Dynamic Mathematics Interviews in Primary Education: The Relationship Between Teacher Professional Development and Mathematics Teaching

Jarise Kaskens
Windesheim University of Applied Sciences

Eliane Segers
Radboud University

Sui Lin Goei
Windesheim University of Applied Sciences

Johannes E. H. van Luit
Utrecht University

Ludo Verhoeven
Radboud University

Received: December 24, 2021 Accepted: January 23, 2023

In this quasi-experimental study involving 23 fourth grade teachers, we investigated the effect of implementing teacher-child dynamic mathematics interviews to improve mathematics teaching behavior in the classroom. After a baseline period of 13 months, the teachers participated in a professional development program to support the use of dynamic mathematics interviews followed by a period of practice in mathematics interviewing to identify children's mathematics learning needs. To determine the effects of the teacher professional development program, pretest and posttest videos of mathematics interviews were compared. To analyse the effects of the intervention, mathematics teaching behavior, mathematics teaching self-efficacy and perceived mathematical knowledge for teaching were measured. Results showed not only the effect of the program on the quality of the dynamic mathematics interviews, but also the effects of the intervention on mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching.

Keywords • mathematics teacher education research • professional development • dynamic mathematics interview • teaching behavior • mathematical knowledge for teaching • self-efficacy • mathematics teaching

Introduction

The premise of mathematics education is that through effective mathematics teaching practice, teachers can offer all children the opportunity to maximise their learning potential. Achieving this requires understanding the diverse learning needs of all children and being able to adapt to these needs in the regular mathematics classroom setting (Forgasz & Cheeseman, 2015). Meeting children's varied needs is complex, and a major challenge for many mainstream teachers. Teachers must be able to manage multiple learning trajectories and provide tailored support to learners with different mathematics abilities (Deunk et al., 2018). In order to adjust their teaching, teachers must be able to identify children's mathematics learning needs, which is an area where dynamic mathematics interviews may be helpful (Allsopp et al., 2008; Ginsburg, 2009). Dynamic mathematics interviewing is a flexible, semi-structured mathematics assessment approach in which the teacher interacts with a child to get insight into their mathematical thinking, conceptual understanding and underlying procedures and strategies, as well as their beliefs and emotions regarding mathematics (Allsopp et al., 2008; Ginsburg, 2009).

Although research has shown the promise of dynamic mathematics interviews in primary education, not much is known about the impact of learning how to conduct such interviews as a form of professional learning to help teachers to identify children's mathematics learning needs. Besides, to our knowledge, no study to date has yet set out how a teacher professional development program in teacher–child dynamic mathematics interviewing supports the quality and effectiveness of dynamic mathematics interviews. Furthermore, it has yet to be established whether learning to conduct teacher–child dynamic mathematics interviews is linked to other teacher-related factors regarding mathematics teaching.

Dynamic Mathematics Interviews

The need for teachers to measure children's developmental potential—not only their present ability—has led to dynamic mathematics assessment approaches. These assessment approaches are closely related to clinical and flexible mathematics interview methods, as described by Ginsburg (1997), and to contemporary conceptions of learning and mathematics education (e.g., Heng & Sudarshan, 2013; Jeltova et al., 2007). Pellegrino et al. (2001) designed a learning assessment model comprised of three elements. The first was how children represented knowledge and developed subject domain competence (cognition). The second involved teachers observing children's performance (observation). The third required teachers to analyse data based on children's interactions with specific domain tasks (interpretation). Dynamic mathematics assessment fulfills all these requirements. Such an assessment is flexible and process-oriented and enables teachers to obtain information about diverse children's thinking and conceptual understanding across the mathematics curriculum (Allsopp et al., 2008; Groth et al., 2016). It can provide more insight into children's mathematics learning capabilities than traditional tests (Seethaler et al., 2012).

To successfully identify and adapt to children's mathematics learning needs, teachers need insight into their students' mathematical performance, thinking, understanding, and beliefs (Deunk et al., 2018). Dynamic mathematics interviewing may be helpful in gaining this insight. A dynamic mathematics interview is an adaptable assessment approach in the form of a semi-structured interview with a focus on flexible questioning, where teachers conduct process research in the various domains of mathematics. In the past, such interviews comprised generally of closed mathematical problems that a child had to solve (Ginsburg, 1997). There is a case for dynamic mathematics interviews to also include semi-structured and open-ended mathematical problems. In such an interview, teachers are positioned to assess achievement levels, underlying procedures and strategies, and the type of support children need for further mathematical development (Van Luit, 2019; Ginsburg, 1997).

When posing questions and interacting with children, teachers stimulate children's responses, can better understand their points of view and can help address specific educational needs (Lee & Johnston-Wilder, 2013). The teacher can communicate in a way that helps children discover their mathematics learning strengths and share their experiences and emotions regarding mathematics learning goals, as well as the support needed to achieve them—linked with the future-focused, solution-focused approach (Bannink, 2010). Based on a review of applications of the solution-focused approach with children in school settings, Kim and Franklin (2009) concluded that this approach reduced the intensity of negative feelings and led to improved academic outcomes. Applying this solution-focused way of communication during interviewing could be of additional benefit. With the formative information teachers gather from dynamic mathematics interviews, teachers could develop micro-interventions in the classroom, such as the use of representations, additional instruction, or offering challenging and engaging tasks. These interventions, when in children's zone of proximal development, support their learning and problem-solving abilities and promote their self-esteem (Deunk et al., 2018).

An extensive literature search revealed only a few studies that reported on the effects of learning associated with conducting mathematics interviewing. A study by McDonough et al. (2002) involving preservice teachers who learned and practiced dynamic mathematics interviewing with young children, showed that the interviews provided a greater awareness of the differences between children and the kinds of strategies children use. They found interviewing was powerful for eliciting children's understanding and stimulating preservice teachers to reflect on the appropriateness of classroom experiences. Results of another study in which ten Grade 1 and 2 teachers participated in a series of workshops to use flexible mathematics interviews, showed that mathematics interviewing could support teachers to better understand children's mathematical thinking. Additionally, the teachers started posing more thoughtful questions in the mathematics classroom to elicit children's mathematics understanding (Heng & Sudarshan, 2013). These studies showed effects of mathematics interviewing on only a few aspects related to mathematics teaching.

Teacher-related Factors Regarding Mathematics Teaching

Teachers can influence children's mathematical development by effective mathematics teaching that addresses individual student's learning needs. Research of Kaiser et al. (2017) identified three components of effective mathematics teaching, which are essential for meeting the mathematical learning needs of diverse learners: effective teaching behavior during mathematics lessons, teachers' self-efficacy regarding mathematics teaching, that is, their beliefs in their own capabilities to influence children's learning, achievement and engagement; and teachers' mathematical knowledge for teaching, including deep knowledge of content and the knowledge and skills specific to teaching mathematics. Also contributing to effectiveness of mathematics teaching is teachers' insight into their students' current mathematical thinking as well as knowledge of tools and strategies for representing and explaining mathematics that are in line with children's educational needs (Reynolds & Muijs, 1999). Such insight is reflected in the ability to make efficacious decisions regarding child-related instructional goals, to master relevant prior knowledge and skills within several mathematical domains, to recognise children's preconceptions or misconceptions, to assess children's motivation and to group and support children according to ability (Hoth et al., 2016; Ketterlin-Geller & Yovanoff, 2009). Dynamic mathematics interviews can help provide insight into the impact of decisions made in the classroom (Allsopp et al., 2008).

Based on observing elementary school mathematics lessons, Van de Grift (2007) identified the following aspects affecting the quality of teaching behavior: safe and stimulating learning climate, efficient classroom management, clear instruction, activating learning, adaptive teaching, and use of teaching and learning strategies (e.g., model, explain, scaffold). In follow-up research, teaching behaviors were organised according to their levels of complexity, ranging from the less complex, such as providing a safe learning climate and undertaking efficient classroom management, to the more complex, such as learning strategies and differentiation and adapting lessons (Van der Lans et al., 2018). Using this schema, observers could assess teacher behaviors according to levels of complexity, while teachers could better understand their effectiveness at each level and anticipate the teaching needs at the next level. Deunk et al. (2018), however, showed that teachers found it challenging to provide refined adaptations that met an individual child's mathematics learning needs, which requires more complex teaching behavior (Van der Lans et al., 2018).

Another teacher-related factor that impacts on student learning is teacher self-efficacy. Teacher self-efficacy refers to teachers' perceptions of their own teaching abilities and is context-specific (Tschannen-Moran & Woolfolk Hoy, 2001). A meta-analysis showed that teachers' self-efficacy is an aspect of teacher competence that plays an important role in the educational process and professional learning and is strongly associated with teaching performance (Klassen & Tze, 2014). With regard to mathematics teaching, several studies showed that teachers' mathematics teaching self-efficacy influences children's learning, achievement and engagement. Chang (2015) found that teachers' mathematics teaching self-efficacy reciprocally influenced children's mathematics self-efficacy and achievement. On the one hand, successful mathematics teaching contributes to strong teacher self-efficacy. On the other hand, children's successful learning outcomes are influenced by their teacher's effective teaching performance, which is strengthened, in part, by the teacher's self-efficacy. Furthermore, Nurlu (2015) showed that teachers with higher mathematics teaching self-efficacy took greater responsibility for children' successes and failures and made more effort to support low-achieving children, while lower self-efficacy had a negative impact.

With reference to mathematical knowledge for teaching, a distinction can be made between pedagogical content knowledge (knowledge of content and student, and knowledge of content and teaching, e.g., the ability to select and use representations and models) and subject-matter knowledge (e.g., understanding concepts, skills, symbolism, procedures and student errors) (Shulman,1987). Subject-matter knowledge has a sub-domain concerning specialised content knowledge specific to teaching mathematics, including selecting good examples, representations, models and explanations for adapting instruction and asking questions to elicit children's mathematical thinking (Ball et al., 2008). Teachers' mathematical knowledge for teaching has been related to the quality of mathematics teaching —especially instructional quality (Hill et al., 2008). However, other research has suggested that this relationship is nuanced rather than clear-cut. According to Wilkins (2008), many variables appear to play a role in mathematics teaching practice, including beliefs and attitudes towards teaching mathematics. The relevance and power of teachers' beliefs, particularly as specific beliefs interact with teachers' mathematical knowledge (Campbell et al., 2014). A multiple-case study conducted by Charalambous (2015) found that mathematical knowledge for teaching and teachers' pedagogical beliefs about teaching and learning mathematics interact to inform teaching behavior. In other words, mathematical knowledge for teaching is not enough to ensure successful teaching. To enhance successful mathematics teaching, attention is needed to both teachers' mathematical knowledge and to teachers' beliefs about mathematics teaching and learning (Campbell et al., 2014).

In summary, research has established three key components of effective mathematics teaching that can help teachers better meet individual children's mathematics learning needs. To successfully identify these needs and adapt to them, teachers require insight into children's mathematics performance, thinking, understanding, emotions and beliefs. Dynamic mathematics interviewing may be an effective way to help gain these necessary insights. There is the potential the strategy could-make observable aspects of mathematics teaching behavior, teachers' self-efficacy and teachers' mathematical knowledge for teaching as aspects that contribute to the quality of mathematics teaching. However, this has not yet been investigated.

Effective Teacher Professional Development

The literature has identified the following characteristics of effective teacher professional development: active and practice-based learning, collective participation, focus on content and classroom practice, collaboration, duration and coherence (Desimone, 2009; Heck et al., 2019; Van Driel et al., 2012). With regard to focus on content, Copur-Gencturk et al. (2019), found that emphasis on curricular content knowledge in professional development was significantly related to increases in teachers' mathematical knowledge for teaching.

Using selected video clips from mathematics lessons in teacher mathematics training is also effective (Borko et al., 2011). Tripp and Rich (2012) explored how video influenced teacher change. They found that video and discussion motivated teachers and helped them adjust their teaching. Their work showed that teachers rated video analysis as a very effective feedback tool. In addition, Heck et al. (2019) found that teacher mathematics training that strengthened connections between the development of mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching was effective.

Scripted tools could help the teachers conduct dynamic interviews, but these are few and far-between (Caffrey et al., 2008). To our knowledge, only a few scripted tools for mathematics assessment exist, and they focus on specific domains of mathematics (Emerson & Babtie, 2014; Wright et al., 2006). For the present study, we created a tool to enhance teacher–child dynamic mathematics interviews to identify mathematics learning needs that was based on relevant research (Allsopp et al., 2008; Bannink, 2010; Delfos, 2001; Ginsburg, 2009; Ketterlin-Geller & Yovanoff, 2009). This semi-structured tool enables the teacher to conduct a process-oriented mathematics interview for various domains of mathematics and to examine children's mathematics-related experiences, emotions and beliefs in a solution-focused way (see the interview model in the Appendix). For example, the tool offers suggestions for questions that help gain insight into what the child understands, for questions that can support the child's thinking about solutions and future goals and for providing support (e.g., What are you proud of regarding mathematics? What kind of instruction do you prefer? How are you going to solve this mathematical problem?). In this way, the tool goes beyond standardised norm-referenced testing and existing assessment tools (Allsopp et al., 2008; Franke et al., 2001; Wright et al., 2006).

A few studies to date have investigated the effects of teacher professional development on teacher-related factors within the context of mathematics teaching in elementary schools (e.g., Heck et al., 2019). To our knowledge, no study has examined a teacher professional development program focused on the knowledge and skills needed to conduct teacher–child dynamic mathematics interviews that covers mathematics experiences, emotions and beliefs as well as mathematics achievement level, mathematical thinking and problem-solving processes, and in which support can be given for finding out what is helpful for the child's development. Additionally, the effects of professional development for dynamic mathematics interviews on teachers' mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching have not yet been studied.

Aims of the Present Study

Dynamic mathematics interviews may be a promising tool in the development of mathematics teaching skills. However, the direct link between teacher professional development focused on dynamic mathematics interviews and successful, interactive teacher–child interviews is not clear. We still do not know if dynamic mathematics interviews actually improve teachers' mathematics teaching behavior. Therefore, the current study examines the extent to which teachers can be supported to conduct teacher–child dynamic mathematics interviews that help identify the mathematics learning needs of fourth grade children in the Netherlands. The study also explores whether these interviews can improve teachers' mathematics teaching behavior. This intervention study was designed to answer the following questions:

1. *What is the effect of a teacher professional development program in teacher–child dynamic mathematics interviewing on the quality and effectiveness of dynamic mathematics interviews with fourth grade children?*
2. *What is the effect of the intervention—professional development and practice in teacher-child dynamic mathematics interviews—on factors related to mathematics teaching (teaching behavior, self-efficacy, and mathematical knowledge for teaching)?*

To answer the first question, 23 fourth-grade teachers were enrolled in a teacher professional development program focused on knowledge and skills related to dynamic mathematics interviewing. The program was followed by a practice period focusing on using dynamic mathematics interviews to identify children's educational needs when learning mathematics. We expected that the professional development program, based on effective characteristics of teacher professional development, would have a positive effect on the quality and effectiveness of dynamic mathematics interviews.

To answer the second research question, teacher-related factors were measured on four occasions. Three baseline measurements were taken before and one after the intervention period. We expected that the teacher professional development program would affect all three teacher-related factors connected to mathematics teaching. We thought that identifying children's mathematics learning needs and making the transfer to daily educational practice might appeal to teachers' specific mathematical knowledge, teaching skills (e.g., ask appropriate questions, make appropriate interventions) and belief in their own capabilities. Experiencing dynamic mathematics interviews and gaining insight into children' knowledge and thinking might thereby support effective mathematics teaching.

Method

Participants and Study Context

This study took place within the context of the Dutch primary education system. In that system, children develop early numeracy skills via playful activities in kindergarten; formal mathematics instruction starts in Grade 1. Children attend primary education from the ages of 4 to 12. Mathematics is an important school subject, characterised by a mixture of learning in context intended to encourage mathematical understanding and the practice of skills. Most teachers use textbooks to teach mathematics. The aim is to provide appropriate education to all children in mainstream schools. Participants were recruited by open invitations via social media (Twitter) and by direct mail addressed to both elementary school principals and fourth grade teachers (contact information gathered via schools' public websites). Interested teachers were invited to an informational meeting to learn about the aims of the study, what was expected from participants, and what they could expect from the researchers. Thirty-one teachers, responsible for teaching 610 nine-year-old elementary school children in grade 4 (children 8-10 years old), were initially involved. Due to illness, pregnancy, job changes and other factors, 23 teachers responsible for teaching 452 elementary school children completed the two-year study. Data were collected in the first year, but no intervention took place. The participants came from 22 Dutch elementary schools and had an average of 12.8 years of experience (*SD* = 9.8; range of 3 to 40 years). Most of the teachers (70%) had a bachelor's degree in education. An additional 26% had some graduate training and 4% had a master's degree in education.

Each group of children was divided into three mathematics achievement levels. Children were classified according to the results of the criterion-based standardised national Dutch mathematics tests given at the end of grade 3 (about 9 years old). These tests, designed to monitor mathematics progress, are given twice a year (Janssen et al., 2005). Children at every mathematics achievement level have educational needs. Therefore, the researchers randomly selected three low mathematics-achieving, three average mathematics-achieving and three high mathematics-achieving children per group to make sure all mathematics achievement levels were represented. Teachers were asked to conduct dynamic mathematics interviews with three children in their group during the professional development and with six among the selected children during the practice sessions. The participants were treated in accordance with institutional guidelines as well as APA ethical standards. Schools, parents, and children were informed about the procedures, duration and purpose of the research. They were also given the name of a contact in the event they had additional questions. Both schools and parents gave active, informed participation consent.

Design

To obtain a robust baseline, teacher-related factors (teaching behavior, self-efficacy and mathematical knowledge for teaching) were measured on three occasions. These were the start and end of the first school year and the beginning of the second school year (T1, T2, T3). The fourth measurement was after the intervention period, at the end of the second school year (T4). The same participating teachers were followed in their school setting for 2 years and all teachers followed the same procedure.

In the quasi-experimental design, Year 1 constituted the control condition. No intervention was conducted during that year. Year 2 constituted the experimental condition. A pretest-posttest design was used to assess the effect of the dynamic mathematics interview teacher professional development program. The *intervention* consisted of the professional development program and a practice period where each participating teacher conducted dynamic mathematics interviews with six children at different mathematics achievement levels. The effect was determined by comparing teacher-related factors regarding mathematics teaching before and after the intervention. The 2-year research project design is shown in Table 1.

Table 1
The Research Design

School Year 1	
Aug–Sep	Baseline-measurement, Year 1 (T1)
October–mid June	Mathematics taught in classrooms as usual
June	Baseline-measurement, Year 1 (T2)
School Year 2	
August–September	Baseline-measurement, Year 2 (T3)
October	*Individual feedback on a dynamic mathematics interview*
November–mid February	Pretest
	Teacher professional development program, including the tool for dynamic mathematics interviews
February	Post test
	Individual feedback on a dynamic mathematics interview
March–mid June	Practice period
June	Measurement, Year 2 (T4)

Note: T1, T2, T3 = Baseline measurement of teacher-related factors: mathematics teaching behavior, mathematical knowledge for teaching, mathematics teaching self-efficacy.

Intervention: Teacher Professional Development

The intervention consisted of a teacher professional development program comprised of four 4-hour meetings, followed by a period of dynamic mathematics interview practice. The program was based on design features for effective professional development (e.g., Desimone, 2009; Heck et al., 2019; Van Driel et al., 2012): the collective participation of teachers of the same subject (mathematics) and grade (Grade 4), employing active and useful learning activities (e.g., good practices in mathematics interviews), focus on content (related to dynamic mathematics interviews and mathematics teaching), focus on inclusive mathematics classroom practice (coping with different needs of mathematics learners), collaboration (e.g., discussing articles, watching each other's mathematics interview videos and giving peer feedback), coherence (e.g., identifying the teachers' needs prior to the professional development program using the same mathematics interview tool) and generous time investment.

The program's design prototype was reviewed by five students enrolled in professional master's programs in educational needs in mathematics/dyscalculia, one school mathematics coordinator, and one mathematics education researcher. The review occurred between May and June at the end of the first school year. The teacher professional development program was fine-tuned in August and September at the beginning of the second school year. The program included an explanation of the tool for dynamic mathematics interviews and of mathematical knowledge for teaching related to dynamic mathematics interviews, examples of dynamic mathematics interviews on video, and peer feedback in the second and third meetings. The first author, an expert teacher trainer, organised the meetings.

The 4-hour meetings began a few weeks after the pretest. Between the first and second and the second and third meetings, the teachers practiced giving a videotaped dynamic mathematics interview. In the next meeting (either the second or third meeting), teachers provided structured qualitative peer feedback in groups of two or three, using a theory-based observation tool specifically constructed for the study. The feedback addressed, for example, the number of open-ended questions and in-depth questions, the presence of questions seeking to identify what instruction, tasks, learning environment and so on the child needs, questions about emotions and experiences during mathematics education, questions focused on identifying the child's planning process, solution strategies, the reflection process, and the types of support given during the interview.

The posttest—a video-recorded dynamic mathematics interview—occurred between the third and fourth meeting and was submitted for evaluation at the fourth meeting. At the end of the last meeting, teachers completed a written evaluation form about the training. The average teacher training satisfaction score with respect to content and achieved goals was 3.55 on a scale of 1 to 4 (e.g., 3.7 was the average score for the goal "Be able to prepare and conduct a dynamic mathematics interview"; 3.2 for "Expansion of knowledge and ideas to adjust to diverse mathematics learning needs.").

Each teacher received individual pretest feedback from the researcher before the first meeting and posttest feedback after the last meeting. In the practice period that began after the four meetings, the teachers conducted and recorded dynamic mathematics interviews with six of the nine children in their group. Teachers were not given feedback on those interviews, but they provided evidence that the dynamic mathematics interviews took place (i.e., treatment fidelity).

Measurement Instruments

Pretest and posttest dynamic mathematics interview

Pretests and posttests were a video-recorded assignment with the same instructions: teachers had to conduct a dynamic mathematics interview in which three teacher-selected mathematical word problems (presented using mathematical notation, text, and/or pictures) were administered. These problems were chosen from criterion-based standardised Dutch national mathematics tests (Janssen et al., 2005), for example:

> How many cartons of juice are in this box?
> [accompanying picture depicted a full box in which only some of the cartons were visible]

Initially, the teachers were asked to conduct a mathematics interview in a fashion they considered appropriate. Between pretest and posttest, teachers went through the professional development program that included the tool for dynamic mathematics interviews. The teachers, however, could choose for themselves whether to use the tool for the posttest interview.

A theory-based coding book was developed to analyse pretest and posttest transcripts based on Mayring's (2015) qualitative content analysis. The coding book was improved and refined based on feedback from five mathematics teaching experts (one validation session) and eight researchers (one validation session). The following nine aspects of dynamic assessment that contribute to the quality and effectiveness of a dynamic mathematics interview were analysed. After coding, the total number of questions per aspect (for the first six aspects) was counted.

1. *Questions focused on the child's mathematics experiences, beliefs and emotions.* The teacher can ask questions that widen the scope of the dynamic mathematics interview, such as, "What do you like the most about mathematics lessons? What kinds of mathematical problems do you find hard? How does it feel when you successfully solve a problem?" (Allsopp et al., 2008; Bannink, 2010; Ginsburg, 1997).
2. *Questions focused on the child's thinking and solution processes*. The teacher can pose process-oriented questions, such as "How did you solve this mathematical problem? Tell me" (e.g., Allsopp et al., 2008; Ginsburg, 1997, 2009).
3. *Questions to identify a) the child's mathematics needs in general, with active input from the child's own voice, b) the child's instructional needs, and c) the child's needs regarding content and methods.* The teacher can ask questions to identify the child's mathematics learning needs, such as "What do you need to practice the multiplication tables?" The questions could have a solution-focused character designed to elicit student voice, such as, "What is your next aim in learning mathematics? What do you need to reach that goal? How can you be helped to solve these mathematical problems?" (Bannink, 2010; Lee & Johnston-Wilder, 2013).
4. *Questions to check whether the child knows the right answer*. These questions are product-oriented, designed to assess the correctness of the child's answer. Although correctness of answers is important, obtaining process information as opposed to product (i.e., outcome) information should prevail for the dynamic mathematics interview to have added value near standardised tests (Franke et al., 2001).

5. *Questions to determine the level and adequacy of the child's prior knowledge and understanding.* The teacher asks qualitative and quantitative questions to gauge the child's prior knowledge and understanding of mathematics concepts and procedures (Van Luit, 2019). For example, the teacher can check procedural knowledge for division tasks while assessing the domain of fractions.
6. *Give support.* The mathematics interview tool contains suggestions on ways the teacher can support the child's thinking and solution processes. These include giving support by structuring, by reducing complexity, verbally (e.g., hints), by using representations of real situations, by using models or schemes, by using concrete materials, or by modelling. Some suggestions for support were developed by Gal'perin (1978), based on Vygotksy's action theory; others were based on Van Luit (2019).
7. *Safe and stimulating climate during mathematics interview.* In order to conduct a good mathematics interview, several conditions must be met. These include a relaxed and warm atmosphere, respect, starting with a mathematical problem the child is likely to solve, verbal encouragement and sincere, supportive remarks (Delfos, 2001).
8. *Teacher summarises the mathematics learning needs.* The teacher succinctly summaries the child's needs using the child's own words. In this way, the teacher shows that they have been listening attentively and can confirm the educational needs and goals. This fosters co-responsibility by both the teacher and the child (Delfos, 2001; Bannink, 2010).
9. *Scope of the dynamic mathematics interview.* The scope indicates the range of aspects of the child's mathematical development about which information was sought during the mathematics interview, from narrow (limited information) to wide (preferred; Ginsburg, 1997).

All pretest and posttest videos, which varied in length (15 minutes on average), were fully transcribed. We sought to compare segments of equal length using Dudley's (2013) approach: we analysed two segments from each video, namely, 2 minutes from the beginning of the interview (0.30-2.30) and 3 minutes later on. The second segment showed the child solving three mathematical word problems that were selected beforehand by the teacher. The first author analysed the pretest and posttest videos using the refined coding book. A mathematics teaching expert with a university master's degree in special education—blind to the research design and scope—analysed randomly selected transcripts using the same coding book. The inter-rater reliability for scoring was good (0.93).

Teacher-related Factors

Baseline-measurement of teacher-related factors, teaching behavior, self-efficacy and mathematical knowledge for teaching, at the start and end of School Year 1 and the beginning of School Year 2 (T1, T2, T3). The fourth measurement was after the intervention period, at the end of School Year 2 (T4).

Actual teaching behavior in mathematics lessons

Actual mathematics teaching behavior was measured using an observation instrument: the International Comparative Analysis of Learning and Teaching (ICALT, Van de Grift, 2007). ICALT examines 32 aspects across six scales of teaching behavior; a seventh scale focuses on children's involvement. The teacher behavior scales range from lower to higher order teaching behavior: providing a safe and stimulating learning climate, efficient classroom management, clarity of instruction, activating learning, teaching learning strategies, and differentiation and adapting the lesson (Van der Lans et al., 2018). Because the ICALT is not mathematics-specific, we developed an additional eighth scale incorporating eight aspects of mathematics-specific teaching strategies for this study (based on Gal'perin, 1978 and Polya, 1957) They are 1) informal manipulation, 2) representations of real objects and situations, 3) abstract mental representations (models and diagrams), 4) abstract concepts/mental operations, 5) making connections between the previous four levels and using these connections to support lesson goals, 6) focus on planning, 7) problem-solving processes, and 8) metacognitive skills. The internal consistency of the ICALT and the supplemental scale (ICALT+S) used in the present study was good at all four timepoints (α range: 0.85-0.86). The internal consistency of all subscales in the study was also good (α range: 0.85 and higher).

Teachers' self-efficacy

The Dutch online version (Goei & Schipper, 2016) of the long form of the Teachers' Sense of Self Efficacy Scale (TSES; Tschannen-Moran, & Woolfolk-Hoy, 2001) was used to measure teachers' self-efficacy with respect to the teaching of mathematics. The questionnaire contained 24 items divided among three subscales: efficacy for student engagement, efficacy for instructional strategies and efficacy for classroom management. The teachers responded using a 9-point scale ranging from 1 (*not at all*) to 9 (*a great deal*). The reliability of the scale was good (α = 0.86 at all four timepoints).

Teachers' mathematical knowledge for teaching

Teachers' beliefs in their mathematical knowledge were measured with a Teachers' Sense of Mathematical Knowledge for Teaching Questionnaire (TSMKTQ; Kaskens et al., 2016)—an online questionnaire developed for the current study. The 38 questions focused on teachers' pedagogical content knowledge, subject-matter knowledge or specialised content knowledge. Teachers used a 4-point response scale for all items, ranging from 1 (*to a very small extent*) to 4 (*to a very large extent*). The internal consistency of the TSMKTQ was good (α = 0.86 at all four timepoints).

Procedure

After participants were recruited, an informational meeting was organised in two regions of the Netherlands. The teachers were given printed information about the study and a fact sheet about the data collection methods to be used. The teachers gave email consent to be observed and video-recorded giving a mathematics lesson. As part of the larger, longitudinal research project (Kaskens et al., 2020), teacher competency data were obtained at four measurement timepoints (see Figure 1).

The pretests and posttests were video-recorded interviews by teachers—one from before and a second at the end of the teacher professional development program. These video-recordings were handed in to the researcher.

To assess mathematics teaching behavior, mathematics lessons given by each teacher were observed and video-recorded on four occasions. The lesson topic—either fractions or proportions—was determined in advance. The video-recordings were scored using ICALT+S observations consisting of 40 items with 4-point Likert scales ranging from 1 (*predominantly weak*) to 4 (*predominantly strong*). The scoring of full lessons was done by the first author and a second observer, both trained and certified to use ICALT. The inter-rater reliability for live scoring was good (0.86).

The TSES and TSMKTQ were sent to the participating teachers by e-mail. A direct link was embedded in the web-based questionnaire services in Formdesk. Teachers were asked to complete the questionnaires at the beginning and at the end of each school year; reminders were sent on each occasion. The response rate was 100% and all data collected from all 23 teachers were included in the subsequent analyses.

Data Analyses

To address the first research question, the effect of a teacher professional development program on the quality and effectiveness of dynamic mathematics interviews, we conducted paired samples *t*-tests (2-tailed). We controlled for multiple testing using the Bonferroni correction (see Table 2).

We checked normality using the Shapiro-Wilk test, which is more appropriate for small sample sizes. The following outliers were identified: questions to identify children's instructional needs, questions to identify children's content and method needs, reduced complexity support, verbal support, material support and support using representations. Because the final analysis was not affected by inclusion or exclusion of these data, we left them in.

To examine the effect of the intervention (professional development program and practice period) on teacher-related factors, Research Question 2, we conducted three repeated-measures ANOVAs–

actual mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching—to compare differences between timepoints (baseline T1, T2, T3 and T3–T4, before and after the intervention). The Bonferroni correction was again applied. The data and descriptive statistics for these measures were screened at the outset for potential errors and outliers. We discovered two outliers when checking for normality. One was found in the "Safe and stimulating learning climate" scale at Timepoint 3 and another was found in the "Clarity of instruction" scale at Timepoint 4. These datapoints were winsorized, but the resulting transformation did not impact the results. Therefore, the original data were used for data analyses.

Next, post hoc analyses were conducted to investigate the differences between teacher-related factors after checking sphericity using Mauchly's test. Finally, a paired sample *t*-test was conducted to compare the differences between T3 and T4 (before and after the intervention) and the differences between T1–T3 (baseline), controlled for multi-testing.

Results

Effect of Teacher Professional Development Program

Table 2 shows the descriptive statistics. To answer the first research question addressing the effect of a teacher professional development program in teacher–child dynamic mathematics interviewing on the quality and effectiveness of dynamic mathematics interviews with fourth grade children, paired samples *t*-tests were run. We found that the professional development program had the following effects on dynamic mathematics interviews (Table 2): during the post-test mathematics interview, teachers asked significantly more questions about children's mathematics experiences, asked more questions about children's reasoning and problem-solving processes, created a safer and more stimulating climate and summarised their children's educational needs more often. The posttest dynamic mathematics interviews focused on more aspects of children's mathematical development than the pretest interviews did. Some examples of coding:

> Teacher: When do you feel fine during a mathematics lesson? (Code 1: Questions focused on child's mathematics experiences, beliefs and emotions).
>
> The child reads the mathematical problem and the teacher asks: How are you going to solve this problem? (Code 2: Questions focused on child's thinking and solving processes).
>
> While the child is solving a mathematical problem, the teacher asks: How much is 15 divided by 3? (Code 4: Questions to check child knows the right answer).

The results showed that the teacher professional development program had a lesser effect on other qualitative aspects of dynamic mathematics interviews. For example, teachers did not ask significantly more questions designed to identify a child's specific needs and were not more focused on supporting these needs. When teachers gave support, it was most often verbal.

Table 2

Means and Standard Deviations for Scores on Pretest and Posttest Dynamic Mathematics Interview Teacher Professional Development Program (N = 23)

	M (*SD*) pre-test	*M (SD)* post-test	*t*	*p*
1. Questions focused on child's mathematics experiences, beliefs, emotions	1.91 (3.72)	20.83 (12.84)	-7.00	.001**
2. Questions focused on child's thinking and solving processes	24.09 (12.84)	37.83 (16.97)	-3.41	.003*
3a. Questions to identify child's needs in mathematics in general actively involving student's voice	.04 (.21)	.52 (.85)	-2.71	.013
3b. Questions to identify child's instructional needs	.04 (.21)	.39 (1.08)	-1.79	.088
3c. Questions to identify child's needs regarding content and methods	.00 (.00)	.09 (.29)	-1.45	.162
4. Questions to check child knows the right answer	3.61 (2.33)	3.43 (2.63)	.25	.807
5. Questions to determine level and adequacy of child's prior knowledge and understanding	.26 (.86)	.48 (.51)	-1.00	.328
6. Giving support:				
a. Structuring	.48 (.59)	.70 (.47)	-1.31	.203
b. Reducing complexity	.04 (.21)	.13 (.34)	-1.00	.328
c. Verbal support	.87 (.34)	1.00 (.00)	-247	.022
d. Using representations of real situations	.13 (.34)	.17 (.39)	-.04	.665
e. Using models or schemes	.13 (.34)	.30 (.47)	-1.45	.162
f. Material support	.04 (.21)	.18 (.39)	-1.82	.083
g. Modelling	.00 (.00)	.09 (.29)	-1.45	.162
7. Safe and stimulating climate during dynamic mathematics interview	2.48 (.95)	3.48 (.51)	-5.30	.001**
8. Teacher summarises mathematics learning needs	.70 (1.89)	2.43 (1.24)	-3.83	.001**
9. Dynamic mathematics interview focused on wide scope	2.74 (.69)	1.35 (.78)	7.09	.001**

Note. $^*p \leq .01$ (after Bonferroni correction 0.05/17 = 0.0029), $^{**}p \leq .001$

Effect of the Intervention on Teacher-related Factors in Mathematics Teaching

The second research question addressed the effect of the teacher professional development program and practice period of dynamic mathematics interviewing on teachers' actual mathematics teaching behavior, their mathematics teaching self-efficacy and mathematical knowledge for teaching. Descriptive statistics, means, and standard deviations for the different measurement timepoints are presented in Table 3.

Table 3
Measures of Teacher-related Factors at Four Timepoints (N = 23). The intervention was between T3 and T4

	T1	T2	T3	T4
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
1. ICALT Actual teaching behavior	2.82 (0.29)	3.01 (0.42)	3.06 (0.37)	(0.36)
a. Safe and stimulating learning climate	3.50 (0.38)	3.56 (0.51)	3.78 (0.36)	3.79 (0.35)
b. Efficient classroom management	3.48 (0.41)	3.45 (0.45)	3.65 (0.51)	(0.29)
c. Clarity of instruction	2.97 (0.39)	3.23 (0.48)	3.42 (0.50)	(0.42)
d. Activating learning	2.74 (0.47)	3.07 (0.47)	3.04 (0.44)	(0.36)
e. Differentiation and adapting lesson	2.33 (0.75)	2.68 (0.85)	2.42 (0.78)	(0.50)
f. Teaching learning strategies	2.05 (0.53)	2.51 (0.49)	2.30 (0.48)	(0.46)
g. Mathematics-specific teaching strategies	2.55 (0.64)	2.60 (0.51)	2.58 (0.65)	3.10 (0.54)
2. Mathematics teaching self-efficacy	7.12 (0.43)	7.20 (0.45)	7.15 (0.39)	7.47 (0.37)
3. Mathematical knowledge for teaching	3.16 (0.37)	3.27 (0.34)	3.19 (0.33)	3.43 (0.35)

To examine the effect of the intervention on teacher-related factors (Research Question 2), we first conducted repeated-measures ANOVAs to compare differences between timepoints (baseline T1, T2, T3, and before and after the intervention T3–T4). Next, we used post hoc tests to confirm where the differences occurred between T3 and T4. Finally, we conducted a paired samples *t*-test to compare the differences between baseline comparisons and T3–T4. The results are displayed in Table 3.

Table 4
Development of Teacher-related Factors (N = 23)

Teacher-related factors	Baseline T1–T2–T3				T3–T4			
	λ	*F*	*p*	η_p^2	λ	*F*	*p*	η_p^2
1. Actual mathematics teaching behavior	.73	5.06 (2,42)	.011	.19	.62	13.60 (1,22)	.001**	.38
a. Safe and stim. learning climate	.71	3.79 (2,42)	.031	.15	.99	0.02 (1,22)	.898	.00
b. Efficient classroom management	.90	1.19 (2,42)	.315	.05	.94	1.41 (1,22)	.248	.06
c. Clarity of instruction	.61	6.66 (2,42)	.001**	.24	.87	3.37 (1,22)	.080	.13
d. Activating learning	.71	5.09 (2,42)	.010	.20	.52	20.58 (1,22)	.001**	.48
e. Differentiation and adapting lesson	.86	1.80 (2,42)	.180	.08	.52	20.58 (1,22)	.001**	.48
f. Teaching learning strategies	.64	6.49 (2,42)	.003*	.24	.54	18.99 (1,22)	.001**	.46
g. Mathematics-specific teaching strategies	.99	0.11 (2,42)	.900	.01	.48	23.91 (1,22)	.001**	.52
2. Mathematics teaching self-efficacy	.95	0.39 (2,42)	.677	.02	.66	11.26 (1,22)	.001**	.34
3. Mathematical knowledge for teaching	.87	1.11 (2,42)	.340	.05	.65	11.64 (1,22)	.001**	.35

Note: $^*p \leq .005$ (after Bonferroni correction 0.05/10 = .005), $^{**}p \leq .001$

Baseline T1, T2, T3

The results showed an overall increase from the baseline main scores in two aspects of mathematics teaching behavior across the three timepoints. The scales were ‘Clarity of instruction’ and ‘Teaching learning strategies’. There was no increase over the baseline mean scores of the other variables over time.

T3–Intervention–T4

The results showed an overall effect (all scales together) on mathematics teaching behavior over time, from T3 (before the intervention) to T4 (after the intervention) (Table 4:1). No overall effect over time was found for "Safe and stimulating learning climate", "Efficient classroom management" and "Clarity of instruction" (Table 4: 1a, 1b, 1c). The effect over time on "Clarity of instruction" was significant compared to the baseline, but not across T3 and T4. Results showed an overall effect over time on "Activating learning", "Differentiation and adapting lesson", "Teaching and learning strategies" and "Mathematics-specific teaching strategies" (Table 4: 1d, 1e, 1f, 1g). These scales represent more advanced levels of teaching behavior. The results showed an overall effect between T3 and T4 on teachers' mathematics teaching self-efficacy (Table 4: 2) and mathematical knowledge for teaching (Table 4: 3). To summarise, there were significant time-related effects between T3 and T4—before and after the intervention—related to the three teacher-related factors: mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching.

A paired samples *t*-test was conducted to compare the differences between T1–T3 (baseline), and T3–T4 (before and after the intervention), corrected for multi-testing ($p < .005$). Improvement between T3–T4 was greater than between T1–T3 on the following teacher variables: mathematics teaching behavior (overall), as well as the specific scales "Activating learning", "Differentiation and adapting lesson", "Teaching and learning strategies", and "Mathematics-specific teaching strategies"; mathematics teaching self-efficacy and mathematical knowledge for teaching. These findings corroborated the ANOVA results.

The findings reveal that there was a significant improvement in the assessed teacher-related factors—mathematics teaching behavior (overall score and the scales for advanced-level teaching behavior), mathematics teaching self-efficacy and mathematical knowledge for teaching—between the start and end of the intervention.

Discussion

The aim of this study was to examine the effect of a teacher-child dynamic interview professional development program on the quality and effectiveness of dynamic mathematics interviews with fourth graders, and the effect of learning to do dynamic mathematics interviews on mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching within the elementary school context. The results showed that the teacher professional development program had a positive effect on the quality and effectiveness of dynamic mathematics interviews. Furthermore, results showed an effect of the intervention on all teacher-related factors (teaching behavior, mathematics teaching self-efficacy, mathematical knowledge for teaching).

Effect of the Teacher Professional Development Program

The positive effect of the teacher professional development program is consistent with the findings of other research linking specific design characteristics to effectiveness of professional development (e.g., Copur-Gencturk et al., 2019; Desimone, 2009; Heck et al., 2019; Van Driel et al., 2012). In the present study, the training was focused on content related to dynamic mathematics interviews and effective mathematics teaching. Coherence was achieved by focusing on the policy standard goals for mathematics teaching in primary education, adjusting to teachers' identified needs prior to the teacher professional development program, and using the same supportive tool for dynamic mathematics interviews. The teacher professional development program also achieved the effective design characteristic of collective participation. In the study, Grade 4 teachers with a purposeful focus on mathematics teaching participated in the program and collaborated during the meetings by contributing to discussions, giving peer feedback, and sharing experiences.

Furthermore, the use of videos as a core component supported teacher learning. This corresponds to other studies that used videos taken of teaching practice as part of teacher professional development (e.g., Borko et al., 2011; Tripp & Rich, 2012). In their research, Heck et al. (2019) emphasised the importance of using videos and expert facilitators able to scaffold teachers' viewing and discussion and promote open, thoughtful dialogue. This was also the case in the current study. Teachers gave each other feedback on the dynamic mathematics interviews based on observation and discussion. This element of professional development, an active practice-based way of learning focused on diverse aspects of teacher–child interaction related to mathematics, appeared to be an effective feature of the teacher professional development program.

The novel and innovative features of this study included its focus on the knowledge and skills required for dynamic mathematics interviews and the development of a supportive tool for conducting these interviews. The tool incorporated features needed to conduct an interactive, solution-driven, future-focused dynamic mathematics interview that actively involved individual children in their own mathematical development (Allsopp et al., 2008; Bannink, 2010; Lee & Johnston-Wilder, 2013; Pellegrino et al., 2001). The tool was aimed at supporting teachers' diagnostic skills and mathematical knowledge for teaching (Hill et al., 2008; Hoth et al., 2016).

To summarise, the teacher professional development program in the present study was based on the identified characteristics of effective professional development; this may have contributed to the positive effect of the program on the quality of dynamic mathematics interviews.

Relationships Among the Intervention and Teacher-related Factors

As had been expected, findings showed that the intervention had an effect on mathematics teaching behavior, mathematics teaching self-efficacy and mathematical knowledge for teaching. The intervention whereby teachers conducted dynamic mathematics interviews with fourth grade children to better understand their reasoning, understandings, preconceptions, misconceptions, strategies, mathematics experiences, emotions, strengths and needs, was positively related to advanced aspects of mathematics teaching.

Firstly, the effects of the intervention on teaching behavior during mathematics lessons were seen on all scales of mathematics teaching ("Activating learning", "Differentiation and adapting lesson", "Teaching and learning strategies", and "Mathematics-specific teaching strategies"). The effects were significant for the more complex teaching behaviors of "Differentiation and adapting lesson" and "Teaching and learning strategies" (e.g., Van der Lans et al., 2018). The effect was also significant for the supplemental scale, "Mathematics-specific teaching strategies", another complex teaching behavior. This supplemental observation instrument specifically addressing mathematics teaching was closely related to other aspects, such as the use of representations and attention to solution processes and metacognitive skills. For this reason, teaching behaviors, especially those at an advanced level, improved in this study. This was in line with the work of Porter et al. (2000), in which transfer of the teacher professional development program was most often seen in the implementation of more complex teaching strategies when the program had high-quality characteristics, such as active learning, consistency and coherence, as was the case in the present study. Other research (Deunk et al., 2018) has suggested that an informed view of both children' understanding of mathematics and their mathematics learning needs could contribute to adaptive mathematics teaching in the classroom. The present study found that dynamic mathematics interviews, which were central in the intervention, are an effective way for teachers to become informed, and may affect teaching behavior in elementary school classrooms in which teachers must meet the varied mathematics needs of diverse children.

The study's results revealed no effect of the intervention on the following scales related to less complex teaching behavior: "Safe and stimulating learning climate", "Efficient classroom management", and "Clarity of instruction". It is, however, difficult to interpret why. Teachers may have shifted their focus to more advanced aspects of mathematics teaching as a result of insights and experiences acquired during dynamic mathematics interviews.

Secondly, effects were also found on teachers' mathematics teaching self-efficacy and perceived mathematical knowledge for teaching. This was in line with our hypothesis. The information obtained during dynamic mathematics interviews benefitted these teacher-related factors related to mathematics teaching. This parallels the results of another study (Carney et al., 2016) in which a teacher professional development program focused on children's thinking, problem-solving and content knowledge specific to mathematics led to an increase in teachers' mathematics teaching self-efficacy and mathematical knowledge for teaching. Previous research has shown that teachers with high mathematics teaching self-efficacy and mathematical knowledge for teaching better prepare and adapt their mathematics lessons (Chang, 2015; Hill et al., 2008; Nurlu, 2015). In the present study, the increase in teachers' mathematics teaching self-efficacy and mathematical knowledge for teaching resulting from the intervention appeared to be linked with the professional development and practice period.

Therefore, the results of the present study support the notion that the interaction between mathematics teaching behavior, mathematics teaching self-efficacy and perceived mathematical knowledge for teaching may be related to teachers' mathematics teaching practice. This is consistent with Wilkins (2008) and Charalambous (2015), who suggested that perceptions and knowledge interact to influence mathematics teaching behavior.

Study Strengths, Limitations, and Directions for Future Research

The strength of this study lies, in part, in its longitudinal design. It covered two school years, involved the same teacher participants throughout, and reached across a variety of primary educational contexts (22 elementary schools, of varying sizes and varying populations, spread across the country). Moreover, it explored the associations between a particular intervention focused on learning and practice of teacher–child dynamic mathematics interviews and teacher-related factors within the context of elementary mathematics education. Participation of the same teachers throughout allowed us to control variables that might otherwise influence reliability. A limitation is that the teachers who participated were volunteers, which could have had a positive impact on results. Another limitation is that we analysed two selected episodes for reasons of comparability (Dudley, 2013). As a result, some relevant information might not be included in the analyses. Because of the quasi-experimental study design involving the same teachers for two years, no control group of teachers could be involved. Furthermore, the final measurement occurred shortly after the intervention period. A follow-up study could explore whether the results recorded are sustainable.

The present study is a first attempt to uncover the potential of a dynamic mathematics interview professional development program, as well as its practical application. To more broadly apply the findings, additional replication studies involving more teachers and a teacher control group are needed. Although a small teacher sample size is common in studies using classroom observations and coded videos as part of the intervention, it may limit the use of the findings. In such future research it would also be interesting to consider the impact of the program on the children's learning of mathematics.

While we kept in touch with the school leaders throughout the study, emphasising the need for them to support teacher participation, we did not take into account school contextual conditions such as the role of the school leader, demographics, or professional school culture. It would be useful to investigate if and how these influence teacher-related factors within the context of effective mathematics teaching in future studies.

Implications for Practice

This study supports the notion that a teacher professional development program based on effective characteristics of professional development in combination with a supportive scripted tool for dynamic mathematics interviews can influence the quality and effectiveness of teacher–child dynamic mathematics interviews. The teacher professional development program design may be useful in other (research) contexts to improve mathematics teaching, and the tool developed could help build a framework for dynamic mathematics interviews. The program might be improved by increasing opportunities for peer feedback concerning child support during a mathematics interview.

Conducting dynamic mathematics interviews adds value to mathematics teaching competencies. Interviewing children broadly on diverse aspects—such as problem-solving processes, mathematics experiences, mathematics related beliefs, prior knowledge and skills—that play a role in mathematical development and allow teachers to actively involve children provides insight into the learning and educational needs of children. It also helps teachers meet these needs.

Conclusion

This quasi-experimental study is the first to explore the influence of dynamic mathematics interviews on teachers' mathematics teaching behavior, mathematics teaching self-efficacy and perceived mathematical knowledge for teaching, using an original research design involving consistent teacher participation over two years. Based on the promising results, we conclude that a teacher professional development program with effective characteristics contributes to improved teacher–child dynamic mathematics interviews. In addition, conducting dynamic mathematics interviews with children impacts mathematics teaching behavior, mathematics teaching self-efficacy and perceived mathematical knowledge for teaching. It appears teachers apply the lessons learned in dynamic mathematics interviews in more complex and adaptive teaching behaviors, while their mathematics teaching self-efficacy and mathematical knowledge for teaching increase. Dynamic mathematics interviews seem to provide unique opportunities for teachers to identify and meet children's mathematics learning needs. This study marks an important starting point in research on the effects of dynamic assessment as an approach for teachers to get an informed view of children's mathematical development and their educational needs when learning mathematics, and to be better able to adapt their mathematics teaching accordingly.

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Jarise Kaskens
Windesheim University of Applied Sciences
Postbus 10090, 8000 GB Zwolle
The Netherlands

Eliane Segers
Behavioural Science Institute
Radboud University
Montessorilaan 3
6525 HR Nijmegen, The Netherlands

Sui Lin Goei
LEARN! Research Institute
Vrije Universiteit,
De Boelelaan 1105,
1081 HV Amsterdam, The Netherlands

Johannes E. H. van Luit
Faculty of Social and Behavioural Sciences
Utrecht University,
Heidelberglaan 1,
3584 CS Utrecht, The Netherlands

Ludo Verhoeven
Radboud University
Montessorilaan 3
6525 HR Nijmegen, The Netherlands

Appendix

Model of a Dynamic Mathematics Interview

Mathematics Experiences, Emotions and Beliefs		
	Preparation	
The student: - responds to questions. - actively thinks along about adjusting to mathematics learning needs. - makes his/her voice heard.	Introduction in which the goal is mentioned. Starter questions or performing an activity aimed at contact and safety. Body of the interview focused on mathematics experiences, beliefs and emotions and the student's mathematics learning needs. Summary, mathematics learning needs and ideas for adjusting to the needs. Winding up.	The teacher: - makes contact with the student. - is action-oriented, process-oriented, solution-focused. - listens, observes, asks good questions and summarises. - gives the student space and time during the interview. - thinks from the perspective of growth and possibilities.
Mathematics Achievement Level and Mathematical Thinking and Problem-solving Processes		
	Preparation through collecting and analysing information	
The student: - responds to questions. - actively thinks along about adjusting to mathematics learning needs. - makes his/her voice heard.	Introduction in which the goal of the mathematics interview is stated. Starter mathematical problems. Subsequent mathematical problems, follow-up assignments focused on mathematical thinking and problem-solving processes and mathematics learning needs. Summary (during and at the end), mathematics learning needs and prioritisation, ideas for adjusting to the needs. Winding up.	The teacher: - makes contact with the student. - is action-oriented, is action-oriented, process-oriented, solution-focused. - applies mathematical knowledge for teaching. - listens, observes, asks appropriate questions, gives appropriate support and wraps up. - gives space and thinking time to the student. - thinks from the perspective of growth and possibilities.