Improved pupil performances	3	n.a.
Other outcomes?	-	-
Changes in own teaching practice?	-	more conscious of using math language

1 = totally not applicable; 5 = fully applicable

*Pupil questionnaire*

For the analysis, we standardized all the scale scores for the three pupil scales. Table 3 presents the results of the pupil questionnaire. Pupils assess Susan's teaching behavior as rather activating and cognitively demanding at both moments. However pupils' commitment decreases with ,15 in June 2015 compared with September 2014.

**Table 3.** Mean scores and standard deviations for the three scales in the pupil questionnaire.

<i>Scale</i>	September 2014 <i>M + SD 1(m + hv)</i> <i>n = 44</i>	June 2015 <i>M + SD 2(hv)</i> <i>n = 24</i>
Activating teaching behavior	,87 (.08)	,87 (.09)
Cognitively demanding teaching behavior	,77 (.13)	,84 (.11)
Pupil commitment	,87 (.11)	,72 (.07)

### **Conclusion and discussion**

In this study we explored the effectiveness of Lesson Study in the Netherlands in a single-case study of an advanced beginner using a mixed-method of observations, pupil questionnaires, and teacher interviews and teacher questionnaires. The main research question is to determine whether Lesson Study contributes to teacher's activating and cognitively demanding teaching behavior in regular math lessons.

Conclusions based on this single case study are that participation in Lesson Study seems to enhance teachers' activating teaching behavior a little, but it does not seem to affect teachers' cognitively demanding teaching behavior. Susan in particular works on increasing the pace of her lessons to activate her pupils, which has been observed and was also reported by Susan herself. Although Susan reports to be more precise in the use of mathematical language, this does not impact the cognitive level of her lessons. Her twelve and thirteen-year-old pupils however report something else: They assess Susan's teaching behavior as rather activating and cognitively demanding at both moments, and only report to be somewhat less committed in the second lesson.

We only found a small improvement in activating teaching behavior and for the cognitively demanding teaching behavior we even did not find any improvement at all. A possible explanation for this difference in impact is that less attention in the Lesson Study was paid to the cognitive aspect than to the activating aspect. Besides, activating could be conceived more easily, and could be more visible for teachers than the cognitive aspect. More in general, it is known from the teacher change literature that change in teaching behavior is possible, but that it is very difficult to achieve, and that you need a change in both teaching practices and teacher beliefs (e.g., Clarke & Hollingsworth, 2002; Guskey, 2002; Desimone, 2009). In addition, for such a change the didactical contract (or socio mathematical norms) (Brousseau, 1990; Elbers, 1988), an implicit agreement about the communication in the classroom, needs to be changed. Previous research shows that such a change is difficult. The question is whether Lesson Study has enough impact on teachers to change the fixed patterns of interaction in mathematics lessons. Another question is raised by the pupils whose answers in the questionnaire do not match the observations nor teacher's self-report. Are pupils capable, in particular such young pupils aged 12 or 13 years old, to say anything meaningful about the teaching behavior of their teacher?

This study also has several limitations. We only investigated one teacher before and after two Lesson Studies and observed only four lessons. We propose to investigate eight teachers, four advanced beginners and four proficient teachers, and to monitor them during three years (six



Lesson Studies). Another limitation is that we did not include any data concerning the Lesson Study process: in future research we also intend to include data concerning the research lessons, and both quantitative and qualitative data about the process and the collaboration in the teams. A third limitation is that for the scoring of the teacher observations we should have worked with more than one researcher and with interrater reliability. A tentative last limitation is the representativeness of the observed lessons. Are these lessons really 'regular' lessons, or do the teachers adapt their lessons because of the presence of an observer?

Although this study has some limitations, with our study we hope to contribute to the building up of case-based records of contextualized understandings of Lesson Study which is a necessary prior stage before subjecting the effectiveness of Lesson Study to summative test (Lewis et al., 2006; Xu & Pedder, 2014). Once the value of Lesson Study for contributing to activating teaching in the Dutch context should be determined, this could have important implications for both educational and professionalization practices in the Netherlands.

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**Appendices (available in Dutch on demand)**

**Appendix 1:** Descriptive statistics and scales in the pupil questionnaire

**Appendix 2:** Overview of the indicators for activating and cognitively demanding math lessons connected to the role of the teacher

**Appendix 3.** Scoring rubric for activating

**Appendix 4.** Scoring rubric for cognitively demanding teaching behavior

**Appendix 5.** Scoring rubric for pupil activity in class