



Mathematics Teachers' Goal Setting and Planning Activities in a Lesson-Study Context*

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Article Information	ABSTRACT
Received: 09.11.2021	The purpose of this study is to examine changes in goal setting and planning activities of a lesson study group consisting of three middle-school mathematics teachers. The teachers worked as a group, conducting three study lessons over a period of five months. Data were collected from documents that the teachers developed and used, as well as videotaped observations of their planning meetings. The results showed that teachers shifted their focus from the content towards student engagement with the content when goal setting and planning. As they grappled with the problems of reform mathematics teaching, teachers' goal statements evolved and new goals emerged. They became more attentive to planning the content and discussing ways to present it. They modified curricular materials based on the students' current knowledge and skills, anticipated students' thinking and planned teacher reactions in accordance with meaningful learning. As the teachers began to define more concrete and descriptive implementation steps to achieve their goals, they also developed more specific criteria for success.
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1. INTRODUCTION

Reform movements in mathematics education require teachers to design learning environments that take individual differences into account, use various teaching and assessment methods effectively, integrate technology into their lessons and - most importantly - regulate and improve themselves continuously (Kilpatrick, Swafford, & Findell, 2001; National Council of Teachers of Mathematics, 2020). However, the vast majority of studies have shown that teachers find it difficult to adapt their teaching to match the reform-oriented mathematics teaching (Golding, 2017; Ziebell & Clarke, 2018). It is particularly challenging for experienced teachers, who have already developed conceptions about curriculum, teaching and learning mathematics as well as routines that are hard to change (Superfine, 2008).

In Turkey, the reform-oriented mathematics curricula have been developed and implemented since 2005 (Milli Eğitim Bakanlığı [Ministry of National Education (MoNE)], 2005, 2013, 2017). All curricula aim to promote learning and teaching environments in which students can develop meaningful understanding, productive skills (e.g., problem solving, reasoning and communication) and adaptive dispositions. In order to support teachers' adaptation to the reform curricula, teaching materials and technological resources (e.g. MoNE, 2009, 2012a, 2012b) were developed, and professional development programs were designed and implemented by MoNE of Turkey. Research, however, has shown that the available resources as well as the teacher development programs, which mostly involved short-term seminars, were not sufficient in helping teachers implement reform curricula in Turkey (Bal & Artut, 2013; Budak & Okur, 2012; Karakuş & Yeşilpınar, 2013). We believe that adaptation to the reform-oriented mathematics teaching requires setting goals compatible with the reform curricula and making strategic plans to achieve those goals. Hence, this study makes the case for helping teachers adapt to the reform-oriented teaching mathematics by giving them opportunities to think about and reflect on their own teaching goals and plans by means of lesson study as a professional development model.

* This study is based on the first author's doctoral thesis. This study was ethically approved by the Hacettepe University Ethics Committee with its decision dated 04.03.2014 and numbered 88600825.

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1.1. Teacher Goal Setting and Planning

Given the complexities of teaching mathematics, the everyday work of teachers involves setting goals and making plans to achieve those goals. Whether explicitly or implicitly, in writing or in thought, teachers set goals and plan for every semester, course and lesson. Decisions made during those activities guide their actions in the classroom (Camp, 2017; McAlpine, Weston, Berthiaume, & Fairbank-Roch, 2006; Roche, Clarke, Clarke, & Sullivan, 2014). Setting goals and planning allow teachers to decide which content to include or exclude, which materials to use, how to present them, which aspects of student learning to focus on and many similar decisions that determine the quality of instruction.

Goal setting is a decision-making process that identifies the outcomes one hopes to attain at the end of a task (Zimmerman, 2000). Goals provide criteria that can be used to assess, monitor and guide cognition; hence they help people evaluate their own performance (Pintrich, 2000). Teachers' goals represent their "expectations, intentions about what is or was to be accomplished in teaching and learning...where they wanted to be when they had completed a particular course or class action" (McAlpine et al., 2006, p. 132). Planning is closely related to goal setting because it involves choosing strategies to achieve defined goals (Zimmerman, Bonner, & Kovach, 1996). When planning, individuals convert real-world problems into internal representations to search for solutions. Planning offers reversible, economic and flexible ways to cope with problems (McAlpine et al., 2006). Capa-Aydın, Sungur, and Uzuntiryaki (2009) defined strategic planning within the context of teaching as a process of determining and creating appropriate teaching strategies by considering teaching goals, student characteristics and accessible resources.

Teachers' planning for reform-oriented teaching must consider not only the mathematical content, but also the way in which students engage with that content (Superfine, 2008). Teachers need to design challenging and motivating tasks and plan to guide students to explore underlying mathematical concepts and ideas with these tasks. They need to modify teaching materials according to students' current and evolving knowledge and skills. To respond to students and direct discussions, they must anticipate student responses and common errors (Chazan & Ball, 1999; Fennema, Franke, Carpenter, & Carey, 1993; Stein, Engle, Smith, & Hughes, 2015). In addition, planning for reform curricula requires teachers to reflect on their decisions and actions in terms of offering opportunities for students to explain their ideas, ask questions and discuss.

Teachers' knowledge and skills, dispositions, priorities and judgments influence the way in which they engage with curricular materials and the types of problems they encounter while planning (Sullivan, Clarke, Clarke, Farrell, & Gerrard, 2013; Superfine, 2008). Teachers with strong knowledge and pedagogy can select challenging tasks and anticipate students' responses to plan the most effective ways of implementing those tasks. Teachers who value conceptual understandings plan instructional strategies to guide students explore different ways to solve problems and discuss important mathematical ideas underlying the tasks. Research has shown that mathematics teachers with limited knowledge and pedagogy demonstrated difficulty in setting clear, proximal goals and in making instructional decisions compatible with the goals (Güven-Akdeniz & Dede, 2020). Constraints that teachers anticipate experiencing during the instruction also impact their decisions in goal setting and planning (Sullivan et al., 2013). Likewise, feelings such as joy, freedom or insufficiency emerged during the planning play important roles in teacher's decisions. For instance, mathematics teachers with positive emotions tend to be more creative in the planning process (Grundén (2020). Research has also shown that mathematics teachers who participated in collaborative professional development programs improve knowledge, skills and dispositions for effective planning (Davidson, 2019; Hebert & Worthy, 2001).

1.2. Lesson Study

Lesson study, which is one of the collaborative professional development models, could provide a favorable context for teachers to think, act and reflect on their goal setting and planning practices for teaching reform mathematics curricula. In lesson study model, teachers collaboratively work on a research theme, which could be considered as a long-term goal shared as a group and design a series of study lessons align with the research theme (Fernandez & Yoshida, 2004; Lewis, Perry, & Hurd, 2004; Richardson, 2004; Stepanek, Appel, Leong, Mangan, & Mitchell, 2007; Takahashi & Yoshida, 2004). Each planned lesson is delivered by a group member to his or her own class, while the other members participate as observers. Then all of the members reunite to reflect on the lesson. Based on the decisions they made on reflection, group members could revise, reemployment and reflect on the study lesson, if they want. Teachers use their learning and experience when they design the next study lesson. They are expected to develop goals and plans that are more compatible with the research theme as they progress through the lesson study practices.

A large body of literature has reported the positive impacts of the lesson study model on teachers' knowledge of mathematics and pedagogy, their motivation and instructional behavior. Previous studies have shown that teachers who participated in lesson study improved content knowledge of mathematics as well as knowledge of students (Meyer & Wilkerson, 2011; Ni Shuilleabhain & Seery, 2018) and developed self-efficacy for teaching mathematics (McGuire, 2011; Sibbald, 2009). In addition, teachers who participate in lesson study research were more adaptive in changing their instructional practices compatible with reform-oriented mathematics teaching (e.g., guiding students to reason and discuss) (Letloenyane & Jita, 2020; Özaltun-Çelik & Bukova-Güzel, 2016; Yıldız, 2013). Also, a number of studies have found that lesson study model

facilitated mathematics teachers in setting goals focusing on conceptual understanding and designed effective lesson plans (Huang, Su, & Xu, 2014; Wright, 2009).

To contribute literature in this area, the present study aims to examine the changes in the goal setting and planning activities of a group, consisting of three middle-school mathematics teachers in the context of lesson study. The following research questions are addressed: (1) Taking into account the research theme they agreed on, how teachers' goal statements and the way they set goals have changed throughout the lesson study practices? (2) Taking into account the research theme they agreed on, what aspects of teachers' planning have changed throughout the lesson study practices?

2. METHODOLOGY

The present study adopted a qualitative single-case study design. The goal setting and planning activities of three mathematics teachers were considered as a single case. The teachers worked as a group over a 5-month period, designing, conducting, and reflecting on three study lessons. Their goal setting and planning activities were explored.

2.1. Participants and Context

Three middle school (Grades 5-8, ages 11-14) mathematics teachers from the public schools in the central district of a medium-sized Turkish city took part. Snowball-sampling method (Merriam, 2009) was used to determine the participants (Nuray, Nihat ve Mina). Nuray, Nihat and Mina had eight, eleven, and nine years of professional experience respectively. Teachers stated that they have some background knowledge about reform mathematics curricula through the seminars designed and implemented by MoNE. However, they did not have any knowledge and experience of lesson study. They were motivated to participate by the opportunity to develop their teaching skills through cooperating with other teachers.

At the start, researchers interviewed each teacher twice and observed two one-hour lessons to understand his or her planning routines and teaching. In these preliminary interviews, they stated that they did not make detailed preparations for their routine lessons. Their usual way of planning involved choosing tasks and problems and providing task variety. They taught students by presenting content and then solving the tasks and problems with the students, a conventional teacher-centered approach. Even though teachers are expected to use the reform mathematics curricula (MoNE, 2013), the accountability mechanism is mainly based on students' achievements on standard tests and results of high school entrance exams. Hence, teachers stated that they felt more pressure on preparing students for the exam compared to meeting the goals of reform mathematics curricula.

2.2. Lesson Study Practices and Researcher Roles

The teachers carried out three study lessons over five months. Beforehand, the first author met the teachers three times. The purpose of the first meeting was to establish trust and rapport among the participants and also between the teachers and the researcher. The second meeting was used to explain the lesson study process and the roles and responsibilities the teachers were expected to fulfil. The first author situated his role as a participant observer. While he provided resources (copies of documents, a quiet place to work, etc.) and guided discussions, he let the teachers decide when, how and which goals to set and plan. The purpose of the third meeting was to identify a research theme for the teachers to focus on throughout the three study lessons. They decided on a research theme that is developing 'meaningful learning' and 'student-centered teaching'. These preliminary meetings were not recorded.

For each study lesson, the teachers chose a topic. They conducted four, six and seven meetings (total is 17) in the planning processes for three study lesson respectively. The teachers planned three-part study lessons, incorporating warm-up activities, the main activity and practice. The three study lessons were conducted respectively by Nuray, Mina and Nihat in their own classrooms. Both the researcher and the teachers observed and took notes during the study lessons; each study lesson was also recorded using a video camera. After the lessons were finished, the participants watched video recordings and reflected on their planning-related goals and decisions. In the second and third planning processes, a pilot lesson was conducted by the practitioners (Mina and Nihat respectively) of the study lessons. Other teachers and the researchers did not participate in these lessons.

2.3. Data Collection

Data were collected by observing teacher meetings and analyzing documents. Before the data collection an ethical permission was taken from Hacettepe University's Ethics Committee (dated 04.03.2014 and numbered 88600825). Another permission was taken from the Uşak Provincial Directorate of National Education (dated 16.08.2013 and numbered 29425508/42/2100875). In the data collection process, the first author observed 17 planning meetings in total and took field notes, using an open-ended observation form adapted from the literature on lesson study, goal setting, and planning. All of the meetings were video- and audio-recorded. In addition, the documents produced and used by the teachers (lesson plans, resources, concrete materials, and worksheets) were collected and included in the data set.

2.4. Data Analysis

Before starting the analysis, 17 video recordings (1426 minutes) of teacher planning meetings were transcribed. The observation notes, video and audio recordings, transcripts and documents were then examined separately and coded, using NVivo 10 software. The analysis framework was developed based on the goal-setting, planning and lesson study literatures. For developing the codes and categories related to goal setting (e.g., cognitive, dispositional, behavioral goals), classifications of educational goals on the literature was used (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956; Pintrich, 2000). For developing the codes and categories related to teacher planning (e.g., planning the content, planning for success criteria), literature on lesson study (e.g., Fernandez & Yoshida, 2004; Lewis et al., 2004) and planning in mathematics teaching (e.g., Sullivan, Borcek, Walker, & Rennie, 2016; Superfine, 2008) are used. The teachers' statements and preparations indicating decisions and actions about goals, content, teaching materials and sources, methods of instruction, the order of tasks, possible student thinking and questions and criteria for success are considered as their ways of setting goals and planning. The teachers' goals were extracted from statements about their intentions, expectations and decisions about what to achieve in each lesson or part of a lesson. Some goals were explicitly stated, as the teachers were completing their lesson plans; others were inferred from discussions. The framework used to examine the teachers' goal statements and their planning is briefly described in Tables 1 and 2. In order to examine changes in teachers' goal statements and planning, we first coded their decisions and actions in terms of the categories listed in Table 1 and Table 2, then we compared codes under each study lesson and searched for the evolving and emerging codes.

Table 1.

Framework for Analysing Teachers' Goal Statements

Learning (student) goals: Goal statements related to developing cognitive, dispositional or behavioral aspects of learning	
Type of goals	Descriptions
Cognitive goals	Developing conceptual or procedural aspects of learning mathematics or process skills (e.g., problem solving, connections)
Dispositional goals	Developing a positive attitude and adaptive motivation toward mathematics
Behavioral goals	Developing adaptive habits or actions for learning mathematics (e.g., working as a group, listening to others)
Teaching (teacher) goals: Goal statements related to developing teaching actions to improve the quality of instruction (e.g. design and implement a non-routine lesson)	

Table 2.

Framework for Analysing Teachers' Planning

Categories	Descriptions
Planning the content of the lesson	Decisions about the structure (e.g., concepts, algorithms, skills), amount (with respect to the curriculum) and source (e.g., printed resources, personal recommendations) of the mathematical content that will be focused in the lesson
Planning the presentation of the content	Decisions about the tasks and activities (e.g., concrete materials, questions, problems) Decisions about teaching methods and techniques Decisions about the order of and connections among the tasks and activities Decisions about possible student thinking and teacher responses
Planning for success criteria	Decisions about what counts as a successful indicator in the lesson

3. FINDINGS

Teachers' goal setting and planning activities for each study lesson are presented separately in the following sections. In order to make connections with the analytical frameworks, brief statements related to the categories are included in parenthesis or in italics. The results are compared over time, to show the evolving nature of goal setting and planning.

3.1. First Study Lesson: Let's Try and See!

The first study lesson represented the teachers' initial attempts to work as a group. They focused on the subject of "measuring time" (5th grade), which included recognizing measures of time (e.g. year, month, day, hour, minute), converting units of time measurements and finding elapsed time. Teachers' planning did not begin by explicitly stating goals. As they made decisions about content, tasks and activities, various goals emerged. They explicitly stated their goals near the last planning meeting. Overall, the teachers aimed to achieve: (i) active student participation, (ii) meaningful learning and (iii) connecting content with everyday life. In addition, the teachers aimed to motivate their students and reveal prior knowledge using warm-up activities. These goals seemed compatible with the research theme. None of the goals involved developing their own teaching (*teaching goals*), all involved developing cognitive and dispositional aspects of learning (*learning goals*). As the following excerpt shows, the statements about goals were specific to the content and focused mostly on *procedural aspects of learning*.

Mina: They (the students) will recognize the units of time measurement. For example, (expressing) how many hours, minutes, and seconds are there in a day.

Nihat: Yes.

Mina: Afterwards, (they will express) how many weeks, days are there in a year.

Nihat: Yes.

Mina: For the conversation of measurements, they will use the operations.

Nihat: Exactly.

The teachers planned the first study lesson by exchanging opinions and experiences. They mainly consulted the textbook and curriculum (*source of the content*), taking into account the students' level of the achievement. They accepted or rejected each other's ideas without much thinking or discussion, and opted to focus on presenting and comparing measures of time, converting one measure into another and solving problems. The content level was intense (*amount of the content*), requiring three lesson hours within the curriculum (MoNE, 2013). The teachers focused mainly on presenting time measures through real-life examples, in accordance with the research theme. They also included tasks requiring routine algorithms (*structure of the content*).

Their *planning to the presentation of the content*, consisted mainly of choosing tasks and activities that they were familiar with. They did not think about clear, concrete implementation steps and were skeptical of new ideas. For instance, Nihat's suggestion (estimating how many days they spend sleeping in one month) was refused by Mina and Nuray since the students were not familiar with making assumptions and estimations. They also decided not to use concrete materials (e.g., models of clocks, timelines) because they considered these materials too simple for fifth graders (*tasks and activities*). Likewise, they were distant and cautious about taking actions that neither them nor their students were familiar with (*teaching methods*). For instance, the suggestion of Mina about less talk of the teacher who will implement the lesson, and increasing opportunities for student to speak was not accepted by Nuray and Nihat (see the dialogue below). As a result, the tasks and activities they chose for the first study lesson were not very different from the ones in their routine instructions.

Mina: ...I think we shouldn't talk much in the beginning of the lesson.

Nihat: Okay, then let's give them an opportunity to talk.

Nuray: Let "we (the teacher)" and "they (the students)" both talk (laughing).

Nihat: We (teachers) have so accustomed (to talk).

Nuray: How will the lesson flow if we don't talk?

Nihat: If I don't talk for 30 minutes of 40 minutes (one lesson time), I will feel incomplete.

Nuray: I would feel bad as well.

Mina: Let's begin the lesson without telling the subject (measuring time) and let them (students) know by themselves.

Nuray: But, it would be strange (for students) ... They would ask the topic. They aren't accustomed to this (this kind of teaching).

When *planning for the presentation of the content*, the teachers did not consider how students interact with content, an essential component of planning a reform mathematics classroom. When they noted a misconception or a common difficulty, they did not plan how to react (*student thinking and teacher response*). They implicitly agreed to explain the content or the correct solution, leaving it up to the presenting teacher to react as he or she felt best. In addition, the greatest challenge for the teachers was *determining success criteria for the lesson*. They identified only one general criterion for the warm up activities: "ensuring student participation" which is depicted below.

Nuray: (Reading the lesson plan) They (the students) will be able to understand the units of time, and will be able to establish relationships between them. We will consider their participation rate.

Mina: Why did we write it (referring to the participation rate)?

Nihat: It is unclear, isn't it?

Mina: Him, we wrote it to define how we will evaluate the success (of the students in this activity). We will observe whether we attract the students' attention by considering their participation rate.

Nihat: All right.

The teachers had prepared four warm up activities, one main activity, and a worksheet which included six tasks for the practicing phase. During the warm up activities, they planned to focus on "expressing the date as the day, month, and year", "showing examples for daily use of common units of time", "sorting units of time" and "showing students the knuckle tricks to remember which months have 31 days". For the main activity, they had prepared a time table showing a student's daily activities and five tasks requiring to calculate elapsed time for daily activities (e.g. studying). In the practicing activity, students were expected to do calculations with units of time and make conversions.

Nuray conducted the first study lesson, implementing warm-up activities and the main activity; there was no time for the students to practice. The lesson mainly consisted of teacher-directed questioning and the teacher presenting and explaining the content. The teacher responded to student mistakes by explaining or providing the correct answer. Although students

participated in the activities by answering the teachers' questions, there was little space for student exploration or discussion. The teachers were dissatisfied with the overall lesson, evaluating it as teacher-centered. As they agreed that the first lesson was too much like ordinary instruction, they concluded that it was not consistent with the research theme.

3.2. Second Study Lesson: Change Comes With Struggles!

For the second study lesson practice, the teachers were more eager to exceed their boundaries, try new ideas and design a more creative and original lesson. They worked on the subject of "solving first-degree linear equations with one unknown" (6th grade). The main goals were similar to the first study lesson. The aspect that changed from the first study lesson was the way in which they conceptualized student participation and understanding. They focused on engaging all students in learning—particularly low achievers. To do this, they opted to keep the content accessible to all students. By taking students, rather than content, into the center of goal setting, the teachers were more successful in setting detailed goals that reflected the research theme. In the first study lesson, their goal statements were broad and focused on specific content, such as 'to calculate elapsed time' or 'to read and interpret a table'. Goal statements in the second study lesson were more concrete and focused on *conceptual aspects of learning*; they included 'to notice that carrying out the same operations on both sides of the equation doesn't change the equality'. Such goal statements made it easier to evaluate the lesson by providing concrete *criteria for success*. Mina and Nihat stated their expectations from the students as: "Our purpose is to make them solve the equation by carrying out the same operation on both sides of the equation and by maintaining the equality." "This (referring to solving the equation with inverse operation) is not our purpose."

The teachers also set goals for developing their own teaching (*teaching goals*). They aimed to develop and conduct non-routine lessons, be less intrusive, talk less and give students more opportunities to participate in class discussion. They thought about hypothetical teaching situations (e.g., teacher questions, student responses) during the planning meetings; this helped them predict how the instruction might go (*student thinking and teacher response*). In this way, they were able to make more concrete decisions about their teaching practices (*teaching methods*), as shown in the following dialogue:

Nihat: I did it again [with frustration]. I began talking and kept on [telling, explaining], right? That is not right [referring to the hypothetical teaching situation].

Mina: You talked more. Like, you said 'let's subtract 5'. Well, we should not say that. Why don't we ask 'how can we find the answer?' And then wait [for the students to respond].

Nihat: OK.

For the second study lesson, the teachers wanted to keep the content simple and attainable in one lesson hour (*amount of the content*). They did not succeed, however, as their planning included content that would normally take almost six lesson hours to cover, according to the curriculum (MoNE, 2013). This time, however, they were more open to considering new ideas. They designed concrete materials for the warm-up and main activities and consulted additional resources and online sources (*tasks and activities, source of the content*).

In contrast to the first study lesson, the teachers were more attentive in *selecting tasks and activities*. They discussed how each task would help them achieve meaningful learning goals. As an example, Mina suggested using 6x8 cm cardboard number cards, displaying numbers, four operations, and equal signs. Nihat asked whether using cards would be any different from writing on the board. The dialogue below shows how the teachers were beginning to question each other's ideas:

Nihat: It is the same. That is why I am not sure. I mean, I could easily write it [the equation] down on the board. Why am I using the cards?

Nuray: Well, here they [the students] can see what you subtract. They do not see it clearly when we write on the board.

Mina: Yeah...They do not see it. For example, here they can see that I am taking 6 [referring to $6+a=11$].

Nihat: Well, that is it? The idea is OK, but I think there still are drawbacks...

Nuray: We could develop the idea [number cards].

The teachers also discussed ways of implementing tasks and activities (*teaching methods*). In a change from the first study lesson, they considered how students would interact with the tasks and activities (*student thinking and teacher response*). A pilot lesson carried out by Mina the day before helped them predict student thinking, as the dialogue below illustrates:

Mina: Yesterday [referring to the pilot lesson] most students did it [the task: $5 + \blacksquare = 12$] this way [students' solution way: $\blacksquare = 12 - 5$].

Nihat: They're subtracting from the other side, as well.

Mina: But this will be wrong if they keep the 5 [on the left side] and subtract from the other side [on the right side].

Nihat: Yeah, that would be incorrect.

Mina: Let's write that down, as a warning, on the plan.

Nihat: OK.

They had developed one warm up activity, one main activity, and five tasks for the practicing phase. In the warm up activity they focused on finding the unknown in a given equation (e.g., $7 + 4 = \blacksquare + 5$) by using inverse operations (i.e. $7 + 4 = 11$, $11 - 5 = 6$) and relational thinking (i.e. if 5 is one more than 4, then \blacksquare is one less than 7). In the main activity and practicing phase, they focused on solving first degree linear equations with one variable by the method of conservation of equality (e.g., $5 + a = 12$; $5 - 5 + a = 12 - 5$; $a = 7$).

Mina implemented the second study lesson. She conducted the warm-up and main activities, as well as some practice worksheet problems. She put a lot of effort into making the students engage with the tasks and gave them more opportunities to talk. She avoided directly explaining or evaluating student answers, allowing other students to think about and discuss the ideas. However, the participation was low, in comparison to the first study lesson. The teachers evaluated the lesson as unsuccessful because of the low participation rate. Mina explained her frustration as ‘we made them think but not talk’. However, the teachers stated that this second attempt was more consistent with the research theme.

3.3. Third Study Lesson: Learning From Experience!

After the first two study lessons, the teachers became more aware of their own teaching methods, as well as the demands of teaching reform mathematics. In the third and last planning process, they focused on “drawing a parallelogram using a grid or dotted paper” (5th grade). As in the first two study lessons, the teachers set goals that reflected the research theme. In addition, they set a new goal of developing effective communication skills (listening and discussion) because they realized that the students were not listening to each other, when given a chance to discuss the topic. They therefore decided to focus on developing the students’ communication skills (*process skills*).

Mina: ...She [the student] said ‘I slide the point [corner] three units’. Nobody listened. She offered an important explanation. We should focus on this. ...I wish the other students had listened to her, discussed the topic and agreed with her. I think we should develop this [referring to listening skills].

The teachers continued to focus on developing their own teaching, in accordance with the following goals: (i) to develop and conduct a non-routine lesson, (ii) to be less intrusive during class discussion and provide more opportunities for students to talk, (iii) to encourage students to explain and discuss idea, (iv) to stay calm and composed under pressure (*teaching goals*). The following dialogue illustrates this:

Nihat: ...Look, to me...I see this now...when we teach someone, we should leave him alone. We should just act as guides—this is what student-centered education should look like, as I understand it, right?

Nuray: Yeah.

Nihat: Now I will distribute [geometry strips]. They will form [parallelograms] with the material [geometric strips] and work on them, right?

Mina: [The student] will describe the properties.

Nihat: Yeah, we will let them discuss the properties. So, what will we discover here? What will they tell us? Let us say ‘parallel sides’ and ‘corresponding sides are equal in length’. We could even talk about the angles.

As in previous meetings, the teachers stated their goals toward the end of the planning session, during the fourth meeting. However, in contrast to the first two study-lesson practice sessions, they discussed the goals in detail and set more clear and descriptive goals. The dialogue below illustrates that teachers began to discriminate among goals (recognize parallelogram vs. discover its properties) and decide which goal is more consistent with their research theme (*learning goals*).

Mina: ...This is what we should let them realize, guys: How can we draw a parallelogram? Without recognizing whether it is a parallelogram or not.

Nihat: Yeah.

Mina: I mean, when we show a parallelogram, the student will either recognize it as a parallelogram or not. So, what? We should let them discover this trick of sliding the corners, figure out that the line segments have equal lengths or draw the parallel lines by themselves.

By setting more specific goals, the teachers clarified the *criteria for success*. In particular, they decided that the main activity would be successful if the students were able to draw parallelograms from one given corner and to explain their reasoning. As in the second study lesson, the teachers considered the participation of low-achieving students to be another criterion for success.

While choosing the content and deciding how to present it, the teachers considered the research theme and engaged in more detailed discussions. As in the second study lesson, the teachers wanted to keep the content simple and attainable in one lesson hour (*amount of the content*). They therefore excluded content involving diagonals and related properties. While they were more successful in limiting the content than in earlier study lessons, the content they chose to include (properties of parallelograms and drawing parallelograms on dotted/square paper) was estimated to cover two lesson hours in the

curriculum (MoNE, 2013). While *planning the content of the lesson*, the teachers mainly consulted the textbook but also considered the curriculum and the pilot lesson (*source of the content*).

The main change from the way they planned the first and the second study lessons was that the teachers were more attentive about how to deliver the content. They considered the research theme and took into account how students engage with the content when making decisions about how to present the content (*students thinking, connections*). The following excerpt illustrate this approach:

Nihat: How would you [Mina] make this transition? Let me see your suggestion.

Mina: Hmm, well, [I would say] let's draw this parallelogram. "How would you draw it, guys?" I would ask. The students would probably suggest different ways. Let see...Maybe one of them would say 'I would make the figure [using geometric strips] on this [paper] and then draw it'. Another student might say 'I would determine one point [corner] and then move it five units to the right to determine the other point [corner]. Well, [we'll see if she] will find all the points/corners.

As can be seen from the dialogue below, the teachers planned ways to react to incorrect student answers and solutions, as well as correct ones. They decided to ask for an explanation, provide hints and use questions to make the students think and discuss the topic. When responding to correct student answers, they decided to ask for an explanation and reinforce student thinking (*student thinking and teacher response*).

Mina: What should we do when the drawing is correct?

Nuray: We'll ask "how did you draw it?"

Nihat: We'll reinforce it. We'll ask her/him to explain her/his method.

Nuray: But, he/she has already explained it [on the board] when he/she drew the side. He/she will say that this side is parallel and also have to determine the length of the side.

Mina: OK, then we'll ask "how do we understand that it is a correct drawing?"

For the third study lesson, teachers seemed to develop a shared perspective on teaching according to the reform mathematics curricula. In particular, they agreed to create a discussion environment, provide the students with new opportunities to think and explain and encourage the students to think about and discuss topics, using hints and questions when they struggled and reinforcing correct answers and explanations. However, they were still hesitant to use teaching strategies that they and the students were unfamiliar with (*teaching methods*). For instance, Nuray and Nihat rejected Mina's suggestion about using group work because they thought it might cause chaos; they might not be able to manage the students.

Teachers had prepared three warm up activities. In these activities, students are expected to work on constructing triangles, rectangles and transforming the rectangular shapes into parallelograms with geometric strips. Then they are asked to build parallelograms with different sizes and positions by using geometry strips and describe the properties of parallelograms. They developed one main activity. During this activity, students are expected to draw parallelograms with different sizes and positions when a point (as one corner) or a line segment (as one side) were given. In the practicing phase, students are expected to work on two tasks that asks to draw parallelograms when an oblique line segment was given as one side and a point was given as one corner of the parallelogram.

The third study lesson was carried out by Nihat, who delivered all parts of the lesson (the warm up, main activity, and practice). He expended a lot of effort guiding the students to explore, using hints and feedback to encourage them to participate and discuss different solutions. He avoided providing direct explanations, corrections or evaluations when the students presented incorrect drawings or insufficient explanations. While the students were eager to participate, they found it difficult to complete correct drawings or to explain their thinking. The teacher therefore encouraged other students to think about the drawings and supported their correct use of mathematical language.

The teachers evaluated the third study lesson as unsuccessful because the students did not perform well on their drawings and explanations. However, they thought they had been successful in encouraging the students to engage with the content as they drew parallelograms and explored their properties. They judged themselves as having been successful in implementing a non-routine lesson that reflected the research theme.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

Even when teachers are motivated to adopt the reform mathematics curricula, they need a context to break down their routines and exceed their boundaries (Golding, 2017; Ni Shuilleabhain & Seery, 2018). We argue that this change could start with goal setting and planning. In this study, the teachers worked as a group to design, conduct and reflect on three study lessons. They were provided with opportunities to evaluate whether their goals are compatible with the reform mathematics curricula, and plan, implement and reflect on their teaching accordingly. The findings helped us understand the ways in which their goal setting and planning activities have changed in accordance with the reform mathematics.

The teachers' initial goal setting behaviors were similar to that of mostly described in prior literature (e.g., Fujii, 2016; John, 2006; Morine, 1975; Peterson, Marx, & Clark, 1978; Sullivan et al., 2013; Taylor, 1970; Zahorik, 1975). They did not start planning by setting explicit goals. They postponed explicitly defining goals until they were almost finished planning. Also, their goal setting simply involved listing the sub-topics of the subject. However, the expectation made them think about goals—beyond those included in the curriculum. Moreover, the opportunities to implement and reflect on study lessons helped them evaluate the extent to which they had achieved the goals.

The first study lesson did not differ greatly from the teachers' usual, conventional method of instruction. The teachers evaluated this lesson as unsuccessful in terms of achieving the research theme. This first 'unsuccessful' experience created a context in which the teachers could discuss their goals, lesson plans and ways of implementing lessons. It provided a starting point, which allowed them to develop a shared vision of what it meant to teach the reform mathematics curricula. Although the general goal statements did not change throughout the lesson study, the way in which the teachers conceptualized those goals did change. They shift their focus from the content to the ways students' engage with the content when setting goals. These findings support the literature by showing that teachers who participated in lesson studies are able to set goals that are more specific and focused on student mathematical thinking (Huang et al., 2014).

Unaccomplished goals became 'problems of teaching' (Lampert, 2001; Superfine, 2008) to be solved and used to develop new goals. To adopt reform mathematics, the teachers had to embrace the problems of reform mathematics teaching (Ball, 1996; Handal & Herrington, 2003). After the second study lesson, Mina's comment, 'we made students think but not talk' shows how goals emerged from the struggles of the lessons. Even when the teachers had gained the courage to design and implement non-routine lessons, the students were not used to discussing their own mathematical ideas or listening to each other. This teaching problem generated a new goal that the teachers had never considered before: 'developing students' communication skills'. They also realized that they needed to make space for more student exploration, which could only be achieved by changing their teaching behaviors. This led to a new teaching goal: 'be less intrusive and provide more opportunities for students to talk'.

Discussing problems of teaching makes the goals clearer and more explicit (Locke & Latham, 2002, 2013). It then becomes easier to make decisions and take actions (i.e. planning) to overcome specific problems (Superfine, 2008). For instance, the teachers realized that they could not achieve the goal of 'meaningful learning' by using intense content. The goal, 'increasing the participation of even low achievers', forced them to narrow down the content and focus on fundamental mathematical ideas. Although it was difficult to carry out that 'less is more' (Redfield & Rousseau, 1981), they began to reduce content in favor of higher cognitive demand, leaving more space for student exploration and discussion.

In the present study, goal setting became an active and evolving activity, which in turn affected the quality of instruction planning. As the teachers began to think about goals, the way they conceptualized those goals changed; this, in turn, changed their planning. Working as a group helps teachers share responsibility and develop the courage to change (Beck & Kosnik, 2006; Butler, Lauscher, Jarvis-Selinger, & Beckingham, 2004; Meirink, Meijer, & Verloop, 2007). The teachers began to exceed their boundaries by making concrete decisions and taking actions to design and conduct non-routine lessons from their own perspective. As the study progressed, they became more attentive to planning the content and discussing ways to present it. The lesson plan format they used continually encouraged the teachers to think about and discuss possible student thinking.

They also found opportunities to observe student thinking closely and to evaluate the impact of their own instructional decisions and actions. They modified curricular materials, based on the students' current knowledge and skills, anticipated students' thinking and planned their reactions in accordance with meaningful learning. They changed the way they reacted to incorrect answers—from explaining or providing the correct answer to asking other students for an explanation or offering hints and questions. These findings support literature showing that lesson study improve teachers' ability to predict possible student reactions and to plan appropriate responses (Harle, 2009; Watanabe, 2001).

The teachers' efforts to design non-routine lessons also caused them to search for and develop various novel materials. They thought about the materials, questioning whether they were effective and suited the goals. These findings are supported by literature showing that lesson study help teachers develop teaching materials that are more compatible with meaningful learning and student needs and focus on student-centered teaching methods (Copriady, 2013; Kadroon & Inprasitha, 2013; Ni Shuilleabhain & Seery, 2018; Verhoef, Coenders, Pieters, van Smaalen, & Tall, 2015).

As the teachers began to define more concrete and descriptive implementation steps to achieve their goals, they also developed specific criteria for success. Their criteria for the success of each lesson were likewise transformed, from a focus on correct student answers and a high participation rate to an engagement with the students' ways of thinking and exploring. Hence, despite lower student participation rates, the teachers evaluated the second study lesson as more successful than the first—because they were able to make the students think.

These study results indicate that goal setting and planning can benefit teachers by encouraging them to act, inspiring them to think about the way they teach and empowering them to control their own teaching. The teachers commented that this study was the first time in their professional lives that they ever focused on setting detailed goals. It was also their first opportunity

to monitor their own performance, an experience that helped them make decisions and take steps to design and implement lessons that reflected the research theme. Even though the teachers who took part in this study showed progress in setting goals and planning; findings are limited by data that have not been collected from their actual lessons. Further work needs to be done to explore how such experiences could impact teachers' goal setting and planning routine lessons. This study also confirms that goal setting and planning must be implemented with care and an understanding of the challenges and efforts to be overcome.

Research and Publication Ethics Statement

The authors declare that they comply with research and publication ethics and respect the copyright regulations for the intellectual and artistic works used.

Contribution Rates of Authors to the Article

The authors declare that they have contributed equally to the article.

Statement of Interest

The authors declare that there is no conflict of interest between them.

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