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ARTICLE

Dynamic maths interviews to identify educational needs of students showing low math achievement

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ABSTRACT
We investigated the adequacy of the conduct and possible benefits of the use of dynamic maths interviews by 19 fourth grade teachers with students showing low maths achievement to facilitate the identification of maths needs. This study shows the potential of an analytical framework to evaluate the adequacy and benefits of dynamic maths interviews in a more valid way by viewing relevant aspects in conjunction. The intervention consisted of a dynamic maths interview teacher professional development programme and a practice period. During this practice period the teachers conducted an interview with each individual student involved in this study. Qualitative analyses of the transcripts of the video-recorded interviews showed the conduct of the individual dynamic maths interviews to be adequate and to facilitate the identification and understanding of the educational needs of students with low maths achievement. Using dynamic maths interviews, teachers provided feedback and support that were clearly attuned to the specific maths needs of students.

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KEYWORDS
Low maths achievers; dynamic maths interviews; educational needs; maths development; maths beliefs; emotions

Introduction

The success of students' maths achievement accounts for considerable variance in educational outcomes but also impacts daily lives, self-reliance and later career opportunities. Persistent difficulties can occur in several domains of basic mathematics including learning arithmetic facts, retrieving these facts from long-term-memory, and the mastery and application of procedures for solving maths problems (e.g. Andersson 2008; Fuchs et al. 2016; Geary 2004, 2011; Mazzocco 2007). Identifying and meeting the specific needs of students with low maths achievement is a major challenge for teachers in general and those with inclusive classrooms in particular (Mitchell 2015). To successfully understand the educational needs of low maths achievers, teachers need insight into their mathematical performance, thinking, understanding, and beliefs (Deunk et al. 2018). However, current maths assessment is dominated by standardised, norm-referenced testing with its focus on the products of student learning as opposed to requisite maths solving

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Supplemental data for this article can be accessed here.

strategies, underlying thought processes, learning potential, and maths-related beliefs and emotions (Allsopp et al. 2008). A promising alternative is the use of the dynamic maths interview (hereafter, DMI): a flexible, process-oriented, semi-structured assessment approach that can help identify the specific educational needs of students and particularly those with low maths achievement (Wright, Martland, and Stafford 2006; Van Luit 2019). In the present study, we implemented a DMI within the context of inclusive maths learning in order to better identify students' maths needs (Allsopp et al. 2008; Ginsberg 1997; Ginsburg 2009).

The developmental courses of average and low maths achievement

In the first years of primary school, children are expected to develop an understanding of numbers, counting, and basic arithmetic skills or the prerequisites for later maths development (Geary 2004). Starting in grade four, the focus of mathematics education shifts to advanced mathematics (e.g. fractions, proportions) and the more abstract mathematical problem-solving required for more complex maths. In several longitudinal studies, strong associations have been demonstrated between early and later maths achievement (e.g. Watts et al. 2014). And in other research, the development of students' maths ability has been shown to be helped by the promotion of arithmetic fluency, an understanding of underlying concepts but also insight into calculation principles and the formulation of solution plans for maths problem-solving (Andersson 2008). Not only the cognitive aspects of maths learning but also the beliefs and emotions of students have been shown to impact students' maths development (Chinn 2012).

Students showing low maths achievement are known to experience difficulties with both the basic and more abstract aspects of maths (Fuchs et al. 2016; Träff et al. 2020). They have also been found to be more influenced by affective maths-related factors than average maths achievers (Lebens, Graff, and Mayer 2011). All of this shows a need to take not only cognitive factors but also the beliefs and emotions of students into account to identify their educational needs.

Dynamic maths assessment

Dynamic maths assessment differs from traditional standardised testing on a number of fronts. First, dynamic testing procedures all have an intervention or training phase for students, which is aimed at the identification of how individual instruction can lead to improved achievement (Elliott, Grigorenko, and Resing 2010; Fuchs et al. 2008). Second, in an interactive teacher-student dialogue, students demonstrate their mathematical understanding and thinking and maths knowledge/skill and teachers address specific errors, provide support and gain in-depth insight into the strengths and weaknesses of students (Ginsberg 1997; Ginsburg 2009; Pellegrino, Chudowsky, and Glaser 2001).

Dynamic maths assessment could typically be conducted as a semi-structured interview in which the teacher undertakes process-oriented research to determine not only achievement levels but also the application and use of critical procedures and strategies to identify educational needs and suitable forms of instruction and (additional) support (Wright, Martland, and Stafford 2006; Van Luit 2019).

DMIs have been shown to be an effective form of dynamic maths assessment (Allsopp et al. 2008; Caffrey, Fuchs, and Fuchs 2008; Van Luit 2019). Outcomes of DMIs are assumed to be informative in guiding classroom instructions and interventions. Explicit modelling, increased use of visual representations and/or manipulatives can be offered (e.g. use of imitation money, fraction circles) (Emerson and Babtie 2014; Gersten et al. 2009). To our knowledge, only some existing scripted assessment tools are directed on a specific maths domain (e.g. Wright, Martland, and Stafford 2006).

To date, the empirical evidence on the adequacy and actual benefits of dynamic maths assessment is limited. In a review of four earlier studies (Caffrey, Fuchs, and Fuchs 2008), dynamic assessment was found to contribute unique variance to the prediction of future maths achievement and thus go *beyond* traditional static maths assessment. In a study by Seethaler et al. (2012) involving the presentation of scaffolded maths content to first graders, a dynamic assessment approach was found to provide greater insight into the learning capabilities of the student relative to traditional assessment and particularly with regard to the students' word problem-solving.

In the past, Ginsberg (1997) suggested video-recording dynamic maths interviews for subsequent review and discussion, the creation of guidelines for evaluation purposes, and the explicit assessment of inter-interpreter reliability. Further information on the validity and benefits of dynamic maths assessment of educational needs is not available. Therefore, insight into the conditions needed to determine the validity of DMIs, and the adequacy and the benefits of such an approach to identify educational needs, is thus needed.

The ability of teachers to conduct dynamic maths interviews

Dynamic maths interviewing requires specific competencies, such as the ability to explore and expand the limits of a student's knowledge and understand a student's thinking (Ginsburg 2009). The teacher must be able to stimulate student responding and thereby gain insight into the student's perspective (Empson and Jacobs 2008; Lee and Johnston-Wilder 2013). The interaction with students should often have a solution-focused character. Teachers then pose questions to help students identify their learning strengths and weaknesses but also stimulate them to share their maths-learning experiences, identify maths-related emotions, specify maths learning goals, and gain the support needed to achieve these goals (Bannink 2010). In order to become competent maths interviewers, teachers must practice with the observation, posing appropriate questions, and adequate responding. Video recording of DMIs for practice, training, reflection, and ongoing review purposes is critical (Wright, Martland, and Stafford 2006).

In order to meet the educational needs of each and every student, teachers must recognise the diversity of learning trajectories and have the capacity to provide scaffolded support along the way (Deunk et al. 2018; Empson and Jacobs 2008). Van de Grift (2007) identified the provision of a safe but stimulating learning climate, efficient classroom management, and clear instruction as necessary for effective teaching. Aspects of adaptive teaching such as showing students how to *simplify* complex problems have also been identified as critical aspects of effective maths teaching (Van der Lans, Van de Grift, and Van Veen 2018). Teachers must have the required knowledge base but also knowledge of alternatives for stimulating student maths learning (see Hill et al. 2008). Only then can teachers decide which alternative is most suited for a given student, in a given domain of learning, and a given problem at a given point in time. Thus, when teachers are better able to identify the educational needs of students showing low maths achievement, they should be able to better establish meaningful instructional goals and make the necessary adaptations to their maths education (Hoth et al. 2016).

The present study

Whether or not the DMI is an effective tool for identifying the educational needs of – in particular – low maths achievers has yet to be demonstrated. We therefore posed the following question. What is the adequacy of teachers' use of a DMI to identify the educational needs of students with low maths achievement? To answer this question, critical elements for the determination of the reliability, validity, and benefits of using a DMI were identified and thus elements for the development of an analytic framework.

In order to help teachers with the conduct of DMIs, a scripted protocol was developed on the basis of the learning assessment model of Pellegrino, Chudowsky, and Glaser (2001), the interview model of Delfos (2001), and the available research on dynamic educational assessment (e.g. Allsopp et al. 2008; Bannink 2010; Black et al. 2004; Ginsberg 1997; Ginsburg 2009). The developed tool examines thinking and problem-solving processes for various domains of maths and also the maths-related experiences, beliefs, and emotions of the students and thus a wide range of educational needs.

We expected the conduct of DMIs to indeed help teachers identify the educational needs of low maths achievers. In addition, we expected that teachers demonstrating *high levels of competence* for the conduct of DMIs also show relatively better maths teaching behaviour. Observations of maths teaching behaviour afforded us information on the levels of effective maths teaching behaviour.

Method

Study design and participant selection

Data on teachers' actual maths teaching behaviour was collected at the start (T1) and the end (T2) of the school year. The DMI teacher professional development programme was conducted between November and mid-February followed by a practice period. Data on DMIs was collected between March and mid-June (see Figure 1).

Participants were recruited by open invitation via social media (Twitter) and direct mail (school principals and fourth grade teachers). An information meeting was held for interested teachers in two regions of the Netherlands and 23 teachers (from 22 different schools) agreed to participate in the end. Nineteen of these teachers, who conducted a DMI with a student showing low maths achievement, were involved in this study. The teachers were given printed information about the study and a factsheet about the data collection methods.

The 23 participating teachers were asked to identify students showing low maths achievement (i.e. scores below the 20^{th} percentile on a criterion-based standardised Dutch national test) (Cito; Janssen, Scheltens, and Kraemer 2005). The mean score on this maths achievement test for the entire group of students being taught by the 23

One school year					
Aug-Sep	Oct	Nov-mid Feb	Feb	March-mid June	June
T1	*Individual feedback on a conducted DMI*	Teacher professional development programme	*Individual feedback on a conducted DMI*	Practice period Individual data collection for each teacher with one student showing low math achievement	T2

Figure 1. The research design.

participating teachers (*n*= 449) was 216.43 (*SD* = 28.19) (range of 110–312) with 92 students showing low maths achievement.

All of the 23 teachers participated in the professional development programme. Only 19 of the 23 teachers had students with low maths achievement in their classes, however: 3 men and 16 women with an average of 11.6 years of teaching experience (*SD* = 9.63, range 3–40). Thirteen had a Bachelor's degree in education (68%), five had additional graduate training (26%), and one had a Master's degree.

Each of the 19 teachers participating in the present study conducted a DMI with a student with a maths score below the 20th percentile criterion on the Cito test. The DMI was conducted during the practice period and video-recorded for data collection purposes. These students along with their teachers constituted the DMI research group (*n*= 19). The mean age of the students was 9.26 years (*SD* = 0.41): 12 boys, 7 girls.

The sample was treated in accordance with institutional guidelines as well as APA ethical standards. Schools, parents, and students were informed about the purpose of the research, duration of the study, and procedures. Both teachers and parents provided active informed participation consent.

Procedure

The teachers consented via email to being observed and video recorded during the teaching of a regular maths lesson on the topic of fractions or ratios. Each teacher was observed and recorded teaching a maths lesson on two occasions (T1, T2). The lessons were scored using the ICALT+S. And the teachers were debriefed following observation.

The *intervention* entailed a professional development programme consisting of four meetings with a duration four hours each, followed by a period of DMI practice. The programme followed the design features recommended for professional development training purposes (e.g. Van Driel et al. 2012). The training prototype was reviewed by experts and fine-tuned several times. The first author, an expert teacher trainer, organised and conducted the sessions. The programme included an explanation of the protocol for a DMI, mathematical teaching knowledge related to DMIs (e.g. understanding student errors), video examples of DMIs, and *peer* feedback on practiced and video recorded DMIs. Each teacher *also* received individual feedback from the teacher trainer on two occasions: once before the first meeting and once after the last meeting. On these two occasions, the teachers were asked to conduct DMIs for three self-selected word maths problems from the Cito maths test in a manner they considered suitable. During the subsequent DMI practice period, the 19 teachers conducted and recorded the DMIs with the 19 students participating in the study. These videos, which varied in length, were fully transcribed and coded.

Measurement instruments

Analytic framework

Using the method of qualitative content analysis as developed by Mayring (2015), we developed an *analytic framework* to examine the video recorded DMIs. The framework encompassed aspects of dynamic assessment considered critical for a DMI to be effective. For purposes of the present study, we focused on 10 aspects judged to be critical for the identification of student *maths needs* and thus providing a stepping stone for meeting the needs (see Figure 2 The analytical framework and Supplement 1 for an extensive version). Three validation sessions were conducted in which eight researchers (one session) and five maths teaching experts (two sessions) coded transcripts with concepts from the tentative analytic framework. Following each validation session, the analytic framework and accompanying manual were adjusted and refined. Several codes, for example, were added to identify the types of questions posed by the teachers and the type of support provided. Directions for the coding of the questions posed by the teachers were made more specific and refined. We also added coding of the adequacy of teacher responding to students to the analytic framework.

The first author coded all of the transcribed DMIs. An additional maths teaching expert with a Master's degree in special education but blind to the aims and design of the present study coded a random selection of six transcripts using the analytic framework. The inter-rater reliability for the scoring of the six transcripts was found to be good with a consensus norm of 81% agreement.

Analytical framework

(1) *Ratio open to closed questions posed by teacher*. Open questions are assumed to elicit greater information and therefore preferred over closed questions. At the start of the DMI, closed questions may nevertheless be more suitable for the purpose to establish trust or to check the teacher has understood the student correctly. By asking in-depth questions, the teacher can gain more information or clarity. The proportion open questions should be higher than the proportion closed questions.

(2) *Questions focused on student's maths experiences, beliefs, and emotions*. With the intention of a wide scope for the DMI, the teacher can also ask questions addressing students' maths experiences, beliefs, and emotions. The percentage of the total number of posed questions focused on this aspect should be more than 20% of all questions of the DMI to be judged adequate.

(3) *Questions focused on student's thinking and problem-solving processes*. These questions help gain insight into what the student understands and does not understand. The teacher can obtain an explanation for why the student does not understand things or cannot complete the problem correctly. The percentage of the total number of questions posed is calculated and should be higher than the percentage product-directed questions (aspect 4).

(4) *Questions to check student knows the right answer*. With these questions the teacher can gain information about maths achievement levels and mastery of skills. The attainment of process information as opposed to product (i.e. outcome) information should nevertheless prevail for the DMI to have added value near

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4. *Questions to check student knows the right answer.* With these questions the teacher can gain information about math achievement levels and mastery of skills. The attainment of process information as opposed to product (i.e. outcome) information should nevertheless prevail for the DMI to have added value near standardised tests. The percentage of the total number of questions posed is counted.
5. *Questions to identify math needs by actively eliciting student's voice.* By posing questions with a solution-focused character the teacher can help the student begin moving towards solutions and future regarding math learning. Have you ever had great math help? What did the person who gave you that do? What do you need to reach your next math learning goal? are examples of questions that elicit student's voice. Also increasing waiting time after posing a question can maximise the chances of gaining insight into the student's own thinking, the student's ideas, the promotion of commitment, and increased ownership. The percentage of the total number of questions posed is counted and should be at least 10% for the DMI to be judged adequate.
6. S*upport given.* The teacher can provide support during a DMI. We distinguished: a) stimulating the student to write down steps in thinking, b) verbal support (e.g. hints), c) verbal support provided by notes by the teacher, d) material support (e.g. manipulate with imitation money), e) use of concrete representations of abstract models, f) use of representations of concrete mathematical actions and situations, g) clear structuring of problem/task, h) reduction of complexity, i) demonstration, and j) modelling. Support provided four times or more is indicated as most frequently provided support. Most important is that the support be appropriate.
7. *Adequate responding.* When a teacher responds to what a student says or does, they must do this in a manner which allows the student to take advantage of their response. This requires extensive mathematical knowledge. Adequate responding requires: insight into possible misunderstandings, provision of not only clear but also complete support, correct interpretation of students' mathematical statements, determination of appropriate support, and effective timing of the support. On the basis of this information, adequacy of responding can be assigned a score between 1 (= to a very small extent) and 4 (= to a very large extent), with a score $\geq$ 3 indicating adequacy.
8. *Creation of safe and stimulating climate.* Particularly for the conduct of a productive DMI, several conditions must be met: creation of a sufficiently warm and relaxed atmosphere, showing of respect, starting with a math problem on which the child is likely to succeed, encouraging verbalisations, sincerity, and supportive remarks. This aspect of the DMI is assigned a score between 1 (= to a very small extent) and 4 (= to a very large extent), with a score $\geq$ 3 indicating adequacy.
9. *Teacher summary of educational needs*. When the teacher succinctly reproduces what lies at the core of the student's needs, using the student's own words, this shows that the teacher has been listening carefully. It also allows the teacher to check their understanding of the student's educational needs and goals. Co-responsibility on the parts of the teacher and student is also fostered. Summary of educational needs assigned a score of 0 (= not) or between 1 (= to a very small extent) and 4 (= to a very large extent), with a score $\geq$ 3 indicating adequacy.
10. *Scope of the DMI.* A beneficial DMI must address various aspects of a student's math development: thinking and problem-solving abilities; math-related experiences, beliefs, and emotions; and active involvement in the identification what they need for successful math achievement. We distinguished five types of DMI scope, with the widest (a) being most preferred: a) teacher focus on student's math thinking and problem-solving; math experiences, beliefs, and emotions; and active involvement in identification of needs; b) teacher focus on math achievement; math experiences, beliefs, and emotions; c) teacher focus on math experiences, beliefs, and emotions; active involvement in identification of needs; d) teacher focus on math achievement; active involvement in identification of needs; and e) focus solely on math achievement.

Figure 2. The analytical framework.

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Maths teaching behaviour

The International Comparative Analysis of Learning and Teaching (ICALT; Van de Grift 2007; Van der Lans, Van de Grift, and Van Veen 2018) was used to observe 32 aspects of *actual teaching behaviour* (7 scales). The first six observational scales address less complex to more complex teaching behaviours: providing a safe and stimulating learning climate; efficient classroom management; clarity of instruction; activating learning; teaching of learning strategies, and differentiation and adaptation of lesson. The seventh scale assesses student involvement. Given that the ICALT is not maths specific, a supplemental eighth scale (S) for maths teaching strategies in particular was created.

The eight items for the maths-specific scale were developed by the first author in consultation with the co-authors for purposes of the present study. Two teaching models were drawn upon. First, the four levels of action as identified by Gal'perin (1978), 1) informal mathematics and procedures, 2) depiction of concrete mathematical actions and situations, 3) depiction of abstract models, and 4) formal mathematical operations. Second, Polya's (1957) four-step problem-solving model: 1) understand the problem, 2) devise a plan, 3) carry out the plan, and 4) check and interpret. The internal consistency of the 8 scales considered together was good ($\alpha \geq 0.89$). This was also the case for the individual scales ($\alpha \geq 0.85$). The scoring for each of the 40 observational items was done along a four-point Likert scale ranging from 1 (=*predominantly weak*) to 4 (= *predominantly strong*) and conducted by two independent maths teaching experts (the first author and a second observer, who were both trained and certified to use the ICALT). The inter-rater reliability was found to be good ($\alpha = 0.86$).

Data analysis

To answer our research question, we first conducted qualitative analyses for the 19 videos and then quantified the data.

Results

Table 1 presents the results of our qualitative analyses of the 19 DMIs in terms of adequacy of the DMIs (10 coded aspects) and changes in teaching behaviour from T1 to T2 (i.e., before and after participation in teacher training programme) .

Adequacy. Our analysis of the DMIs provided an abundance of information. Only the highlights of the findings of relevance to our research question are presented here. All of the 19 teachers were found to ask more open than closed questions in the analysed DMIs.

For 14 of the teachers (73.7%), more than 20% of their questions addressed the maths experiences, beliefs, and emotions of the student. Sixteen (84.2%) asked more process- than product-oriented questions (i.e. focused on students' maths thinking and problem solving). Twelve of the DMIs (63.2%) showed a wide range of attention and thus addressed: students' maths thinking and problem solving; students' maths experiences, beliefs, and emotions; and active involvement of students in the identification of their maths needs. Fourteen teachers (73.7%) showed adequate responding (≥3), sixteen teachers (84.2%) created an adequate safe and stimulating climate (≥3). Eight teachers (42.1%) summarised educational needs to an adequate extent (≥3). The most frequently provided support was verbal support: 17 teachers (89.5%) provided verbal support more than four times during the DMI.

With regard to the range of teacher performance in the DMIs, six teachers (31.6%) showed a high degree of attention to students' maths thinking and problem-solving, on the one hand, and active involvement of students in the identification of their maths needs, on the other hand (> 20% of all questions). The latter is also reflected in the extent of identified and explicitly verbalised educational needs: a larger number of needs (range 6–11) was cited in the DMIs of teachers *5, 8, 10, 11, 12, and 15*. In the other DMIs, teacher *3* mentioned only one student need; *16* two needs; and *19* no needs. Supplement 2 provides excerpts from some DMIs.

The qualitative analyses and criteria described in Figure 2 show adequate DMIs for teachers *2, 5, 8, 10, 11*, and *12*. A good balance was found in the types of questions posed (aspects 1–5); a wide range of topics was addressed (aspect 10); and adequate support and responding was given (aspects 6 and 7). A safe and stimulating learning

Table 1. 10 Aspects of dynamic maths interviews and actual teaching behaviour start and end of the school year.

T	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Actual teaching behaviour	
	% open	%	%	%	%	≥4 times	1–4	1–4	0–4	a-e	T1	T2
1	54.84	19.36	47.31	10.75	8.06	b	3	3	2	a	2.96	3.44
2	54.00	42.00	38.00	8.00	10.00	a,b	4	4	4	a	3.47	3.67
3	59.02	14.06	31.15	36.07	1.64	b	3	4	1	b	2.86	3.40
4	67.44	2.33	48.84	20.93	11.63	b,e	4	4	3	d	3.32	3.68
5	87.50	21.88	31.25	18.75	26.56	-	4	4	4	a	3.52	3.68
6	56.76	25.23	33.33	22.52	17.12	a,b,c	2	3	4	a	3.31	2.95
7	66.07	23.21	35.71	23.21	3.57	b	1	2	2	b	2.46	2.97
8	72.09	21.28	21.11	11.70	37.87	a,b	3	4	4	a	2.91	3.31
9	64.29	20.00	35.71	22.86	8.57	b	3	4	2	a	2.85	2.97
10	80.65	40.32	12.90	16.13	22.58	b	3	4	4	a	2.16	3.38
11	71.74	28.28	32.61	14.49	21.74	a,b	4	4	4	a	3.15	3.48
12	75.38	14.29	25.00	9.52	34.52	a,b,e	4	4	4	a	3.57	3.70
13	54.70	54.70	15.39	8.55	10.26	b	2	2	1	a	3.63	3.75
14	87.32	32.39	29.58	26.76	5.63	b	3	3	2	b	3.44	3.30
15	50.00	50.00	20.00	0.00	33.33	b	4	4	2	a	3.33	3.70
16	75.00	6.25	45.83	33.30	0.00	b	1	2	0	e	2.90	2.83
17	60.20	17.20	23.66	21.51	9.68	a,b,c	3	4	1	a	2.81	2.73
18	71.90	46.15	7.69	15.39	10.26	d	3	4	1	b	2.96	2.68
19	57.45	25.93	51.06	8.51	0.00	b,c	2	3	0	b	3.22	3.54

Note: T = Teachers; See Figure 2 for extensive description of 10 coded aspects of DMIs.

climate was created (aspect 8). A summary of the student's maths needs was supplied (aspect 9). In these DMIs, various aspects of a student's mathematical development were addressed by adequate teacher-student interaction with the aim to identify student's maths needs.

Four the aforementioned teachers (*2, 5, 11, 12*) showed high scores for *actual teaching behaviour* (> 3) on both measurement occasions and two (*8, 10*) showed increases on the second occasion (T1: < 3, T2: > 3). The one DMI that was judged to be less than adequate was conducted by teacher *16*. It showed an insufficient balance between the different types of questions (aspects 1–5); a small scope (aspect 10); inadequate support and responding (aspects 6 and 7); little or no creation of a safe and stimulating learning climate (aspect 8) and no summary of maths needs (aspect 9). For this teacher, low actual teaching behaviour scores were also found on both occasions (T1 and T2 < 3). It should nevertheless be noted that not all teachers showing high teaching behaviour scores (T1, T2 > 3) conducted DMIs which were judged to adequate on all aspects (teachers *4, 13, 14, 15, 19)*. Conversely, not all teachers showing low teaching behaviour scores (T1, T2 < 3) conducted DMIs which were judged to be inadequate on all aspects (teachers *7, 9, 16, 17, 18*). All teachers have their strengths and weaknesses.

Benefits of DMIs for identification of educational needs. Identification of educational needs was coded on the basis of explicit verbalisation by the student or verbalisation by the teacher with confirmation from the student (e.g. I need a ruler, I need to read the maths problem more thoroughly, check your answers). In 18 of the 19 analysed DMIs (94.7%), educational needs were explicitly identified; in one (*19*), they were not.

Discussion

In this study, we investigated whether teachers can adequately conduct DMIs to identify the educational needs of students with low maths achievement. Eighteen of the nineteen interviews (94.7%) showed clear identification of specific educational needs, such as the need for concrete visual-schematic representations, the need to read more carefully, the need to write down interim results, and the need to persevere and therefore not give up. It can be assumed that these needs and accompanying recommendations would not have been revealed using of standard testing. The conduct of a DMI allows the teacher to better appreciate the student's point of view, thereby identify specific educational needs, and hence select suitable interventions (i.e. interventions which are within the student's zone of proximal development) (Lee and Johnston-Wilder 2013).

The five teachers who demonstrated the highest levels of competence in the conduct of their DMIs also showed qualitatively good maths teaching behaviour during the observed maths lessons. Nevertheless, there were teachers who showed high scores on teaching behaviour but less than adequate DMIs and teachers who showed adequate DMIs but low teaching behaviour scores. There may be, at most, an indication that maths interviewing competence and maths teaching competence may somewhat be related, which corresponds to the findings of a previous study by Hoth et al. (2016).

The professional development programme used in combination with a practice period involving peer review and reflection on video recorded DMIs appear to have facilitated the teachers' ability to follow the DMI protocol, ask more open questions (among other things), and thereby better explore and understand student's maths knowledge, thinking, problem-solving procedures, experiences, emotions, and beliefs (Elliott, Grigorenko, and Resing 2010; Empson and Jacobs 2008; Ginsburg 2009; Wright, Martland, and Stafford 2006). The training of teachers to ask questions aimed at actively involving students in identification of their needs by asking solution-focused questions also enhanced the conduct of the DMIs (Bannink 2010). At the start of the study, teachers were not familiar with such questions and their subsequent use appears to have contributed to the identification of a greater number of educational needs (as seen in six DMIs).

It is striking that many of the teachers in our study spontaneously noticed students being able to solve a maths problem during the DMI which they previously could not solve. A calm but stimulating learning climate with a focus on the thorough reading of instructions and word maths problems, thinking out loud, and writing down interim steps in problem solution are examples of educational needs determined during DMIs. These identified educational needs go beyond standardised test results.

The DMIs may have contributed to the ability of the teachers in our study to understand *why* some maths skills constitute a stumbling block for certain students and/or certain domains of maths. This information may have proved useful, in turn, for identifying just how they can better meet the needs of these students. In other words, the adequate conduct of dynamic maths assessment in the form of a DMI appears to be particularly promising for identifying the specific maths needs of individual students (also see Caffrey, Fuchs, and Fuchs 2008).

Study strengths, limitations, and directions for future research. A strength of the present study is the involvement of teachers coming from a variety of schools in the Netherlands, which suggests that our results are fairly representative. Another strength is that the video-recordings and observations were done in the real school setting and the DMIs conducted with students in their own school contexts.

We created what appears to be a useful teacher professional development programme with the focus on DMIs. Furthermore, we developed a scripted tool for the conduct of DMIs that can presumably be used in all domains of mathematics and with all students. The tools proved reliable enough for more widespread use and examination on a larger scale. Furthermore, an analytic framework was clearly articulated and developed to facilitate the qualitative analyses of the DMIs conducted by the teachers. Further refinement of the framework is nevertheless needed. For example, adequacy of responding or, in other words, responding which is well-timed and allows the student to take advantage of the teacher's response was only scored as an overall impression within our analytic framework. More in-depth exploration and specification of teacher responding is thus needed (Empson and Jacobs 2008).

Additional research is called for on the interrelations between maths interviewing competence and maths teaching competence (and vice versa). We expect the proficient conduct of DMIs to help teachers identify the specific needs of students and subsequently incorporate this information into their daily teaching practices to become better teachers. This will include, for example: more responsive listening and provision of suitable support, more attention to the problem-solving processes which students need to use and more involvement of students in determining and meeting their maths learning needs (e.g. Deunk et al. 2018; Gersten et al. 2009).

A clear limitation on the present study is the relatively small sample size. This is nevertheless common in studies with detailed, qualitative coding of behaviour and student-teacher interactions. But caution should be exercised when attempting to generalise the results to other settings, problems, and/or populations.

The present study is a first attempt to analyse the adequacy and potential benefits of using DMIs with primary school students (in this study: students known to have low maths achievement). Replication and expansion to include more teachers and a wider variety of students is therefore welcome.

Implications for practice. DMIs proved useful for gaining insight into the maths thinking and problem-solving processes of students but also their maths beliefs, maths emotions, maths fears, and the types of support needed. With the competent conduct of a DMI, as found in the present study, teachers can attune the support which they provide to the individual student's zone of proximal development and thereby maximise the effectiveness of their efforts. It may nevertheless be the case that not only the introduction of a teacher professional development programme and DMI practice are needed to foster a better recognition and understanding of the educational needs of students today; it is possible that a more systemic implementation of dynamic assessment techniques is needed within the wider school context and learning community (Franke et al. 2001). In today's inclusive classrooms, students showing low maths achievement (or low achievement in general) require extra attention. The conduct of dynamic maths interviews is a promising tool for providing the attention which is needed and thereby meeting the educational needs of all students.

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