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Teacher Scaffolding in Small-Group Work: An Intervention Study

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Adapting support contingently to student needs by first diagnosing their current understanding, that is, scaffolding, is considered a key aspect of excellent teaching. The use of classroom scaffolding is rare, however. We therefore investigated the benefits to teachers of a professional development program that was based upon a model of contingent teaching (MCT) with the following 4 steps: diagnostic strategies, checking of diagnoses, giving contingent support, and checking of student learning. In our experimental study, 17 of 30 teachers participated in this program. All of the teachers (prevocational education; teaching social studies) taught the same 5-lesson project on the European Union. The frequency and quality of their use of the 4 steps from the MCT were then compared. The teachers who worked with the MCT increased their teaching quality more than the teachers who did not participate, especially with regard to the steps of contingent teaching. They also showed more complete cycles of contingent teaching at postmeasurement than the other teachers. Less successful teachers showed a tendency to provide less support because they

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mistakenly thought that prompting was not part of scaffolding. Future scaffolding research and professional development efforts aimed at promoting scaffolding can benefit from the MCT, provided that teachers' understanding of scaffolding is closely monitored.

Scaffolding or adaptive support is recognized as a distinctive feature of excellent teaching (Borko, Mayfield, Marion, Flexer, & Cumbro, 1997; Seidel & Shavelson, 2007; Wittwer & Renkl, 2008). Ausubel (1968) recognized this more than four decades ago: "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (p. vi). Scaffolding effectively helps learners (Mattanah, Pratt, Cowan, & Cowan, 2005; Pino-Pasternak, Whitebread, & Tolmie, 2010; Pratt, Green, MacVicar, & Bountrogianni, 1992). The metaphor of scaffolding is powerful, moreover, and it appeals to the imaginations of both teachers and researchers (Mercer & Littleton, 2007; Saban, Kocbeker, & Saban, 2007).

Because scaffolding is temporary support tailored to students' needs and aimed at the transfer of responsibility from teacher to student, providing it can be challenging. Several studies in which this definition of the concept is adhered to have found scaffolding to be scarce in the classroom (Elbers, Hajer, Jonkers, Koole, & Prenger, 2008; Lockhorst, Wubbels, & Van Oers, 2010). This is at least in part because diagnosing student understanding before giving support, which gives teachers information that is critical for scaffolding, is difficult (Elbers et al., 2008; Nathan & Petrosino, 2003; Van de Pol, Volman, & Beishuizen, 2011; Webb, Nemer, & Ing, 2006; Wittwer, Nückles, & Renkl, 2010).

Finding ways to promote teachers' scaffolding skills is thus vital, but, to our knowledge, only a few studies have investigated this so far. We therefore examined the effects of a professional development program (PDP) promoting the use of scaffolding. The model of contingent teaching (MCT), in which diagnosing students' understanding before giving support is central (Van de Pol, Volman, & Beishuizen, 2012), formed the basis of this program. In an experimental study, we compared the extent to which teachers who worked with the MCT differed from those who did not. This was done in terms of the frequency and quality of the contingent teaching steps undertaken and the giving of contingent support.

THE CONCEPT OF SCAFFOLDING

The concept of scaffolding is related to Vygotsky's (1978) sociocultural theory and particularly to his zone of proximal development. The zone of proximal development describes the difference between what learners can do on their own (i.e., their actual level of performance) and what learners can do when given support (i.e., their potential level of performance). The term *scaffolding* was coined in 1976 by Wood, Bruner, and Ross to describe the support that tutors can provide to help tutees complete a task that they would otherwise not be able to complete. Scaffolding can thus be considered support that helps learners reach their potential level of performance.

Scaffolding has three main features: (a) adaptivity or contingency, (b) fading of support over time, and (c) transfer of responsibility for a task or for learning to the student (Van de Pol, Volman, & Beishuizen, 2010). Contingency refers to adapting support to the student's needs (e.g., Wood, Wood, & Middleton, 1978). In order to do this, one must diagnose the student's current understanding prior to providing the support (e.g., Snow & Swanson, 1992; Wittwer & Renkl, 2008). Once support has been provided, it must then be faded out to gradually transfer responsibility for further task performance and learning to the student.

DIAGNOSING STUDENTS' UNDERSTANDING

Diagnosing students' understanding is inherently part of scaffolding (Pea, 2004; Puntambekar & Hübscher, 2005). To be able to tailor support to a student's understanding, one must first explore this understanding, for example by asking questions (Wittwer & Renkl, 2008). Diagnostic questions are always concerned with the student's actual understanding (e.g., "What do you understand about the internal market?"). Diagnostic questions are typically open questions that do not indicate a direction for thinking or give hints on how to respond. The posing of diagnostic questions is an important part of the scaffolding process because general teacher estimates of a learner's understanding are often inaccurate (e.g., Begeny, Krouse, Brown, & Mann, 2011; Chi, Siler, & Jeong, 2004). Teachers have often been found to not initially diagnose a student's understanding before providing support (Elbers et al., 2008; Lockhorst et al., 2010; Nathan & Petrosino, 2003; Van de Pol et al., 2011; Webb et al., 2006; Wittwer et al., 2010). The following are mentioned as reasons for not posing diagnostic questions: (a) insufficient diagnostic skills, (b) general information about students is used (e.g., "This student is a bad reader" or "This student cannot concentrate very well"), (c) automatic reaction to provide support directly, and (d) time constraints (Elbers et al., 2008; Morrison & Lederman, 2003; Wittwer et al., 2010).

Even when teachers diagnose a student's understanding, actually using this information to provide support is reported to be difficult (Ruiz-Primo & Furtak, 2007). The few diagnostic questions that are posed have also been found to be of low quality; that is, they only elicit claims of understanding (e.g., "I get it"; Wittwer et al., 2010) or low-level factual recall (Chin, 2007; Morrison & Lederman, 2003; Roth, 1996). More open diagnostic questions that elicit demonstrations (e.g., students' explanations) and questions that elicit more than factual recall (i.e., students' conceptual understanding) give teachers more detailed information about the students' understanding; such questions provoke deeper reasoning and could therefore be considered to be of higher quality. Some research has shown a relation between the use of these types of questions and increases in student achievement (Barnes, 1975; Redfield & Rousseau, 1981; Ryan, 1973).

Promotion of the use of diagnostic strategies—and of high-quality diagnostic strategies in particular—is thus crucial. However, little is known about how to promote teachers' diagnostic skills. And the few available studies on fostering the use of diagnostic strategies have been conducted in individual tutoring or peer tutoring contexts (e.g., King, Staffieri, & Adelgais, 1998; Roscoe & Chi, 2007) and not in classroom contexts.

CREATING SHARED UNDERSTANDING

Creating shared understanding is important before giving support. This facilitates communication and prevents misconceptions of the student's current understanding. The teacher checks whether his or her perception of the student's understanding is correct. The purpose of doing this is not to provide feedback to the student via subsequent revoicing or recasting (O'Connor & Michaels, 1993; Yifat & Zadunaisky-Ehrlich, 2008). The purpose is, rather, to check the *teacher's* understanding of the student's understanding. An example of such checking is the following: "So if I understand you correctly, your understanding of the internal market is that it represents free traffic between countries in the European Union?"

Creating shared understanding is stressed in a teaching method that is closely linked to scaffolding, the Socratic dialogue (Heckmann, 1981). In a Socratic dialogue, student learning is guided and directed by a facilitator using specific communication rules. Checking whether the student is understood correctly is one such communication rule (Knežiç, 2011). When Knežiç (2011) investigated the effects of an intervention aimed at promoting the use of Socratic dialogue and this checking step in particular, she found that teachers who participated in the program increased their checking significantly more than teachers who did not participate in the program. The overall use of this check, however, remained considerably low in both groups. Increasing the use of this check thus seems possible, yet improvements can still be made in promoting this important scaffolding step. In the current study, we focused on promoting both the frequency and the quality of using this step.

CONTINGENT SUPPORT

Once information on a student's understanding has been collected and checked, the teacher can proceed to providing *contingent support.* This is support that is adapted to the diagnostic information that has been gathered. Contingency is generally recognized as a crucial characteristic of effective support in small-group work (Blatchford, Baines, Rubie-Davies, Bassett, & Chowne, 2006; Chiu, 2004; Webb, 2009), and it is a crucial predictor of the success of the support given (Mattanah et al., 2005; Pino-Pasternak et al., 2010; Pratt et al., 1992).

Contingency is considered a necessary condition for scaffolding; if fading or transfer of responsibility takes place in a noncontingent way, one cannot speak of scaffolding. In the present study, we therefore focus on *contingency* defined as the tailoring of a teacher's support to the responses of students. This definition of contingency does not encompass the effects of contingent support on student understanding. We distinguish between two interrelated types of contingency: (a) contingency control, which entails tailoring the degree of control or regulation in response to a student's understanding; and (b) contingency uptake, which entails the degree to which the teacher uses (i.e., takes up) what students say.

In elaborating the concept of scaffolding, Wood and his colleagues emphasized that support (in terms of the degree of control) needs to be tailored to the understanding of the student: The level of control should be increased when the learner fails and decreased when the learner succeeds (Wood & Middleton, 1975; Wood et al., 1978). When lack of understanding is detected in response to open questions (i.e., low level of control), for example, the teacher contingently adapts (increases in this case) the level of control and provides some explanation (i.e., a high level of control). This principle is called the *contingent shift principle* and is highly related to the other key characteristics of scaffolding, namely, fading and transfer of responsibility (cf. Wood, 1991). That is, with successful progression, the teacher fades the degree of control and gives the learner increased responsibility.

With regard to contingency uptake, adapting support to a student's responses can be accomplished by acknowledging and using what a student says during a conversation (e.g., Nystrand, Wu, Gamoran, Zeiser, & Long, 2003; Wells, 2010). When such uptake occurs, the student's responses can then influence the further course of the conversation. This means that the teacher has to listen carefully to what a student says in order to incorporate it into the ongoing conversation; the teacher's response is dependent upon and tailored to the student's responses (Nystrand et al., 2003). A teacher is, for example, taking up a student's idea when he or she asks a follow-up question that deepens the student's answer.

Tutors (in one-on-one situations) have been shown to be able to give contingent support when receiving information on student understanding (Wittwer & Renkl, 2008). However, Ruiz-Primo and Furtak (2007) found that teachers in classroom situations were able to gather information on student understanding but had difficulties with the actual use of diagnostic information when providing support. This finding calls for additional research on the promotion of this important skill of providing contingent support in the classroom context.

CHECKING OF STUDENT LEARNING

Finally, after providing support, a teacher should check student learning. This is different from diagnosing student understanding in that the focus is obviously not on the student's initial understanding but on his or her new understanding as it has developed over the course of the conversation. The same question could be a diagnostic question or a question to check a student's learning, depending on the place within the conversation. Checking of student learning is also different from creating shared understanding in that the focus of checking student learning is on the *student's (new) understanding* and not the *teacher's* understanding of the student's understanding.

The checking of student learning is mainly performed by asking questions, preferably questions that elicit a demonstration of knowledge (e.g., an explanation or elaboration) rather than only a claim of understanding (e.g., "I get it"; Koole, 2010; Sacks, 1992). Only via demonstration can the teacher determine how a student interpreted new subject matter and decide whether to transfer responsibility for the task back to the student. In addition, students often have difficulties gauging their own understanding of subject matter and tend to overestimate their understanding (Freund & Kasten, 2012). Checks that elicit demonstrations of understanding are thus a critical part of scaffolding. When such checks are used in classroom practice, however, mostly short and simple answers are still elicited as opposed to demonstrations (Kao, Carkin, & Hsu, 2011). Finding ways to promote this skill as part of scaffolding behavior thus seems important.

THE MCT

A model of teaching that integrates the four aforementioned aspects of scaffolding is the MCT (Van de Pol, Volman, & Beishuizen, 2012; based on Ruiz-Primo & Furtak, 2007; Figure 1). The MCT contributes to the conceptualization and operationalization of scaffolding by providing a concrete, step-by-step model. According to the MCT, the teacher must first diagnose a student's current (i.e., actual) understanding by, for example, asking diagnostic questions or reading the student's work. The teacher's understanding of the student's understanding must then be checked to ensure a shared understanding. Then the teacher must provide contingent support by basing the support on the diagnostic information gathered. Finally, the teacher must check the student's new (i.e., potential) understanding.

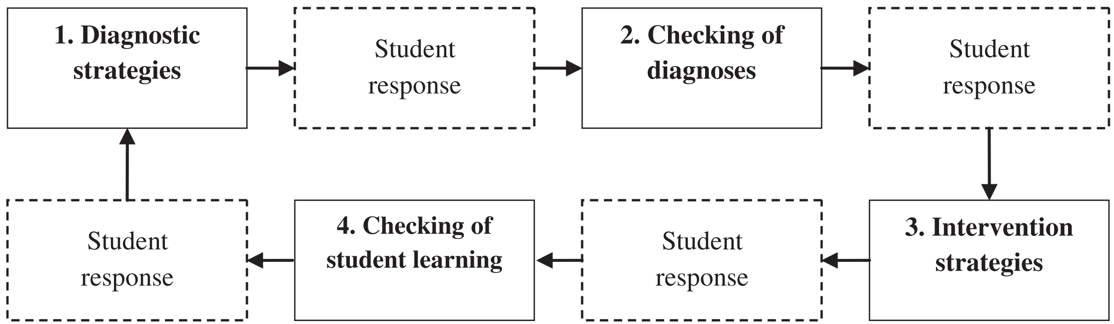

FIGURE 1 Model of contingent teaching.

Examples of each step of the MCT are discussed in the Results section of this article. The MCT was central to the PDP used in the current study to promote teacher scaffolding.

THE CURRENT STUDY

The goal of the current study was to investigate the extent to which and how teachers working with the MCT differed from teachers not working with the MCT in terms of the frequency and quality of steps of contingent teaching. In addition, we explored the extent to which the teachers used parts of or entire cycles of contingent teaching. Finally, we explored variations in the enactment of the different steps of the MCT *within* the group of teachers who participated in the PDP.

The MCT constituted the "curriculum" for the teachers learning how to scaffold. The PDP drew upon insights from recent reviews of the factors that enhance the effectiveness of PDPs (Darling-Hammond & Bransford, 2005; Loucks-Horsley & Matsumoto, 1999; Timperley, 2007; Van Veen, Zwart, & Meirink, 2012). The program included the following features: (a) learner centrality (i.e., a focus on learners' prior knowledge), (b) knowledge centrality (i.e., teachers were given opportunities to develop well-organized bodies of knowledge by using, e.g., a central conceptual framework), (c) assessment centrality (opportunities for reflection, feedback, and revision), (d) immersion (i.e., engagement with actual student learning materials), (e) integration of knowledge and practice, (f) collaborative work (i.e., involvement of external researchers), and (g) the use of various vehicles (e.g., workshops, coaching). In a previous small-scale exploratory study, we developed the PDP that was used in the current study and investigated the contingent teaching learning processes of four teachers (Van de Pol, Volman, & Beishuizen, 2012).

The subject area for the current study was social studies. This subject has gone largely untouched as scaffolding research has been concentrated on either literacy (cf. the review by Van de Pol et al., 2010) or math and science (Hmelo-Silver, Duncan, & Chinn, 2007; Puntambekar & Kolodner, 2005; Smit, van Eerde, & Bakker, in press; Tabak, 2004). Because students have difficulties developing understanding of substantive concepts[1] in this area (e.g., Kneppers, Elshout-Mohr, van Boxtel, & van Hout-Wolters, 2007; Limon, 2002; Van Drie & van Boxtel, 2003, 2008), high-quality teacher support via scaffolding is important.

[1]The term *substantive concepts* refers to "historical phenomena, structures, persons, and periods" (Van Drie & van Boxtel, 2008, p. 89). Examples are democracy, internal market, and export.

Specific Research Questions and Hypotheses

In an experimental study with a between-subjects research design, 30 teachers of prevocational Dutch secondary education were asked to teach the same five-lesson project on the European Union (EU). About half of them participated in a PDP on scaffolding based on the MCT (i.e., the scaffolding condition), and about half of them did not participate in this program (i.e., the nonscaffolding condition). The main research question was as follows: To what extent and how does working with the MCT promote teachers' scaffolding behavior in terms of the frequency and quality of their use of the steps of contingent teaching and, ultimately, in terms of contingency compared to teachers who have not worked with the MCT?

First, we expected the *frequency* and the *quality* of diagnostic strategies (step 1), checking the diagnosis (step 2), and checking of student learning (step 4) to increase more for teachers in the scaffolding condition than for teachers in the nonscaffolding condition (see Table 1 for a schematic overview of all hypotheses). A focus on conceptual understanding is considered of higher quality than a focus on facts; therefore, we expected a shift toward a focus on conceptual understanding in the scaffolding condition for these three steps. For step 1 (diagnostic strategies) and step 4 (checking of student learning) we additionally expected that the quality would increase in terms of the elicited mode, that is, more elicitations of demonstrations of understanding than claims of understanding. We did not have this expectation for step 2 (checking the diagnosis) because of the nature of this step, which will mostly elicit short answers.

With regard to intervention strategies (step 3), we had a different set of hypotheses. The frequency of using of this step was not expected to be a problem, but the quality of the use of intervention strategies has been shown to be low (Chiu, 2004). We therefore focused on the *quality* of this step in terms of contingency (control and uptake) and expected this to increase more for teachers in the scaffolding condition than for teachers in the nonscaffolding condition. In keeping

TABLE 1
Overview of the Hypotheses of this Study

Step	*Frequency*	*Quality—Focus (Conceptual Level)*	*Quality—Mode (Demonstrations)*
Diagnostic strategies (step 1)	1a: +[a]	1b: +[a]	1c: +[a]
Checking of diagnoses (step 2)	2a: +[a]	2b: +[a]	n/a
Intervention strategies (step 3)		3a: Contingency control: +[a]	
		3b: Contingency uptake: +[a]	
Checking of students' learning (step 4)	4a: +[a]	4b: +[a]	4c: +[a]

[a]Teachers in the scaffolding condition will show a greater increase on this aspect than teachers in the nonscaffolding condition.

with others (e.g., Chiu, 2004; Webb, 2009), we expected that diagnosing student understanding would help teachers tailor their support and that working with the MCT would enhance the contingency of their support.

Second, we also explored the extent to which the teachers used an entire cycle of contingent teaching or only parts. We explored differences between conditions by comparing measurement occasions.

Third, because the teachers in the scaffolding condition could respond to the PDP in different ways and succeed in giving contingent support to different degrees, we also explored individual variation *within* the scaffolding condition. We investigated how and why the teachers following the same PDP differed on the enactment of the steps of contingent teaching and the contingency of their support. Given that scaffolding is difficult to perform, gaining greater insight into the learning of teachers with regard to scaffolding is valuable. The identification of critical elements of the learning process and obstacles to scaffolding in the classroom can thus facilitate future professional development.

METHODS

Participants

A total of 30 teachers from 20 schools participated in this study: 17 teachers from 11 schools were in the scaffolding condition, and 13 teachers from 9 schools were in the nonscaffolding condition. Each participating school contained between 1 and 3 participating teachers. Nine schools accommodated prevocational education only; 11 schools also accommodated higher levels of education in their school buildings. The schools were distributed throughout The Netherlands. Of the participating teachers, 20 were men and 10 were women. The teachers taught social studies in the eighth grade of prevocational education. The average amount of teaching experience was 10 years. Each teacher participated with one class; therefore, a total of 30 classes participated.

The average class size was 27 students, and the lessons lasted 53 min on average. During the lessons taught by all teachers in the study, the students worked in small groups. The total number of groups was 184, with an average of 4.15 students per group. A total of 768 students (385 boys and 383 girls) participated in the study: 455 in the scaffolding condition and 313 in the nonscaffolding condition. The students were between 12 and 15 years of age, with an average age of 13.7 years.

We checked whether the conditions were comparable in terms of type of school (only prevocational education vs. more types of education within the school building), years of teaching experience, and teacher gender. We also checked the teachers' knowledge of the subject matter of the lessons (i.e., the EU) via administration of 17 multiple choice questions that we constructed, with four response options per question. A sample question was as follows:

> The main reason for the collaboration between European countries after World War II was: (a) to be able to compete more with other countries; (b) to be able to transport goods, people, and services across borders freely; (c) to collaborate with regard to economic and trade matters; or (d) to be able to monitor the weapons industry.

Item difficulty and discrimination were found to be sufficient (cf. Van de Pol, Volman, Oort, & Beishuizen, 2013). In addition, we checked to see that the extent to which students and teachers were accustomed to small-group work was comparable by asking the teachers to indicate on a 5-point Likert scale the extent to which they made use of small-group work with the participating class (1 = *never,* 5 = *always*). Finally, we also checked whether the study tracks being followed within the classes in the two conditions were comparable, as the Dutch secondary education system has a system of increasingly difficult study tracks. Most classes (95%) had the higher prevocational education tracks. *T* tests for independent samples showed nonsignificant results for all of these comparisons.

Procedures

We recruited teachers by sending out a call both directly to schools and in several online community newsletters. The information in the call was limited so that the teachers would not know the exact purpose of the study. The teachers were informed that the study involved the conducting of a five-lesson project on the EU to be supplied by the researchers and that the focus was on student learning in small groups. The teachers who showed an interest in the study were contacted and visited to discuss their participation. They were then alternately allocated to conditions according to order of visitation: All teachers from the first school to be visited were allocated to the scaffolding condition, all teachers from the second school to be visited were allocated to the nonscaffolding condition, and so forth.

The study was conducted between September 2009 and March 2010. During each term, about six teachers (i.e., three for the scaffolding condition and three for the nonscaffolding condition) taught the project lessons. All of the teachers were later fully informed of the purpose of the study and the study outcomes.

Project lessons.

All of the teachers taught the same project on the EU. This project consisted of five lessons in which the students had to complete several assignments in small groups of four (e.g., a poster, a letter about the advantages and disadvantages of the EU). In most cases, one project lesson was taught per week. We had piloted the project in a previous study (Van de Pol, Volman, & Beishuizen, 2012). Groups were composed by the teacher and consisted of boys and girls with different performance levels. Only the first and last lessons of the project were used for analyses (premeasurement and postmeasurement, respectively). These lessons were videotaped for all of the teachers and thus included lessons in both the scaffolding and nonscaffolding conditions. In the first lesson, the students made a brochure about what the EU means for children and young people in their everyday lives and had to use important concepts related to the EU. In the last lesson, the students worked on an assignment called Which Word Out (Leat, 1998). Three related concepts are first chosen from a list of concepts about the EU; one concept must then be left out and two arguments provided for doing this. Both of these tasks are open-ended discussion tasks because reasoning (rather than providing the right answer) was the focus of the task. The students were stimulated to collaborate by the very nature of the tasks (e.g., the students needed one another to complete the task) and by the rules for collaboration introduced in all of the classes (e.g., encourage one another to participate, make sure everyone understands the lesson, ask one another for help before asking the teacher for help). Following premeasurement, all of the teachers participated in a meeting in which the subsequent project lessons were discussed and prepared.

Scaffolding program. The scaffolding PDP was developed and piloted in the year prior to the present study (cf. Van de Pol, Volman, & Beishuizen, 2012). The PDP consisted of a theoretical session of 2 hr and four opportunities to successively practice the steps of the MCT in the lessons, followed by reflection sessions with the first author on video recordings of those lessons. Prior to the start of the PDP, the first author videotaped the first project lesson for each teacher. These recordings provided both premeasurement material and footage for the theoretical session.

The first author, who had experience with the teaching of this program, conducted the scaffolding PDP. All sessions were held at the teachers' schools. The reflection sessions were conducted individually (i.e., with the teacher and the first author) and were always held on the same day as the project lesson.

In the first project lesson, we asked the teachers to teach as they would normally teach. In the theoretical session, the first author and the teachers (a) discussed the theory of scaffolding and the steps of contingent teaching, (b) watched and analyzed video examples of scaffolding, and (c) discussed and prepared the other four project lessons. In the subsequent project lessons, the teachers in the scaffolding condition gradually worked on improving the quality and frequency of the steps of the MCT. They started with step 1 (i.e., diagnostic strategies) in lesson 2 and progressed to steps 1 *and* 2 (i.e., diagnostic strategies *plus* check of diagnoses) in project lesson 3; then included steps 1, 2, *and* 3 (i.e., diagnostic strategies, check of diagnoses, and intervention strategies); and finally included all four steps of the MCT (i.e., diagnostic strategies, check of diagnoses, intervention strategies, and checking of student learning) in lesson 5. In the corresponding reflection sessions, several video fragments were viewed and discussed in terms of the steps of the MCT of concern for that session and the scaffolding of student learning.

Measures

Lesson observations.

Videotaped fragments in which the teacher discussed subject matter (as opposed to, e.g., metacognitive strategies) with a small group of students (premeasurement and postmeasurement) were selected from our recordings for analysis (Derry et al., 2010). These fragments were called *interaction fragments.* Interaction fragments started when the teacher approached a group and ended when the teacher left the group.

Two interaction fragments from the first project lesson and two interaction fragments from the final project lesson were randomly selected for each teacher and transcribed. The interaction fragments were selected randomly to increase the chances of the selected fragments being representative of the whole corpus of fragments. For an interaction fragment to be selected, the teacher had to help the students (i.e., using step 3 of the MCT). One teacher in the nonscaffolding condition did not have any interaction fragments on the subject matter at all at postmeasurement. Therefore, the interaction fragments of the remaining 29 teachers were used. The total number of selected interaction fragments was 108,[2] consisting of 4,073 conversational turns. A turn consisted of everything a participant said until another participant started to speak.

Steps of contingent teaching.

Each teacher turn in the selected interaction fragments was coded with regard to the steps of contingent teaching. A teacher turn was coded as a diagnostic strategy when the teacher used it "to discover the level of the student's ability to perform without assistance" (Tharp & Gallimore, 1988, p. 59). We defined step 2 (i.e., checking of diagnoses) as a teacher's verification of whether he or she has understood the student correctly and coded teacher turns according to this definition. We coded a turn as an intervention strategy (i.e., step 3) when it contained a strategy aimed at facilitating a student's thinking, such as giving a hint or an explanation. A teacher turn was coded as step 4 when it was aimed at discovering a student's understanding of a concept or theme for which the student had already received assistance in the interaction fragment (cf. Van de Pol, Volman, Elbers, & Beishuizen, 2012). Examples of steps 1, 3, and 4 can be found in Tables 3–6. An example of a turn that was coded as step 2 is the following: "So if I understand you correctly, you think that an internal market is about

[2] If a teacher did not have more than one interaction fragment on the subject matter in a lesson, only that interaction fragment was used in the analyses. Four fragments in total were missing in the scaffolding condition (two at premeasurement, two at postmeasurement), and four fragments in total were missing in the nonscaffolding condition (two at premeasurement, two at postmeasurement).

the market on Saturday?" All teacher turns that could not be coded as step 1, 2, 3, or 4 were coded as no step. A total of 20% of the data was coded independently by two observers to determine the reliability of our coding. With a Krippendorff's alpha of .74, the interrater reliability for coding the steps of contingent teaching was acceptable; Krippendorff (2004) considered an alpha between .66 and .80 as acceptable and one above .80 as good. For the frequency hypotheses (Hypotheses 1a, 2a, and 4a), the percentages of teacher turns reflecting a step of contingent teaching relative to all teacher turns that were coded as one of the four steps of contingent teaching or as no step were calculated for each step for each teacher and on each measurement occasion.

The quality of the teacher turns was specified in two ways. First, the *focus* of the turn was determined for all teacher turns that were coded as step 1, 2, or 4. The focus could be factual, conceptual, or miscellaneous (based in part on Krathwohl, 2002). The focus was coded as eliciting factual knowledge when it addressed the basic elements that students must know, such as terminology and specific details (e.g., "What does internal market mean?"). The focus was coded as eliciting conceptual knowledge when it addressed the interrelationships between the basic elements within a larger structure, such as knowledge of classifications and categories (e.g., "To what extent are the EU and the European Coal and Steel Community similar and different?"). Finally, the focus of a teacher turn was coded as miscellaneous when no answer was elicited at all from the student (e.g., an explanation was given), the turn concerned the ongoing work process (e.g., task order), or the turn addressed off-task issues (e.g., organizational issues).

To establish the interrater reliability of the coding of the focus of a teacher turn, two observers independently coded 20% of the data. With a Krippendorff's alpha of .78, the interrater reliability for the coding of focus was acceptable. The number of turns coded as having a focus on conceptual understanding relative to the total number of turns coded for the particular step of interest was calculated per teacher per measurement occasion. For step 1, for example, we calculated the percentage of step 1 turns that were coded as having a conceptual focus relative to all turns that were coded as step 1.

The second way in which the quality of the teacher turns was assessed was by coding the *mode* of response elicited from the student for all teacher turns that were coded as step 1 or step 4. A teacher could elicit (a) a claim of understanding or not understanding (e.g., "Do you get it?") or (b) a demonstration (e.g., "Can you explain why the EU was founded?"). Teacher turns for which no student responses were elicited were coded as no elicitation. To establish the interrater reliability of the coding of the mode of response elicited by a teacher turn, two observers independently coded 20% of the data. With a Krippendorff's alpha of .66, the interrater reliability for the coding of the mode of response elicitation was acceptable.

Contingency control. Contingency control was assessed using the contingency framework of Van de Pol, Volman, and Beishuizen (2012), which is based on Wood et al. (1978). The degree of control exercised in a teacher support interaction is related to the degree of control in the subsequent teacher support interaction, taking into account students' understanding. The unit of analysis was therefore a teacher turn, a student turn, and the subsequent teacher turn (i.e., a three-turn sequence). As we were interested in the contingency of the teachers' *support,* at least one of the turns of the three-turn sequence needed to be a turn that was coded as step 3 (i.e., intervention strategy). So either both teacher turns in a three-turn sequence were support turns, or the first or the last teacher turn of a three-turn sequence was a support turn and the other turn was a diagnostic strategy (step 1) or a check of student learning (step 4). Coded examples can be found in Tables 3–6.

To establish the contingency of a three-turn sequence (either contingent or not contingent), we applied the rules of the contingency framework to each of the three-turn sequences in the interaction fragments (see Appendix A). If a student's understanding is low, contingent support consists of an increase in control, whereas if a student's understanding is high, contingent support consists of a decrease in control. To be able to apply these rules we first needed to code three variables: the degree of control a teacher exercised in his or her support, the student's understanding, and the student's mode of expression.

First, all of the teacher turns that belonged to a three-turn sequence were coded for the degree of control exercised by the teacher, ranging from 0 to 5, where 0 represented no control (e.g., when the teacher was not with a group of students) and 5 represented high control (e.g., giving the answer; see Appendix B). To establish the interrater reliability, two observers independently coded 20% of all interaction fragments. With a Krippendorff's alpha of .71, the interrater reliability for the coding of the degree of control was acceptable.

Second, all of the student turns that were part of a three-turn sequence were coded with respect to the degree of understanding that was indicated. Each student's understanding was coded into one of the following categories identified by Nathan and Kim (2009) and Pino-Pasternak et al. (2010): miscellaneous, no understanding can be determined, poor/no understanding, partial understanding, or good understanding (see Appendix C). To establish the interrater reliability for student understanding, two observers independently coded 20% of the data. This yielded a Krippendorff's alpha of .69, which could be judged as acceptable.

Third, all of the student turns that were part of a three-turn sequence were coded with respect to the mode of expression. Two categories of responding were distinguished: a claim of understanding (e.g., "I get it") or a demonstration of understanding (e.g., an explanation by a student). This distinction was made because only demonstrations give teachers enough information to act contingently. To establish the interrater reliability for student mode of expression, two observers independently coded 20% of the data. With a Krippendorff's alpha of 1.0, the interrater reliability was considered good (Krippendorff, 2004).

Finally, the rules of the contingency framework were applied to each of the three-turn sequences of the interaction fragments (Appendix A). The percentage of the three-turn sequences (i.e., contingent and noncontingent sequences) that was judged to be contingent was calculated per teacher per measurement occasion and used in subsequent analyses.

Contingency uptake. Contingency uptake was established by coding each teacher turn that was previously coded as intervention strategy (i.e., step 3) as either uptake or no uptake. The unit of analysis was thus the teacher turn. Based on the coding schemes of Wells (2010) and Nystrand et al. (2003), we coded a teacher support turn as uptake if the teacher connected to what students said within that interaction fragment. The teacher could, for example, ask for an elaboration or explanation of what the student just said (i.e., pose a follow-up question) or incorporate a student response into an explanation. In any case, an uptake turn had to elaborate on what a student said or elicit an elaboration from the student. In contrast to both Wells and Nystrand et al., we did not require an explicit acknowledgment of what the student said (e.g., "interesting" or "brilliant") for a turn to be coded as uptake. Elaboration or asking for elaboration was considered acknowledgment of what the student said. A teacher step 3 support turn was coded as no uptake when the teacher did not connect to what the students said within the same interaction fragment. Examples of no uptake are cases in which the teacher *only* acknowledged a student's contribution (e.g., "interesting" or repetition of the student's response) or the teacher *only* gave an evaluation (e.g., "good"). To establish the interrater reliability for contingency uptake, two observers independently coded 20% of the data. This yielded a Krippendorff's alpha of .74, which was considered acceptable. The percentage of teacher support turns coded as uptake relative to the total number of support turns was calculated per teacher and per measurement occasion and was used subsequent analyses.

Cycles of contingent teaching. For each selected interaction fragment we determined what steps were used. We then determined which combinations of steps the teachers used within the fragment. If, for example, a teacher only used diagnostic strategies (step 1) and support (step 3), this teacher's incomplete cycle was coded as 13, regardless of how many times the steps were used. If a teacher used steps 1, 2, 3, and 4, the teacher's cycle was coded as 1234. We then compared the cycles used by the teachers on the two measurement occasions in the scaffolding and nonscaffolding conditions. This analysis had an exploratory and qualitative character. No statistical tests were used given the high number of cycle types found (13, 134, 1234, etc.) and the low number of teachers per cycle type.

Variation within the scaffolding condition. Variation in the enactment of the steps of contingent teaching within the scaffolding condition—and thus how the teachers in this condition responded to the PDP—was analyzed in three phases. First, we grouped the teachers according to the growth in their contingency control and contingency uptake scores between premeasurement and postmeasurement. Taking the mean score of the scaffolding condition at postmeasurement (i.e., 87%) as our starting point, we determined whether the teachers' contingency levels progressed from high (i.e., above average) at premeasurement to high at postmeasurement, from low (i.e., below average) to high, from high to low, or from low to low with respect to contingency control and contingency uptake (16 possibilities). We then brought the number of groups down from 16 to 2 groups: successful and less successful teachers. Successful teachers were those teachers who went from below average to above average for both types of contingency. Less successful teachers were teachers who went from above average to below average or who remained below average for both types of contingency.

Second, we compared the patterns of contingency for the successful and less successful teachers. We explored systematic differences in the frequency and quality of the steps of contingent teaching between the successful and less successful teachers. We compared the means and standard deviations for the percentages of steps 1, 2, 3, and 4 used at premeasurement and postmeasurement for the successful and less successful teachers. We also compared the quality of the steps used in terms of focus (steps 1, 2, and 4) and mode elicited (steps 1 and 4).

Third, we examined the transcripts from the theoretical and reflection sessions using conventional content analysis (Hsieh & Shannon, 2005). In doing this, we looked for explanations for why teachers were more or less successful in enacting contingent teaching. No preconceived codes were used in these analyses of the transcripts. Instead, we carefully read the transcripts and identified teachers' interpretations of scaffolding and statements that illustrated their interpretations and understanding of scaffolding. These analyses were qualitative in nature. No statistical tests were used in these analyses given the low number of teachers categorized as successful and less successful.

RESULTS

An overview of the interaction fragments is presented in Table 2. The total number of interaction fragments decreased from premeasurement to postmeasurement in both conditions. This is presumably because the students had become accustomed to the project and needed less help. Interactions on the subject matter increased in the scaffolding condition, whereas no such increase occurred in the nonscaffolding condition. This is most likely a result of the teachers in the scaffolding condition

TABLE 2
Number of Interaction Fragments on the Subject Matter and Other Interactions

Condition	*Interaction Fragments on the Subject Matter*		*Other Interactions (e.g., on Collaboration, Organization, Procedures)*		*Total*	*Total*
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*
Scaffolding condition	92	131	362	120	454	251
Nonscaffolding condition	91	81	277	214	368	295
Total	183	212	639	334	822	546

Note. Pre = premeasurement; Post = postmeasurement.

being encouraged to focus on contingency at a content level, that is, with regard to the students' understanding of the subject matter. In summary, the students received about the same amount of help at postmeasurement in both conditions; however, the focus of the help differed.

In the following, we provide two examples of interaction fragments for illustrative purposes: a scaffolding example and a nonscaffolding example. The examples show how contingent teaching may appear in the classroom; they are not intended as proof of the effectiveness of the PDP.

Scaffolding Example

Tables 3–5 illustrate (a) the steps of contingent teaching, (b) contingency control, and (c) contingency uptake. The excerpts come from the postmeasurement project lesson of a teacher in the scaffolding condition. Prior to the interaction shown in these excerpts, the students were working on a series of concepts (i.e., the European Economic Community, the European Coal and Steel Community, and the EU). In this interaction, the students mainly deepened their understanding of the concept of community. The teacher encouraged the students to think very actively and made sure that he learned about the students' understanding. He took the students seriously and gave them room to explain their own thoughts and understanding. Eliciting demonstrations seemed to facilitate the teacher to act contingently. After eliciting demonstrations, he was able to adapt the degree of control to the students' understanding and also take up the students' ideas. The different phases of the scaffolding process will be elaborated later.

Nonscaffolding Example

This excerpt comes from the postmeasurement lesson of a teacher in the nonscaffolding condition (Table 6). The students came up with a series of related

TABLE 3
Scaffolding Example

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
1	Student 1 (S1): (raises hand)								
2	Teacher (T): alright, I'm going to listen. What is the state of affairs?	1	mc	d					
3	S1: this								
4	T: this, explain	1	mc	d					
5	S1: well, we have these (points). And we've done these (points)								
6	T: yes	0							
7	S1: we have that one and that one and we've done that one (points)								
8	T: yes, that and that and that, yes?	1	cc	d					
9	S1: EEC, ECSC and the EU								
10	T: yes	0							
11	S1: and then we said that the EU can be left out								
12	T: yes	0							
13	S1: because the EEC and the ECSC are a community								
14	T: yes	0							
15	S1: and the EU isn't, it doesn't say so in the list of concepts								
16	T: alright	0							

17	S1: and we also thought (reads from own work) "because the EEC and ECSC has relations to more other countries than the EU"								
18	T: okay. It is an interesting combination. First, you have to explain why they are related, okay? Can you already do that? Because now you are working on [the next step]	1	cc	d					
19	Student 2: it's all in the EU								
20	T: okay and what?	1	cc	d	1				
21	Student 3: they all start with an E					pu	d	Cc	
22	S1: no! They all start with an E (imitates student 3 with a funny voice)								

Note. EEC = European Economic Community; ECSC = European Coal and Steel Community; EU = European Union.

[a]Step: 1 = diagnostic strategy, 2 = checking the diagnosis, 3 = intervention strategy, 4 = checking students' learning. [b]Focus: mc = miscellaneous, cf = content factual, cc = content conceptual. [c]Mode elicited: ne = no elicitation, cl = claim, d = demonstration. [d]Degree of control: 0 = no control, 1 = lowest level, 2 = low, 3 = medium, 4 = high, 5 = highest. [e]Student understanding: nucd = no understanding can be determined, nu = poor/no understanding, pu = partial understanding, gu = good understanding. [f]Student mode: cl = claim, d = demonstration. [g]Contingency control: NCc = not contingent control, Cc = contingent control. [h]Contingency uptake: NCu = not contingent uptake, Cu = contingent uptake.

TABLE 4
Scaffolding Example, Part 2

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
23	Teacher (T): yes, what. It all begins with an E. that is true, that's what they have in common. That E that's in there, could you also explain to me whether that is always equally large in all those three concepts?	3	cc	d	2				Cu
24	Student 3 (S3): *** European Union is bigger ****								
25	T: once again very clearly so everybody can hear it	0							
26	S3: with this one, that's about the European coal and steel community so that one is more about coals and steel					gu	d	Cc	
27	T: yes, yes, okay (starts counting explicitly with his fingers)	0							
28	S3: and with the EEC, the European Economic Community, that one is about economics					gu	d	Cc	
29	T: yes	0							
30	S3: and the European Union is more about Europe, so					gu	d	Cc	
31	Student 2 (S2): about laws and stuff					gu	d	Cc	
32	T: okay. So they all have an E, if I understand you correctly, they have an E, and student 3 now discovered, with a hint of mine that there is a difference between those three because she says on the one hand it's about, what was it about? (looks at student 2)	4	cc	d	1				
33	S2: eh								
34	Student 1 (S1): coals and steel					gu	d	Cc	

35	T: coals and steel	3	cf	ne	3				NCu
36	S2: economics					pu	d	NCc	
37	S1: Europe and economics					pu	d	NCc	
38	T: okay, so that's a difference, right? So what is the commonality, after this story, in those three concepts? Is that really that E? Or is there something else?	3	cc	d	1				Cu
39	S1: But actually, if you think about it like that, Europe then, it has to do with Europe and not with coals and steel and then one thinks that transports maybe those products to the people who are with the EU. So about Europe, stuff					nu	d	Cc	
40	T: Yes, but that's getting quite complicated with transport and stuff. I think you have a nice series of concepts, those three. But now we will think about what you're going to write down there together. First, we have to think about why they go together and your first point was (reads from the students' work) "the EU can be left out because the others are a community." Isn't the EU a community?	3	cf	d	3				Cu
41	S: it's a union					nu	d	Cc	
42	T: a union. Okay. So you experience the EU different than a community. What is a union in your understanding?	3	cf	d	2				Cu
43	S2: I don't know					nu	cl	Cc	
44	T: and you (student 4), what is a union?	3	cf	d	2				Cu

(*Continued*)

TABLE 4
(*Continued*)

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
45	Student 4: I don't know					nu	cl	Cc	
46	T: you don't know. Student 3, a union?	3	cf	d	2				Cu
47	S3: a club or something?					gu	d	Cc	
48	T: a club, yes, that is a nice one, don't you think? Union-club, club-union	3	cf	ne	3				NCu
49	S1: but then that is actually also a community!					gu	d	Cc	
50	T: here, what did student 1 say? What could thus be a reason why you've put them all together? Because they are all	3	cc	d	4				
51	S1: communities					gu	d	Cc	

Note. EEC = European Economic Community; EU = European Union.

[a]Step: 1 = diagnostic strategy, 2 = checking the diagnosis, 3 = intervention strategy, 4 = checking students' learning. [b]Focus: mc = miscellaneous, cf = content factual, cc = content conceptual. [c]Mode elicited: ne = no elicitation, cl = claim, d = demonstration. [d]Degree of control: 0 = no control, 1 = lowest level, 2 = low, 3 = medium, 4 = high, 5 = highest. [e]Student understanding: 0 = no understanding can be determined, 1 = poor/no understanding, 2 = partial understanding, 3 = good understanding. [f]Student mode: cl = claim, d = demonstration. [g]Contingency control: NCc = not contingent control, Cc = contingent control. [h]Contingency uptake: NCu = not contingent uptake, Cu = contingent uptake.

TABLE 5
Scaffolding Example, Part 3

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
52	Teacher (T): well, student 4, is that conclusion correct?	4	cc	d	3				
53	Student 3 (S3): (nods)								
54	T: can you explain it to me then, in your own words	4	cc						
55	S3: yes, I don't know								
56	T: well, give it a go, what did she say? Something new that makes you think how it all fits together	4	cc						
57	Student 4 (S4): (long pause)								
58	T: why do you read that differently now, that first reason?	4	cc						
59	Student 2 (S2): because we now know that they are all communities								
60	T: yes, and now student 4 once again. What is now the commonality? Why do they go together?	4	cc	d	1				
61	S4: eh, because they, eh, about the European, are about Europe or something?								
62	T: I just heard a word that you've used in your first reason, do you remember that word?	3	cc	cl	3				Cu
63	S4: yes					gu	cl	Cc	
64	T: okay, so now you try to explain why they go together and you use that word	4	cc	d	1				
65	S4: because they are all communities								
66	T: and what does that mean then?	4	cc						
67	S4: I don't know								
68	T: well, explain	4	cc						
69	Student 1 (S1): it's a group								

(*Continued*)

TABLE 5
(*Continued*)

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
70	T: a group and what do they do together? What do you do together?	3	cc	d	3				Cu
71	S4: deliberate					nu	d	NCc	
72	T: deliberate and	3	cc	d	3				NCu
73	S1: communicate					nu	d	NCc	
74	T: communicate, super. What else? What else are you doing?	3	cc	d	3				NCu
75	S2: talking					nu	d	Cc	
76	S1: discussing					nu	d	Cc	
77	T: talking, discussing and coll. . . .	3	cc	d	4				NCu
78	S4: collaborating					gu	d	Cc	
79	T: right, student 4 saw it coming. So that might be the characteristic of a community, yes. So what could it then be? A reason to leave one out or?	4	cc	d	3				Cu
80	S3: eh								
81	S1: to put them together					gu	d	Cc	
82	T: So student 1 and I say that it might be a reason to put them together. Because they are all communities. Alright? Do we have a point? Perfect starting point. Now we know why they go together. Have a look at your reason then.	3	cc	ne	1				

[a]Step: 1 = diagnostic strategy, 2 = checking the diagnosis, 3 = intervention strategy, 4 = checking students' learning. [b]Focus: mc = miscellaneous, cf = content factual, cc = content conceptual. [c]Mode elicited: ne = no elicitation, cl = claim, d = demonstration. [d]Degree of control: 0 = no control, 1 = lowest level, 2 = low, 3 = medium, 4 = high, 5 = highest. [e]Student understanding: 0 = no understanding can be determined, 1 = poor/no understanding, 2 = partial understanding, 3 = good understanding. [f]Student mode: cl = claim, d = demonstration. [g]Contingency control: NCc = not contingent control, Cc = contingent control. [h]Contingency uptake: NCu = not contingent uptake, Cu = contingent uptake.

TABLE 6
Nonscaffolding Example

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
1	Teacher (T): (hears the students talk) very good, which one do you have?	1	cc	d					
2	Student 2 (S2): we have								
3	T: which one do you have?	1	cc	d					
4	S2: we don't know which concept to leave out								
5	Student 1 (S1): no, that isn't so difficult								
6	T: (reads the work of the students) That's a good one. You should also have a look at where they are seated	3	cc	ne	4				NCu
7	Student 3: okay					nucd			
8	S1: o, in Brussels!					nu	1	NCc	
9	T: But you have a clever one because it's also in the correction book. So you really gave it a thought	3	cc	ne	3				NCu
10	S: yes					nucd	0	NCc	
11	T: and these are of course all institutions that have to do with the EU okay? They regulate things.	3	cc	ne	5				NCu
12	Student 4 (S4): okay (to other group members), if you two think about the reasons, then we'll work on the next one								
13	T: no no no, you have to do it together. You have enough time so	3	mc						
14	S4: okay. Eh, let me see								
15	T: but the reason why they go together is clear right?	4	cc	cl	1				
16	(long pause, no student answers)					nucd	0	NCc	

(*Continued*)

TABLE 6
(*Continued*)

Line	*Turn*	*Step*[a]	*Focus*[b]	*Mode Elicited*[c]	*Degree of Control*[d]	*Student Understanding*[e]	*Student Mode*[f]	*Contingency Control*[g]	*Contingency Uptake*[h]
17	T: that they are all institutions related to the EU (points in the booklet)	3	cc	ne	5				NCu
18	S4: let me see (carries on working)					nucd	1	Cc	
19	T: (reads aloud from the book) "they check whether the European committee works well, they design legislations" and eh, sometimes you can also look at what you've learned previously, what else, because these three, European committee, European parliament, how are they put together?	3	cf	d	4				NCu
20	S4: the European committee and ** (inaudible) together constitute the EU					nu	1	NCc	
21	T: yes, but how are they put together? Those different institutions? Are they being elected or are they appointed, have a look at that. Then you can come up with another reason.	3	cc	ne	4				NCu

[a]Step: 1 = diagnostic strategy, 2 = checking the diagnosis, 3 = intervention strategy, 4 = checking students' learning. [b]Focus: mc = miscellaneous, cf = content factual, cc = content conceptual. [c]Mode elicited: ne = no elicitation, cl = claim, d = demonstration. [d]Degree of control: 0 = no control, 1 = lowest level, 2 = low, 3 = medium, 4 = high, 5 = highest. [e]Student understanding: 0 = no understanding can be determined, 1 = poor/no understanding, 2 = partial understanding, 3 = good understanding. [f]Student mode: cl = claim, d = demonstration. [g]Contingency control: NCc = not contingent control, Cc = contingent control. [h]Contingency uptake: NCu = not contingent uptake, Cu = contingent uptake.

concepts: European Parliament, European Committee, and European Council of Ministers. The teacher did not explore the students' current understanding and therefore did not create opportunities for acting contingently. In addition, no explicit concept development occurred in this interaction.

In the following, we present the results of testing the hypotheses regarding the frequency and quality of using each step of contingent teaching and illustrate the results with the scaffolding and nonscaffolding examples.

Testing of Hypotheses

To test the hypotheses, we conducted repeated measures analyses of variance with condition as the between group variable, measurement occasion as the within group variable, and the percentages of each variable of interest as the dependent variable. Interaction effects between condition and measurement occasion were inspected. For significant results, the effect size (partial eta-squared) is reported. We additionally conducted paired *t* tests to investigate increases or decreases in the use of the steps within the scaffolding condition and nonscaffolding condition by comparing premeasurement and postmeasurement. For significant results, the effect size (Cohen's *d*; cf. Cohen, 1992) is reported. For all tests, the assumptions were checked and no indications of violation were found.

Diagnostic Strategies (Step 1)

Hypothesis 1a (teachers in the scaffolding condition increase their use of diagnostic strategies [step 1] more than teachers in the nonscaffolding condition) was not confirmed (Table 7). However, the frequency of using step 1 did increase significantly from premeasurement to postmeasurement *within* the scaffolding condition (large effect size), although this was not the case in the nonscaffolding condition (Table 7).

Hypothesis 1b (teachers in the scaffolding condition increase their use of diagnostic strategies [step 1] aimed at students' conceptual understanding more than teachers in the nonscaffolding condition) was not confirmed (Table 7). In addition, the difference between premeasurement and postmeasurement *within* the scaffolding condition was nonsignificant, which was also the case in the nonscaffolding condition (Table 7).

Hypothesis 1c (teachers in the scaffolding condition increase their use of diagnostic strategies [step 1] in which demonstrations are elicited more than teachers in the nonscaffolding condition) was confirmed (Table 7). The effect size was medium. The teachers *within* the scaffolding condition significantly increased their use of diagnostic strategies that involved the elicitation of demonstrations (large effect size), whereas the teachers in the nonscaffolding condition unexpectedly showed a significant decrease in this (large effect size; Table 7).

TABLE 7
Means and Standard Deviations for the Frequency and Quality of Diagnostic Strategies (Step 1)

	Nonscaffolding Condition (n = 13)				*Scaffolding Condition (n = 17)*			
	Pre		*Post*		*Pre*		*Post*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Frequency (Hypothesis 1a)								
Condition × Occasion, $F(1, 27) = 2.56$, $p = .12$	.11	.08	.16	.10	.13	.10	.25	.09
Within scaffolding condition, $t(16) = -4.01$, $p = .00$; $d = 1$*								
Within nonscaffolding condition, $t(11) = -1.9$, $p = .08$; $d = 0.52$								
Quality—focus								
Miscellaneous	.38	.39	.59	.34	.17	.27	.28	.20
Content factual	.10	.25	.04	.10	.15	.34	.13	.15
Content conceptual (Hypothesis 1b)	.44	.35	.36	.33	.44	.45	.59	.23
Condition × Occasion, $F(1, 27) = 1.6$, $p = .22$								
Within scaffolding condition, $t(16) = -1.67$, $p = .12$								
Within nonscaffolding condition, $t(11) = 0.45$, $p = .66$								
Quality—mode elicited								
No elicitation	.14	.18	.29	.37	.07	.25	.05	.07
Claim	.00	.00	.18	.36	.03	.08	.04	.05
Demonstration (Hypothesis 1c)	.78	.31	.53	.41	.67	.45	.92	.07
Condition × Occasion, $F(1, 27) = 9.78$, $p = .00$; $\eta_p^2 = .27$*								
Within scaffolding condition, $t(16) = -2.28$, $p = .04$; $d = 0.70$*								
Within nonscaffolding condition, $t(11) = 2.3$, $p = .04$; $d = 0.69$*								

Note. Pre = premeasurement; Post = postmeasurement.
*$p < .05$.

No significant interactions between condition and measurement occasion were found for diagnostic strategies (step 1) coded as miscellaneous, content factual, no elicitation, or claim.

Scaffolding example (Table 3). In Table 3, the teacher used many high-quality diagnostic strategies. He focused on the students' conceptual understanding of the relations between concepts and elicited mainly demonstrations of this understanding.

What we (and the teacher) discovered here is that the students could identify a series of related concepts but were confused by the term *community.* They contended that a union (EU) is different than a community (European Economic Community and European Coal and Steel Community). When the teacher took a step back and asked the students to explain what the three concepts have in common (line 18), student 3 made a seemingly superficial remark (line 21), namely, that the concepts all start with an E. This E does, of course, represent something shared (i.e., being European), and the teacher therefore took the comment seriously; he took it up and tried to build upon it with the students (line 32). Thus, starting with a focus on the students' conceptual understanding, this teacher discovered that their factual understanding was not yet sufficient.

Nonscaffolding example (Table 6, lines 1–6). In the first part of this excerpt, the teacher asked some diagnostic questions. However, the questions gave her little insight into the students' actual understanding. She also elicited brief demonstrations, but the students did not have to explain their understanding and the teacher did not persist in encouraging them to do so. In the end, all she found out is what the students had already written down, namely three concepts. We (and the teacher) therefore do not know anything about the students' actual understanding of the concepts.

Checking of Diagnoses (Step 2)

Hypothesis 2a (teachers in the scaffolding condition increase their checking of diagnoses [step 2] more than teachers in the nonscaffolding condition) was confirmed (Table 8). The effect size was small. The increase *within* the scaffolding condition from premeasurement to postmeasurement was significant (large effect size), whereas the use of checks within the nonscaffolding condition remained at the same level (Table 8).

Hypothesis 2b (teachers in the scaffolding condition increase their checking of diagnoses [step 2] aimed at determining students' conceptual understanding more than teachers in the nonscaffolding condition) was not confirmed (Table 8). However, a significant increase in diagnoses aimed at determining students' conceptual understanding from premeasurement to postmeasurement *within* the

TABLE 8
Means and Standard Deviations for the Frequency and Quality of Checks of the Diagnosis (Step 2)

	Nonscaffolding Condition (n = 13)				*Scaffolding Condition (n = 17)*			
	Pre		*Post*		*Pre*		*Post*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Frequency (Hypothesis 2a)	.01	.02	.02	.04	.00	.01	.05	.06
Condition × Occasion, $F(1, 27) = 4.30$, $p = .048$; $\eta_p^2 = .14$								
Within scaffolding condition, $t(16) = -3.50$, $p = .00$; $d = 1$*								
Within nonscaffolding condition, $t(11) = -1.17$, $p = .27$								
Quality—focus (Hypothesis 2b)								
Miscellaneous	.08	.29	.08	.29	.00	.00	.14*	.33
Content factual	.00	.00	.00	.00	.00	.00	.16	.31
Content conceptual	.17	.40	.25	.45	.06	.24	.46	.46
Condition × Occasion, $F(1, 27) = 3.0$, $p = .10$								
Within scaffolding condition, $t(16) = -3.47$, $p = .00$; $d = 0.88$*								
Within nonscaffolding condition, $t(11) = -0.56$, $p = .59$								

Note. Pre = premeasurement; Post = postmeasurement.
*$p < .05$.

scaffolding condition was significant (large effect size), which was not the case for the nonscaffolding condition (Table 8).

No significant interaction effects were found for checks of diagnoses (step 2) that were coded as miscellaneous or content factual.

Scaffolding and nonscaffolding examples.

In both the scaffolding and nonscaffolding examples, the teachers did not check their diagnoses. In the scaffolding example, the teacher could have checked his diagnosis during the transition from the diagnostic phase to the phase where he provided support. The teacher's question in line 32, which is coded as step 4 (checking of student learning), does contain an element of checking the diagnosis when he says

> So they all have an E, if I understand you correctly, they have an E, and student 3 has now discovered, with a hint of mine that there is a difference between those three because she says on the one hand it's about, what was it about?

However, this turn was not coded as a check of the diagnosis (step 2) because the teacher did not allow the students to react (which is a prerequisite for this step). In the nonscaffolding example, we did not see any opportunities for checks of the diagnoses simply because the teacher did not use any diagnostic strategies.

Contingent Support (Step 3)

Hypothesis 3a (teachers in the scaffolding condition show a greater increase in contingency control than teachers in the nonscaffolding condition) was confirmed (Table 9). The effect size was large. The teachers *within* the scaffolding condition increased their degree of contingency control from premeasurement to postmeasurement (large effect size), whereas the level of contingency control in the nonscaffolding condition remained the same (Table 9).

Hypothesis 3b (teachers in the scaffolding condition show a greater increase in contingency uptake than teachers in the nonscaffolding condition) was also confirmed (Table 9). The effect size was medium. The teachers *within* the scaffolding condition significantly increased their degree of contingency uptake from premeasurement to postmeasurement (medium effect size), whereas the level of the teachers in the nonscaffolding condition remained the same (Table 9).

Scaffolding example (Table 4).

In the first part of this excerpt (lines 23–38), we can see that the teacher referred back to the comment made by a student about the E. In addition, the teacher took up this new thought as explained by student 3 in lines 26–30. The teacher was contingent here, as he acknowledged the student's remark and—more important—built upon it to take the students a step further. This action is contingent not only with regard to uptake but also

TABLE 9
Mean Percentages of Contingent Interaction Fragments

	Nonscaffolding Condition (n = 13)				*Scaffolding Condition (n = 17)*			
	Pre		*Post*		*Pre*		*Post*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Contingency control (Hypothesis 3a)	.42	.22	.45	.15	.43	.26	.87	.08
Condition × Occasion, $F(1, 27) = 16.95$, $p = .00$; $\eta_p^2 = .39^*$								
Within scaffolding condition, $t(16) = -7.03$, $p = .00$; $d = 2^*$								
Within nonscaffolding condition, $t(11) = -0.42$, $p = .68$								
Contingency uptake (Hypothesis 3b)	.29	.24	.20	.16	.31	.27	.52	.20
Condition × Occasion, $F(1, 27) = 7.78$, $p = .01$ $\eta_p^2 = .22^*$								
Within scaffolding condition, $t(16) = -2.72$, $p = .02$; $d = 0.65^*$								
Within nonscaffolding condition, $t(11) = -1.38$, $p = .20$								

Note. Pre = premeasurement; Post = postmeasurement.
$^*p < .05$.

with regard to contingency control. The teacher's question in line 18 (part 1 of the first three-turn sequence) was an open-ended, low-control question. The student's answer ("They all start with an E"; line 21, part 2, of the first three-turn sequence) was coded as partially correct because the answer was not what the teacher was looking for but also was not entirely wrong. The teacher's question in line 23 (part 3 of the first three-turn sequence) was somewhat more closed than the question in line 18 but still quite open ended. The teacher's increased degree of control in reaction to the students' partial understanding is what makes this three-turn sequence contingent.

The teacher and the students discussed the differences among the three concepts, and with that discussion, they deepened their understanding of the concepts. The teacher took up this new knowledge in line 32 by asking another student to summarize what was said. In line 38, the teacher took up the thoughts of the students (about the E and the differences among the concepts), weaved these together, and asked what the concepts had in common. He used what the students came up with but also steered the discussion when he saw that their understanding was not deep enough. The teacher and students deepened their understanding of the concept of community together. In line 40, the teacher explicitly asked them whether a union was not the same as a community. When the students stated that they thought that they were different, the teacher further explored the students' understanding of the concepts. In line 49, student 1 showed a deeper understanding of the concept after having listened to the conversation. We can see that the students' understanding of the concept of community has progressed.

In the second bit of this excerpt (lines 38–51), the teacher steered the discussion a bit more as the students were found to not completely understand things; the teacher helped the students discover that a union is the same as a community. Overall, the teacher acted quite contingently with regard to contingency control and contingency uptake.

Nonscaffolding example (Table 6, lines 9–21). In this interaction, the teacher generally used a high level of control, focused mainly on students' conceptual understanding, and elicited only one demonstration of understanding. The teacher tried to draw attention to some aspects of the concepts, particularly (a) the location of each institution, (b) each institution's task, and (c) the composition of each institution. The last aspect contains some information central to the theme of the EU, namely information on democracy. However, these three aspects and the additional aspect of democracy were only briefly touched upon by the teacher and were not further elaborated upon, asked about, or discussed with the students.

In most cases, the teacher acted noncontingently with regard to contingency control and contingency uptake. Given very little elicitation of demonstrations of students' understanding, the teacher had little information that she could use in deciding how to adapt her level of control or that she could take up in the subsequent conversation.

Checking of Student Learning (Step 4)

Hypothesis 4a (teachers in the scaffolding condition increase their checking of student learning [step 4] more than teachers in the nonscaffolding condition) was not confirmed (Table 10). *Within* conditions, the difference between premeasurement and postmeasurement was also nonsignificant (Table 10).

Hypothesis 4b (teachers in the scaffolding condition increase their checking of student learning [step 4] aimed at their conceptual understanding more than teachers in the nonscaffolding condition) was not confirmed (Table 10). *Within* conditions, the difference between premeasurement and postmeasurement was also nonsignificant.

Hypothesis 4c (teachers in the scaffolding condition increase their checking of student learning [step 4] in which demonstrations are elicited more than teachers in the nonscaffolding condition) was confirmed (Table 10). The effect size was medium. The teachers *within* the scaffolding condition significantly increased their degree of demonstration-eliciting checks of students' learning from premeasurement to postmeasurement (large effect size), whereas the frequency of this activity for teachers in the nonscaffolding condition remained the same (Table 10).

No significant interaction effects were found for checks of student learning (step 4) that were coded as miscellaneous, content factual, no elicitation, or claim.

Scaffolding example (Table 5). In the scaffolding example, the teacher used the step of checking student learning (step 4) relatively often. In most cases, the teacher focused on the students' conceptual understanding (i.e., their understanding of the relations between concepts). Furthermore, the teacher mostly elicited student demonstrations; he made sure that the students extensively demonstrated their understanding and involved several students when doing this. In line 54, for example, we can see that the teacher did not accept the claim of understanding that was given in line 53; he elicited a demonstration of understanding of the concept of community from student 3. This can be considered to be a fruitful strategy because both student 3 and student 4 were struggling with this concept. Toward the end of the excerpt the teacher increased his support to make the meaning of *community* clear for the students. However, the remainder of the excerpt is quite noncontingent, as the teacher did not take up students' ideas, did not elicit demonstrations, and exerted too little control in light of the students' lack of understanding. Overall, however, the frequency and quality of the checks of student learning in this example were high.

Nonscaffolding example (Table 6, line 15). In the nonscaffolding example, the teacher only checked student learning on one occasion (line 15). With the posing of a question ("But the reason why they go together is clear, right?")

TABLE 10
Means and Standard Deviations for the Frequency and Quality of Checking of Student Learning (Step 4)

	Nonscaffolding Condition (N = 13)				*Scaffolding Condition (N = 17)*			
	Pre		*Post*		*Pre*		*Post*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Frequency (Hypothesis 4a)	.03	.04	.02	.04	.03	.05	.06	.07
Condition × Occasion, $F(1, 27) = 1.27$, $p = .27$								
Within scaffolding condition, $t(16) = -1.53$, $p = .15$								
Within nonscaffolding condition, $t(11) = 0.10$, $p = .92$								
Quality—focus (Hypothesis 4b)								
Miscellaneous	.33	.49	.23	.43	.17	.34	.26	.40
Content factual	.00	.00	.00	.00	.09	.28	.18	.34
Content conceptual	.00	.00	.01	.04	.09	.26	.26	.35
Condition × Occasion, $F(1, 27) = 1.4$, $p = .24$								
Within scaffolding condition, $t(16) = -1.53$, $p = .15$								
Within nonscaffolding condition, $t(11) = 1$, $p = .34$								
Quality—mode elicited (Hypothesis 4c)								
No elicitation	.02	.07	.00	.00	.00	.00	.00	.00
Claim	.00	.00	.18	.36	.03	.08	.04	.05
Demonstration	.08	.29	.00	.00	.06	.17	.41	.45
Condition × Occasion, $F(1, 27) = 7.46$, $p = .01$; $\eta_p^2 = .22^*$								
Within scaffolding condition, $t(16) = -2.94$, $p = .01$; $d = 0.77^*$								
Within nonscaffolding condition, $t(11) = -1$, $p = .34$								

Note. Pre = premeasurement; Post = postmeasurement.
$^*p < .05$.

the teacher elicited a claim of understanding and not a demonstration. When the students did not respond to the question, moreover, the teacher did not persist in getting a demonstration of their understanding. Instead, the teacher herself provided an explanation of why the concepts go together. The frequency and quality of the use of this step can be considered relatively low in this interaction.

Cycles of Contingent Teaching

In separate analyses, we explored the teachers' use of partial and complete cycles of contingent teaching. Considered across conditions and measurement occasions, an incomplete cycle consisting of steps 1 and 3 occurred most often (Table 11). A cycle consisting of only step 1 occurred just once.

At premeasurement, the teachers in both conditions mostly used step 3 alone or steps 1 and 3. At postmeasurement, this pattern remained similar for the teachers in the nonscaffolding condition, who mostly used steps 1 and 3 but who also used steps 1, 2, and 3 and steps 1, 3, and 4 to some extent. In contrast, the teachers in the scaffolding condition showed a clear shift to more frequent use of a full four-step cycle or a three-step cycle consisting of steps 1, 2, and 3 or steps 1, 3, and 4. Teachers in the scaffolding condition thus made more use of complete cycles of contingent teaching in the end than teachers in the nonscaffolding condition, who still used many incomplete cycles.

TABLE 11
Frequencies of Contingent Teaching Cycles Within Interaction Fragments of Each Condition and Occasion

	Premeasurement		*Postmeasurement*		
Cycle	*Nonscaffolding*	*Scaffolding*	*Nonscaffolding*	*Scaffolding*	*Total*
1[a]	0 (0.00%)[b]	1 (3.23%)	0 (0.00%)	0 (0.00%)	1
3	4 (17.39%)	10 (32.26%)	2 (9.09%)	0 (0.00%)	16
13	11 (47.83%)	11 (35.48%)	12 (59.09%)	6 (18.18%)	40
34	1 (4.35%)	1 (3.23%)	0 (0.00%)	0 (0.00%)	2
123	2 (8.70%)	0 (0.00%)	3 (13.64%)	7 (21.21%)	12
134	4 (17.39%)	7 (22.58%)	3 (13.64%)	8 (24.24%)	22
1234[c]	1 (4.35%)	1 (3.23%)	1 (4.55%)	12 (36.36%)	15
Total	23 (100%)	31 (100%)	21 (100%)	33 (100%)	108

[a]Only diagnostic strategies (step 1) are used within an interaction fragment. [b]Column percentage. [c]Diagnostic strategies (step 1), checks of the diagnosis (step 2), intervention strategies (step 3), and checks of student learning (step 4) are used within an interaction fragment.

Variation Within the Scaffolding Condition

Although the steps of contingent teaching were central to the PDP, the main aim of the program was to increase the contingency of the support teachers provided. Using steps 1, 2, and 4 from the MCT was expected to facilitate the contingency of step 3 (intervention strategies).

As individual teachers can respond differently to the same professionalization program, we next examined the variation *within* the scaffolding condition with regard to the teachers' enactment of the steps of contingent teaching and their contingency. The teachers' development of both types of contingency is represented in Table 12. The teacher in the upper left corner of Table 12, for example, started with above average levels of both contingency control and contingency uptake (he thus adapted his degree of control to a great extent to students' understanding and took up students' ideas to a great extent as well) and remained above average (and thus highly contingent) for both types of contingency.

From Table 12, it can be seen that the majority of the teachers in the scaffolding condition went from below average to above average for contingency control ($n =$ 13 out of 17). For contingency uptake, quite a few of the teachers remained below average ($n = 7$ out of 17), whereas 5 out of 17 went from below average to above average.

The PDP was unequivocally successful for four teachers who started with below average levels of contingency control and contingency uptake at premeasurement but showed above average levels at postmeasurement. The PDP proved less successful for only two teachers. Most of the teachers in

TABLE 12
Development From Premeasurement to Postmeasurement With Regard to Contingency Control and Contingency Uptake of Teachers Within the Scaffolding Condition: Numbers of Teachers

	Contingency Uptake (M = 52%)				
Contingency Control (M = 87%)	*Pre-High, Post-High*	*Pre-Low, Post-High*	*Pre-High, Post-Low*	*Pre-Low, Post-Low*	*Total*
Pre-high, post-high	1				1
Pre-low, post-high	2	4[a]	1	6	13
Pre-high, post-low					
Pre-low, post-low		1	1[b]	1[b]	3
Total	3	5	2	7	17

Note. "High" means above the average contingency score at postmeasurement in the scaffolding condition; "low" means below this average.

[a]For these teachers, the program was successful.

[b]For these teachers, the program was less successful.

the scaffolding condition either increased to above average or remained above average with regard to at least one of the two types of contingency. One teacher remained above average on contingency uptake but decreased on contingency control.

Patterns of contingency for successful and less successful teachers. Ron, one of the two less successful teachers in our study, remained relatively low with regard to contingency control and contingency uptake (contingency control went from 64% to 81%; contingency uptake went from 18% to 44%), with a relatively high degree of contingency control at postmeasurement. Yet it was still lower than the group average (i.e., 87%) at postmeasurement. Although Conny, the other less successful teacher in our study, increased the degree of contingency control to a considerable amount (from 38% to 67%), she nevertheless showed the lowest contingency control score in the scaffolding condition at postmeasurement.

The average score of the successful teachers for contingency control at premeasurement was 37% (*SD* = 33%); at postmeasurement it was 86% (*SD* = 4%). The average increase was thus considerable at 49% (*SD* = 30%). The average score for contingency uptake at premeasurement was 14% (*SD* = 16%); at postmeasurement it was 72% (*SD* = 11%). The average increase was thus considerable here as well at 58% (*SD* = 21%).

A noteworthy pattern was detected when we compared the *frequency* of the use of the steps of contingent teaching for the more and less successful teachers. With regard to diagnostic strategies (step 1), the less successful teachers increased their use (from 26% [*SD* = 5%] to 34% [*SD* = 2%] on average), whereas use among the successful teachers remained more constant (from 23% [*SD* = 8%] to 26% [*SD* = 9%] on average).

What is surprising is that less successful teachers decreased their use of intervention strategies (step 3) much more compared to successful teachers. The percentage of steps coded as intervention strategy (step 3) for the less successful teachers went from 50% on average (*SD* = 10%) to 29% on average (*SD* = 13%), whereas for the successful teachers the percentage of intervention strategies remained about the same on average (from 41% [*SD* = 16%] to 43% [*SD* = 12%]). Changing the amount of support provided was not an aim of the PDP and was therefore not addressed in a hypothesis. Yet it seems that participation in the program had an unintentional negative effect for the less successful teachers who decreased their provision of support.

The overall use of step 2 (checking of diagnoses) and step 4 (checking of student learning) remained relatively low for both the successful and less successful teachers (between 0% and 17% for step 2 and between 0% and 5% for step 4).

With regard to the *quality* of the steps, the teachers in both conditions only differed, and then considerably, with regard to the checking of student learning (step 4). Successful teachers checked student learning via elicitations of demonstrations of understanding more often at postmeasurement ($M = 63\%$, $SD = 48\%$) than less successful teachers at postmeasurement ($M = 17\%$, $SD = 23\%$).

In summary, less successful teachers increased their use of diagnostic strategies (step 1) and decreased their provision of support (step 3), whereas successful teachers were relatively stable in their use of diagnostic strategies (step 1) and their provision of support (step 3). Successful teachers elicited demonstrations when checking student learning much more often than less successful teachers.

Looking at the reflection sessions, we can see that both the successful teachers and the less successful teachers initially mentioned the same confusion about scaffolding: They mistakenly thought that it is not appropriate to provide the answer or prompt the student when scaffolding. However, the successful teachers dealt differently with this confusion than the less successful teachers. When reflecting on his first lesson, Harry, one of the successful teachers, said, "I am dragging [providing very low control]; I am pulling to get an answer but they're not coming up with anything. I don't know what I can do to scaffold her." After the first author explained to Harry that teacher regulation or prompting *can* also be scaffolding, depending on the students' needs, and after watching another lesson fragment, Harry again saw himself "dragging without helping." But he then recognized the suitability of prompting, which he had previously considered unsuitable. He concluded with, "Wow, what an insight all of a sudden." Harry and most of the other successful teachers realized that giving prompts or explanations can also be scaffolding, but *only* if the students cannot do it by themselves. The result was giving support and prompts as needed and pulling back when the students could clearly do things themselves or, in other words, acting *contingently.*

Conny, one of the less successful teachers, concluded the theoretical session with the following: "But now I will think, every time I want to support them, I can't say anything." In all of the reflection sessions, it was extensively discussed that steering and prompting *could* be appropriate (if more direction is what students needed). Yet Conny kept feeling that she could not prompt students. This might be the reason she gave *less* support in the last lesson rather than more. In her interpretation, scaffolding meant students coming up with answers without being helped. In the last lesson (i.e., postmeasurement) both of the less successful teachers extensively diagnosed student understanding. Yet even if it became clear that students were struggling and having problems, neither of the teachers provided constructive support, and they just instructed the students to keep working themselves or to try again. *If* support was provided, it was mainly in the form of feedback, indicating what was correct or incorrect.

DISCUSSION AND CONCLUSION

In this study, we investigated the extent to which and how working with the MCT promoted teachers' scaffolding behavior compared to not working with the

MCT. The MCT consists of four steps: (a) diagnostic strategies, (b) checking of diagnoses, (c) intervention strategies, and (d) checking of student learning. Whereas previous scaffolding studies have mostly used highly structured tasks in one-to-one tutoring or lab situations, we studied the use of scaffolding in the actual classroom using open-ended and thus not highly structured tasks. We conducted an experimental study in a classroom setting, which is rare in scaffolding research.

Working with the MCT facilitated contingent teaching for the majority of the participating teachers, whereas teachers who did not work with the MCT did not show such progress. Relative to the teachers in the nonscaffolding condition, most teachers in the scaffolding condition significantly improved the quality of their diagnostic strategies (eliciting demonstrations of understanding instead of just claims), the quality of their checks of students' learning (eliciting demonstrations of understanding instead of just claims), and the quality of their support (adapting their degree of control contingently to students' understanding and in taking up students' ideas in the ongoing conversation; Table 13).

The teachers in the scaffolding condition did not significantly increase their use of diagnostic strategies (step 1) more than the teachers in the nonscaffolding condition. Yet the increase *within* the scaffolding condition from premeasurement to postmeasurement was significant, whereas this was not the case in the nonscaffolding condition. As our sample size is from a statistical perspective relatively small, revealing significant effects is difficult. Still, our hypothesis about the use of step 1 could not be confirmed. Using diagnostic strategies (step 1) was promoted by the PDP in this study mainly in terms of quality. Teachers in the scaffolding condition elicited more extensive answers (i.e., demonstrations) from students when diagnosing their actual understanding. The step of diagnosing student understanding is considered very difficult by teachers (e.g., Wittwer & Renkl, 2008). But it is also one of the most important teaching skills (e.g., Seidel & Shavelson, 2007). It is thus a contribution of this study that a way to improve this skill has been developed, namely, by developing the PDP presented here.

TABLE 13
Overview of the Findings of the Study

Step	*Frequency*	*Quality—Focus (More on Conceptual Level)*	*Quality—Mode (More Demonstrations)*
Diagnostic strategies (step 1)	1a: + (*ns*[a])	1b: + (*ns*)	1c: + (Sig)
Checks of diagnoses (step 2)	2a: + (Sig[b])	2b: + (*ns*)	
Intervention strategies (step 3)		3a: Contingency control: + (Sig) 3b: Contingency uptake: + (Sig)	
Checks of student learning (step 4)	4a: + (*ns*)	4b: + (*ns*)	4c: + (Sig)

[a]Not significant. [b]Significant.

The step checking of diagnoses (step 2) was used more often by the teachers who participated in the PDP than the teachers who did not participate in the PDP. The frequency of this step nevertheless was relatively low. This is similar to the findings of Knežiç (2011), who also reported that the use of this step increased but remained relatively low. Investigation of the attitudes of teachers toward this step of the MCT in the future might prove useful, as teacher attitudes are known to be highly related to their behavior (Avalos, 2011). Previous research has shown, moreover, that teachers who have a negative attitude toward this step of checking diagnoses also tend to do this less often than teachers who have a positive attitude toward this step in the MCT (Van de Pol, Volman, & Beishuizen, 2012).

The most prominent finding in our study is that the degree of contingency increased significantly for those teachers who worked with the MCT. Adapting support to student understanding and building upon student understanding have been shown in previous research to be difficult for teachers (e.g., Ruiz-Primo & Furtak, 2007). Teachers appeared to become more contingent by using more complete cycles of contingent teaching. Teachers who were less successful at contingent teaching started to use more diagnostic strategies (step 1) during the study but gave less support (step 3) and thus left students more often to their own devices. Although most teachers initially experienced some confusion about the scaffolding process, and sometimes assumed that teachers should not give prompts when scaffolding, the less successful teachers in our study did not overcome that confusion. This may explain the aforementioned pattern of increased diagnosis but decreased support. Future research should investigate why some teachers do not overcome this confusion about the scaffolding process, and further professional development on scaffolding should address this stumbling block as well.

The checking of student learning (step 4) was promoted by the PDP mainly with regard to the quality of eliciting demonstrations of student understanding and not the frequency of checking. Previous research has shown that when checking student learning, teachers typically elicit short answers (Kao et al., 2011). The development of a PDP that increases the quality of checking student learning is thus a major contribution of the present study.

Overall, the increase in the quality of the teachers' steps of contingent teaching for teachers who worked with the MCT mainly entailed more frequent eliciting of demonstrations and not so much a shift of focus to conceptual understanding. It is conceivable that exploring and checking students' conceptual understanding *and* simultaneously considering how to use the gathered information in the support was just too much, causing cognitive overload (Feldon, 2007). Future research should explore methods to reduce cognitive load for teachers by, for example, building visual representations of students' understanding together with the students. It is also possible that a shift toward a focus on students' conceptual understanding did not take place because staying at a factual level may have been the right level of scaffolding for the students. Precisely because the teachers in the scaffolding condition elicited student demonstrations before giving them support, they may have discovered that moving to a conceptual level was not yet justified. Particularly for the teaching of substantive concepts, scaffolding and especially diagnosing and eliciting student demonstrations of understanding seem to represent a valuable teaching approach. Scaffolding can clearly illuminate student understanding of rather abstract and theoretical concepts.

Limitations

The duration of the present intervention was relatively brief: 8 weeks. The teachers in the scaffolding condition had four lessons to practice their new skills. Slavin (2008) advised a duration of at least 12 weeks for an intervention, as changing one's teaching practices is known to be difficult and time consuming (Loucks-Horsley & Matsumoto, 1999). A longer program that gives the teachers more opportunities to practice the steps of contingent teaching and reflect upon their lessons thus appears to be called for. However, the PDP is already quite labor intensive. The first author filmed five lessons for each of the participating teachers and reflected on these lessons together with the teacher as part of the PDP. As reviews of the characteristics of effective PDPs indicate (e.g., Loucks-Horsley & Matsumoto, 1999; Timperley, 2007; Van Veen et al., 2012), working collaboratively in a community (e.g., with colleagues) can be very effective, especially if discussion is facilitated well (Zhang, Lundeberg, & Eberhardt, 2011). Future research should therefore consider the possibility of integrating this aspect of collaboration into the current PDP; this would reduce the workload for the facilitator while allowing the length of the program to be increased.

Quasi-experimental studies naturally suffer from unexpected events that happen in practice. Given that we disturbed existing routines in the scaffolding condition in particular, it is possible that the teachers had to cope with too much at the same time. Classroom order is, for example, most likely to be a necessary condition for scaffolding to occur. However, keeping order in a classroom may be made more difficult by changing practices.

Although it is known that newly learned skills will fade over time when not accompanied by sustained support (Van Es & Sherin, 2010), we found that teachers who had worked with the MCT in our previous study over a longer period of time still implemented contingent teaching even after a holiday break (Van de Pol, Volman, & Beishuizen, 2012). Nevertheless, a valuable next research step would be to investigate the long-term effects of working with the MCT on teachers' sustaining of contingency.

Conclusion

We have shown the MCT to be an effective tool for promoting teachers' scaffolding of student learning. The observed increases in the quality of the diagnostic strategies used and the contingency of teachers' support are particularly noteworthy, as these are known to be not only highly difficult but also crucial teaching skills (e.g., Ausubel, 1986; Ruiz-Primo & Furtak, 2007).

The results of this study contribute to both educational research and teaching practice. They have contributed to our understanding of how teachers learn to scaffold. We concretized the scaffolding process into discrete steps of contingent teaching and showed that working with these steps can result in more than just using the steps: For many of the teachers in our study, practice with the steps of the MCT resulted in the provision of contingent support. We have thus gained insight into the development of contingent teaching and have developed concrete tools for promoting contingent teaching. The MCT provides a useful tool for both initial teacher training and continuing professional development.

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APPENDIX A: CONTINGENT SHIFT FRAMEWORK

TABLE A1
Contingent Shift Framework

	Three-Turn Sequence[a]			
Sequence	*Teacher Turn 1*	*Student Turn—Demonstration*	*Teacher Turn 2*	*Contingency*
First three-turn sequence	TDc0 (teacher not yet there)	SU0	TDc1 or TDc2	Contingent
		SU1		Contingent
		SU2		Not contingent
Middle three-turn sequences	TDc1 to TDc4	SU0	More in control than in turn 1	Contingent
		SU1		Contingent
		SU2		Not contingent
	TDc2 to TDc5	SU0	Less in control than in turn 1	Not contingent
		SU1		Not contingent
		SU2		Contingent
	TDc2 to TDc4	SU0	Same level of control as in turn 1	Not contingent
		SU1		Contingent
		SU2		Not contingent
	TDc5	SU0	TDc5	Contingent
		SU1		Contingent
		SU2		Not contingent
	TDc1	SU0	TDc1	Not contingent
		SU1		Contingent
		SU2		Contingent
Last three-turn sequence	TDc1 to TDc4	SU0	TDc0 (teacher walks away) or TDc1 (lowest level control)	Not contingent
		SU1		Not contingent
		SU2		Contingent

Note. Teacher's degree of control (TDc): TDc0 = no control, TDc1 = lowest control, TDc2 = low control, TDc3 = medium control, TDc4 = high control, TDc5 = highest control. Student understanding (SU): SU0 = poor understanding, SU1 = partial understanding, SU2 = good understanding.

[a]A three-turn sequence consists of three subsequent turns: teacher turn – student turn – teacher turn.

If no understanding can be determined (SUX)
SUX -> A demonstration needs to be requested

- TDc5 – SUX – TDc5 = NOT CONTINGENT
- TDc1-TDc4 – SUX – TDc5 = NOT CONTINGENT
- TDc1-TDc5 – SUX – TDc1-TDc4 = CONTINGENT
- TDc1-TDc5 – SUX – TDc0 = NOT CONTINGENT

Contingency rules: the degree of control for claims of understanding (SM0)

- Claim of not understanding (SM0/SU1)—First time
  Not taking SM0/SU1 for granted but asking for a demonstration = stay at the same level or lower level
  - TDc1 – SM0/SU1 – TDc1 = CONTINGENT
- SM0/SU1 second time by same student
  Increase level of support = CONTINGENT
- Claim of understanding (SM0/SU3) or partial understanding (SM1/SU2)
  Never take for granted, always ask for a demonstration with TDc1 or the same level as in the previous turn
  - TDc1 – SM0/SU2 or SM0/SU3 TDc1 = CONTINGENT

Exceptions

- In the first three-turn sequence of an interaction fragment (that always starts with TDc0), only inquiring into the level of the student (TDc1 or TDc2) is considered contingent
- Jumping from TDc0 or TDc1 to TDc5 is NOT CONTINGENT
- In a given scenario, the teacher asks about the meaning of, for example, two concepts. First he asks about one concept, and if the student gives a correct response, the teacher can use the same level of control in asking about the next concept. For example:
  - TDc2 – SU3/SM1 or SM2 – TDc2 = CONTINGENT
- If TDc3 is feedback (without extra info), going up (increasing control) after SA3 is CONTINGENT. For example:
  - TDc1 – SU3/SM1 or SM2 – TDc3 = CONTINGENT
- If the teacher stays at level 2 and provides feedback the first time but not the second time, this is contingent. For example:
  - TDc2 – SU3/SM1 or SM2 – TDc2 = CONTINGENT
- If a teacher ignores what a student or students said
  = NOT CONTINGENT

- If there is no three-turn sequence at the end but instead the teacher walks away without having given an demonstration of SA3 in the last two coded student responses (not SUX or SUNOC) = NOT CONTINGENT
- TDc1/2 – SU1/SM1 – TDc1/2: first time = CONTINGENT
  second time = NOT CONTINGENT

APPENDIX B

TABLE B1
Levels of Teacher Degree of Control (TDc)

Category	*Description*	*Code*
No control/no support	Teacher absent	TDc0
Lowest control	The teacher • Provides no new content • Elicits an elaborate response • Asks a broad and open question e.g., Why do these three concepts together?	TDc1
Low control	The teacher • Provides no new content • Elicits an elaborate response, mostly for an elaboration or explanation of something (“why” questions) • Asks a more detailed but still open question e.g., What do you think internal market means?	TDc2
Medium control	The teacher • Provides no new content • Elicits a short response (yes/no or choice) e.g., What came first, the European Union or the European Coal and Steel Community?	TDc3
High control	The teacher • Provides new content • Elicits a response • Gives a hint or suggestive question e.g., (When talking about the meaning of internal market): Think about trade.	TDc4
Highest control	The teacher • Provides new content • Elicits *no* response • Gives an explanation or the answer to a question e.g., Internal market means free traffic of goods, people, and services.	TDc5

Note. TDc0 = 0; TDc1 = 1; TDc2 = 2; TDc3 = 3; TDc4 = 4; TDc5 = 5.

APPENDIX C

TABLE C1
Levels of Student Understanding (SU)

Category	*Description*	*Code*
Not on content	The student's turn is not on the subject matter (e.g., about the task, personal matters).	SUNOC
No understanding can be determined	The student's turn is on the subject matter but no understanding can be determined because, for example, no reasons are given and more answers are possible; depending on the reason, the student does not finish his/her sentence; the student reads aloud from the book; etc.	SUX
Poor/no understanding	The student demonstrates or claims poor or no understanding, for example, what a student says is evaluated wrong by the teacher, the student is not able to formulate an answer (but makes an attempt), the student requests an explanation, etc.	SU1
Partial understanding	The student demonstrates or claims partial understanding, for example, when the student omits a crucial part of what is considered the correct answer by the teacher.	SU2
Good understanding	The student demonstrates or claims good understanding.	SU3

Note. SUNOC = noc; SUX = nucd; SU1 = nu; SU2 = pu; SU3 = gu.