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Patterns of contingent teaching in teacher–student interaction

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Abstract

The present study aimed at investigating the process of scaffolding in a naturalistic setting with focus on a key aspect of scaffolding, namely contingency. Three Social Studies teachers in innovative prevocational schools were observed and interviewed. A coding scheme for the measurement of scaffolding was developed which revealed different patterns of contingent and non-contingent teaching amongst the teachers. In general these teachers of innovative schools showed little contingent teaching. Not adapting the support to students' current understanding and barely diagnosing the students' understanding appeared to be characteristic of this scarcity of non-contingent teaching.

Keywords: Scaffolding; Contingent teaching; Diagnosis; Teacher–student interaction; Prevocational education

1. Introduction

Although scaffolding is considered an effective teaching method, it appears to be rather scarce in classrooms (Van de Pol, Volman, & Beishuizen, submitted for publication), mainly because it is so difficult to perform. Scaffolding is strongly related to the sociocultural theory of Vygotsky (1978) and what he describes as the Zone of Proximal Development (ZPD). According to Vygotsky (1978), learning occurs within the ZPD, which indicates what a student cannot do independently as yet but is nevertheless within his or her reach when guidance is provided. The provision of guidance within the student's ZPD has been referred to as scaffolding by Wood, Bruner, and Ross (1976). Cazden (1979) was the first to relate ZPD to scaffolding and suggest that the metaphor be expanded from the domain of parent–child interactions to teacher–student interactions. Borrowed from construction work, the metaphor of scaffolding refers to assistance which "enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (Wood et al., 1976, p. 90).

The concept of scaffolding has been used extensively over the last decades because it highlights one of the key aspects of children's learning, namely that it is often "guided by others" (Stone, 1998, p. 351). In educational practice, scaffolding is also found to be an appealing metaphor (Saban, Kocbeker, & Saban, 2007). In a literature review (Van de Pol et al., submitted for publication) in which the extensive scaffolding literature of the last decade is reviewed, three main characteristics of scaffolding are distinguished: (1) contingency, (2) fading, and (3) transfer of responsibility.

Within the context of the present study, scaffolding is viewed as the temporarily contingent (i.e., being responsive to the current level of the student) support provided by a teacher to a student during the performing of a task which the student might otherwise not be able to complete. To realise such support, the teacher temporarily takes over parts of the student's task with the goal of transferring the responsibility for the task back to the student at a later point in time. In many studies (Many, Dewberry, Taylor, & Coady, 2009; Murphy & Messer, 2000; Pratt & Savoy-Levine, 1998; Wood, Wood, & Middleton, 1978) contingency is seen as a key feature in the process of scaffolding. If a teacher scaffolds a student and is thus teaching contingently, the support should be faded and the responsibility for the task at hand should be transferred to the student. Therefore, contingency is seen as a prerequisite

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for scaffolding and key characteristic of scaffolding. For that reason, we focus on this key aspect of contingency in this study.

Few systematic analyses of the use of scaffolding in naturalistic classroom settings are available. A description based on a systematic analysis of the scaffolding process in such a classroom setting is therefore the main objective of this article.

1.1. Contingent teaching as a key characteristic of scaffolding

For contingent teaching, the teacher can utilise several tools such as diagnostic strategies and various intervention strategies. Ongoing diagnosis as an element of scaffolding allows the teacher to teach contingently (Puntambekar & Hübscher, 2005). This phenomenon was already mentioned by Dewey (1900) who argued that the diagnosis of a child's capacities should provide the starting point for instruction. Such diagnosis should thus determine the type and level of support to be provided by the teacher.

The actual support and intervention strategies employed, as part of the contingent teaching, have received much more attention in the empirical scaffolding literature than the ongoing diagnosis of student understanding. Numerous scaffolding intervention strategies are described in the literature such as modelling and explaining. Both Tharp and Gallimore (1988) and Wood et al. (1976) have presented useful classifications of the various scaffolding tools and functions. Tharp and Gallimore (1988) describe six means of assisting performance, namely: (a) modelling, (b) contingency[1] management, (c) feeding back, (d) instruction, (e) questioning, and (f) cognitive structuring. Wood et al. (1976) also describe six scaffolding functions: (a) recruitment, (b) reduction of degrees of freedom, (c) direction maintenance, (d) marking of critical features, (e) frustration control, and (f) demonstration. These classification systems have frequently been used to study the scaffolding process.

Both diagnostic and intervention strategies are necessary for contingent teaching and thus for scaffolding. Although consideration of both the diagnostic strategies and the intervention strategies used by teachers is typically not undertaken in the scaffolding literature, this is actually done in research on informal formative assessment. The focus of such assessment is on the gathering of information about the learning of the student in any teacher–student interaction or so-called assessment conversation (Bell & Cowie, 2001). Shepard (2005) is one of the few to make the important link from formative assessment to scaffolding so that the aspect of diagnosis as part of scaffolding can be more developed. More recently, Ruiz-Primo and Furtak (2006, 2007) have developed a model to examine the assessment and instructional conversations of teachers with students, in which they include diagnosis and contingent intervention (respectively eliciting and using in their model). For the purposes of the present study, it was decided to adapt this model (see Fig. 1).

The teacher first elicits student responses via the application of diagnostic strategies. In such a manner, information is gathered on students' current conceptions, available strategies and so forth. The student responses, thus, indicate their understanding and give the teacher a basis on which to decide whether enough is known about the student's capacities, or whether additional diagnostic strategies or a check of the diagnosis should be applied. In the second phase of contingent teaching, the teacher thus verifies whether he or she has understood the student correctly. Thus, the contributions of a student are acknowledged by the teacher (third step in the model of Ruiz-Primo & Furtak, 2007). In the present study an explicit checking of the diagnosis to this model was added because such checking can help both the teacher and the student to establish a shared understanding or so-called intersubjectivity. Biemiller and Meichenbaum (1998) argue that insufficient attention has been paid to such intersubjectivity in connection with teacher scaffolding. After that, the actual support or intervention can be initiated on the basis of the student's responses and understanding. The phases as depicted in Fig. 1 are the visible steps, which a teacher can take. Although teachers do not always follow this path, students of teachers who enact more complete cycles perform better on their science task compared to students of teachers with less complete cycles (Ruiz-Primo & Furtak, 2007).

Contingent teaching appears to be scarce. Ruiz-Primo and Furtak (2006, 2007) found that full cycles of what we call contingent teaching are less prevalent than unfinished cycles (non-contingent). Being contingent, that is, using the information about the knowledge of the students that is gathered thus seems to be the main difficulty for teachers. Nathan and Kim (2009) reported that the teacher who participated in their study showed over half the time no adjustment to the level of the student (non-contingent) when teaching mathematics in a whole-class, small-group and one-to-one setting. Elbers, Hajer, Jonkers, Koole, and Prenger (2008) and Lockhorst, van Oers, and Wubbels (2006) indicated that they encountered no phase of common problem definition or diagnosis in the observed teacher–student interactions.

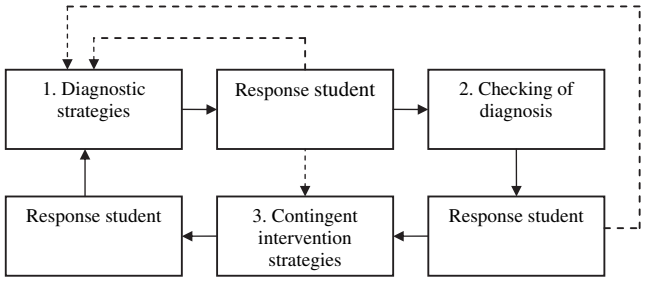

Fig. 1. Observable phases of contingent teaching (adapted from Ruiz-Primo & Furtak, 2007).

[1] The term "contingency" refers to giving rewards and punishments "depending on whether or not the behaviour is desired" (Tharp & Gallimore, 1988, p. 51).

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Without this phase, contingent teaching can hardly take place.

1.2. Scaffolding intentions and means

In the scaffolding literature, a distinction is sometimes made between how scaffolding takes place (means) and what is scaffolded (goals or intentions) (Many, 2002; Silliman, Bahr, Beasman, & Wilkinson, 2000). Different means can be used with different intentions. Drawing upon the six means of scaffolding proposed by Tharp and Gallimore (1988) and the six scaffolding functions outlined by Wood et al. (1976). Van de Pol et al. (submitted for publication) created a framework of analysis in which the distinction between means and intentions is made. The analytic framework was adopted for the aims of the present study (see Appendix A). It distinguishes three main categories of scaffolding means on the vertical axis of Appendix A, namely diagnostic strategies, checking of a diagnosis, and intervention strategies. It also distinguishes three main categories of scaffolding intentions on the horizontal axis of Appendix A, namely scaffolding students' metacognitive activities, scaffolding students' cognitive activities, and scaffolding students' affect.

Regarding the three categories of scaffolding means, the first category (i.e., diagnostic strategies) includes teacher's posing of questions (questioning) and reading of students' work (reading), whereas the second category (i.e., checking of diagnosis) includes only questioning. The third category (i.e., intervention strategies; see Appendix B), on the other hand, involves a variety of strategies, such as feedback, hints, instructing, explaining, modelling, questioning, and others.

The three categories of scaffolding intentions also comprise subcategories (see Appendix C). Specifically, within the first category (i.e., scaffolding students' metacognitive activities) support of the student's approach to a task (A) can be found. In the second category (i.e., scaffolding students' cognitive activities) support in the form of the presentation and discussion of general principles (B) and support on the content of the subject-matter (C) can be found. The task is partly taken over by the teacher, but the student still has to perform the task. The third main category (i.e., scaffolding students' affect) includes recruitment of student interest in the task (D) and frustration control, that is, seeing that a task is not too easy or too difficult for a student (E).

1.3. The present study

All empirical studies mentioned in this section showed that contingent teaching is an effective teaching approach. However, many studies on contingent teaching (Murphy & Messer, 2000; Pratt & Savoy-Levine, 1998; Wood et al., 1978) were performed in a one-to-one tutoring setting with relatively simple tasks, whereas Ruiz-Primo and Furtak (2006, 2007) focused on whole-class teaching. In the present study, scaffolding was studied in a naturalistic classroom setting with all sorts of tasks (both open-ended tasks and simple/straightforward tasks). It was decided to undertake a descriptive study as this allows the process of scaffolding and particularly the concept of contingency to be examined in considerable detail. The focus was on the one-to-one and small-group teacher–student interactions of three participating teachers because whole-class scaffolding is complicated by the multitude of ZPDs in the classroom (Hogan & Pressley, 1997).

These one-to-one and small-group teaching practices were studied by using the framework of analysis proposed by Van de Pol et al. (submitted for publication) with a focus on the three scaffolding means of contingent teaching, namely, diagnostic strategies, checking of a diagnosis, and intervention strategies.

1.4. Research question – hypotheses

The teacher–student interactions were analysed in light of the presented model in Fig. 1 with a focus on the contingency of the teacher's support in order to answer the following research question: ''What patterns of contingent and non-contingent teaching can be distinguished in teacher–student interactions in terms of diagnostic strategies, checks on diagnoses and various intervention strategies?'' With regard to these patterns we had specific expectations which are elaborated below.

The aforementioned studies in which contingent teaching was found to be scarce took place in more traditional schools in which the teacher is mainly expected to lecture in order to transmit knowledge. To gather as many instances of contingent teaching as possible, we chose to observe teachers in innovative schools[2] because in such schools the role of the teacher has changed towards supporting autonomous student learning (see also Nie & Lau, in press), which is also a major aim of scaffolding. Because of this changed teacher role, it was expected that relatively many instances of contingent teaching are to be found rather than of non-contingent (Hypothesis 1), contrary to what is usually found in more traditional schools.

Furthermore, the main difficulty for teachers seems to be not the use of diagnostic strategies itself but giving support (i.e., applying intervention strategies) by using the diagnostic knowledge of the student that has been gathered (see Ruiz-Primo & Furtak, 2006, 2007). Therefore, in light of the model depicted in Fig. 1, it was expected that making use of the knowledge of students collected through diagnostic strategies and diagnostic checks will be absent in non-contingent

[2] There are three different types of innovative schools in the Netherlands (Monitor Onderbouw, 2006). 'Scenario 2' schools are least innovative, that is, the curriculum is organised in separate subjects as well as projects that integrate several subjects. 'Scenario 3' schools integrate subjects such as Geography, History, and Economics into one subject area called Social Studies. Self-regulated learning and cooperative learning are important in this type of schools. 'Scenario 4' schools do not take the subjects as a starting point for learning but the competences of children. The participating schools in this study are 'Scenario 3' schools.

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interactions, not the diagnostic strategies themselves (Hypothesis 2).

Finally, it was expected that the more the teacher's contingent interactions are the greater the variation in scaffolding approaches used (i.e., any combination of a scaffolding means with a scaffolding intention). A greater repertoire of scaffolding approaches will enable a teacher to tailor the support contingently to the needs of the student.

2. Method

2.1. Participants

The three schools participating in this study were secondary education innovative schools of lower prevocational education ('Scenario 3' schools) that belonged to the network of the institute of the authors and were spread over the country. At each school there was only one Social Studies teacher and this course was taught in the first class of 'Scenario 3' schools. The teachers participated voluntarily in the study; Marc (male) had five years of teaching experience, Bert (male) seven years of teaching experience, and Freddy (male) six years of teaching experience. The teachers were informed that this study was on teaching in the new subject area of social studies. Marc's class consisted of 27 students, Bert's class of 28 students, and Freddy's class of 20 students. All of the observed classes involved students who were 12–14 years of age. All students were pursuing the theoretical level of prevocational education which is the highest level in this kind of education.

2.2. Materials

2.2.1. Lessons

The teachers were asked to teach their lessons as usual. Marc worked on three lessons about the United States with his students. The weapons' law was discussed in small groups. An atlas-searching game was also played and a poster was made about the particular climate (different sorts of climates were divided amongst the groups such as tundra climate and dry climate) occurring in the USA. Bert's lessons were about different religions. In the first two lessons, the students performed workbook assignments in pairs. In the third lesson, the students had to summarise texts in pairs. In two of the three lessons taught by Freddy, the students worked in pairs on workbook assignments regarding the characterising of urban and rural areas. In the third lesson, the students worked on a group assignment concerned with their own city and its neighbourhoods.

2.2.2. Interviews

In semi-structured interviews with the three teachers, the possible influence of the presence of a camera on the behaviour of the teachers and the students was evaluated along with the representativity of the observed lessons. In addition, the teachers' knowledge and beliefs with regard to contingent teaching were discussed.

2.3. Procedure

Four lessons with the same class were observed and video recorded for each of the teachers. However, the recordings of the first lesson were not included in the analyses: This observation was meant to allow the teacher and students to become accustomed to the presence of the camera. Observations were made between March and June of 2008. After the fourth observed lesson, an interview including lesson fragments (one-to-one and small-group as well as fragments with cognitive, metacognitive and affective content), which lasted about 1.5 h, was undertaken with each teacher.

2.4. Data analysis

2.4.1. Interaction fragments

Since no generally accepted measurement instrument for scaffolding is available in the literature (Van de Pol et al., submitted for publication), a new categorisation methodology was designed for the purposes of this study. Given that we were only interested in the one-to-one and small-group teacher–student interactions concerned with the subject-matter, it was decided to select only those interaction fragments which met two selection criteria concerned with the context and content. With regard to the context, only those interaction fragments reflecting the interaction of the teacher with a small group of students or a one-to-one interaction with a student were selected for analysis. With regard to subject-matter, only those interaction fragments, which concerned one of the learning goals for the lesson being taught and involved at least two turns from not only the teacher but also the student, were analysed. Those interaction fragments which concerned two different subjects were split.

The interaction fragments were next transcribed and then coded while watching the video. In such a manner, contextual and non-verbal information could be taken into consideration during the coding process. To establish the inter-observer reliability for the application of the selection criteria, the first author and a research assistant coded 20% of all selected interaction fragments. With a Cohen's kappa of .70 for small-group interaction and .75 for one-to-one interaction, the inter-observer agreement was considered substantial. With a Cohen's kappa of .91, the inter-observer agreement on subject-matter versus no subject-matter-related interaction was almost perfect (Landis & Koch, 1977). For each of the relevant interaction fragments, whether the interaction was initiated by the teacher or by the student(s) was also subsequently coded.

2.4.2. Contingency

Each interaction fragment as a whole was coded with regard to contingency. In the distinction of contingent interactions from non-contingent interactions, the focus was on subject-matter-related contingency.

An interaction fragment was coded as contingent when the teacher was judged to use information gathered about

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the student's or students' understanding in his provision of support to the student(s). A prerequisite for this was, thus, that information about the student's current understanding be explicitly gathered by the teacher or spontaneously offered by the student(s). Both the first author and a research assistant divided about 20% of all selected interaction fragments into contingent or non-contingent and with a Cohen's kappa of .88, the agreement on contingency was found to be substantial (Landis & Koch, 1977). Given the complex nature of this contingency coding, all of the remaining fragments were coded by both individuals until consensus was reached on all of the fragments. Examples of an interaction fragment judged to be contingent and an example of one judged to be non-contingent are given below.

Student (S): We cannot find how we can, how can we find North America and land climate.

Teacher (T): Have you already found the climate map? [Diagnostic question]

S: No.

T: Where do you have to start? [Intervention strategy question]

S: Here (points somewhere in the index of the atlas).

T: Which index? [Intervention strategy question]

S: Index of subjects.

T: Index of subjects. And where do you have to look? [Intervention strategy question]

S: Under the "N."

T: The "N" of…? [Diagnostic question]

S: North America.

T: No, because the index of subjects is searched for by subject. So you have to search under… [Intervention question]

S: Land climate.

T: And maybe somewhat more generally? [Intervention strategy question]

S: Climate.

T: Right, OK.

In the previous interaction, the teacher asked diagnostic questions. He tried to find out what the student's problem was, that is, "the student does not understand that one has to search by subject in the subject index". The information which the teacher gathered was subsequently used in his provision of support. This interaction fragment was, therefore, judged to be contingent. The following interaction is an example of a non-contingent interaction.

S: I need this one, don't I? It says that it is so and so much but the number of inhabitants is not 50, is it?

T: No, because population density is, you have to look here, inhabitants per square kilometre. So if I were to draw a rectangle in the landscape, then 50 to 100 people would live there on average.

S: OK.

T: That's how you should understand that.

S: So, 50 to 100 inhabitants are living there?

T: Yes.

S: OK.

T: Per square kilometre.

S: Yes, and how many kilometres is that?

T: That is a square of 1 kilometre by 1 kilometre.

S: Yes, but this is millimetre!

T: (walks away)

In this interaction, no diagnostic questions are posed by the teacher. The teacher does not know what this student knows about the concept of population density. Support is provided immediately, without the gathering of information regarding the student's current understanding. This interaction fragment was therefore judged to be non-contingent.

2.4.3. Scaffolding intentions and means

About 10% of the teacher's utterances were coded for intentions and means by the first author and an educational researcher not involved in this project to determine the inter-observer reliability. A substantial agreement was found, Cohen's kappa between .70 and .90 (Landis & Koch, 1977). It should be noted that a kappa value could not be calculated for the scaffolding intention of recruitment because this intention did not occur in the sample. Therefore, this intention was excluded from the analysis.

Given that the behaviour of the teachers was the object of analysis here, the teachers' utterances or groups of utterances constituted the unit of analysis. Each utterance or group of utterances could only be coded for a single means of scaffolding (i.e., diagnosis, checking of a diagnosis, or intervention strategies) combined with a single intention (i.e., task approach, general principles, subject-matter, or frustration control). The scaffolding means and intentions were thus treated as mutually exclusive. The interaction context played a major role in the analyses of the teachers' utterances. The coding of a scaffolding means depended heavily on the more general function of the teacher's utterance within the conversational context and the reactions of the students. Asking "Can you do that?", for instance, can be coded as a question or an instruction. If the student provides an answer, the utterance is coded as a question; if the student does what has been asked about, the utterance is coded as an instruction. The coding of the scaffolding means is described in greater detail below.

2.4.3.1. Diagnostic strategies. A diagnostic strategy can be used as a tool for scaffolding purposes. In analysing the

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diagnostic strategies used by the teachers in the present research for scaffolding purposes, the focus was on two strategies: (a) the posing of diagnostic questions and (b) the reading of student work. An action on the part of a teacher is labelled as a diagnostic strategy when it is used "to discover the level of the student's ability to perform without assistance" (Tharp & Gallimore, 1988, p. 59). Theoretically, both the means of questioning and reading can be combined with all of the different scaffolding intentions. Given the interest in subject-matter-related contingency, however, it was decided to further focus on the use of the scaffolding means with the intention to scaffold subject-matter (i.e., the cognitive and metacognitive activities of students, that is, subcategories A, B and C as presented in Appendix C).

About 20% of the teacher utterances and groups of utterances were coded by the first author and a trainee. With a Cohen's kappa between .76 and 1.0, substantial to perfect inter-observer agreement was reached (Landis & Koch, 1977). The means "read the work of the student" was only found to occur with the intention to scaffold the cognitive activities of the students.

2.4.3.2. Checking of a diagnosis. Checking of a diagnosis is yet another tool which can be used for scaffolding purposes. Checking of a diagnosis is defined here as verification of whether the teacher has understood the student correctly or not. Although a diagnostic check will give the teacher more information about the current understanding of the student and might, thus, resemble the application of a diagnostic strategy, the defining feature of such a check is that the teacher's understanding of the student's current understanding is at issue. Given that the type of diagnostic check used by the teacher will depend upon the original diagnostic strategy, specific types of diagnostic checks were not distinguished for purposes of the present analyses.

About 20% of the teacher utterances and groups of utterances were coded by the first author and a trainee. With a Cohen's kappa of .73, the inter-observer agreement was considered substantial (Landis & Koch, 1977).

2.4.3.3. Intervention strategies. The final tool, which can be used for scaffolding purposes, is actual intervention strategy which is simply defined as a strategy used to support the student. Feedback, hints, instructing, explaining, modelling, and questioning were the intervention strategies coded in this study. More detailed descriptions of the intervention strategies can be found in Appendix B.

After practice and discussion, about 10% of the teacher utterances or group of utterances was coded by the first author and an educational researcher not involved in this project to determine the inter-observer agreement. For all of the coded intervention strategies, substantial inter-observer agreement was reached with Cohen's kappa between .70 and 1.00. An exception was the intervention strategy of questioning for which only moderate inter-observer agreement was found with a Cohen's kappa of .60 (Landis & Koch, 1977). Although the focus in this study is on subject-matter-related interactions, affective support was also in the relevant interaction fragments and therefore analysed only in conjunction with intervention strategies as a means of scaffolding.

Table 1
Figures for number of interaction fragments, number of utterances, lesson duration, and fragment duration per teacher.

Teacher	Number of fragments	Number of utterances	Lesson duration	Fragment duration
Marc	22 (27%)	199 (25%)	143[a] (23%)	19[a] (13%)
Bert	42 (51%)	437 (54%)	262[a] (42%)	57[a] (22%)
Freddy	18 (22%)	178 (22%)	221[a] (35%)	24[a] (11%)
Total	82	814	626[a]	100[a]

[a] Duration in minutes.

3. Results

All three teachers indicated that the presence of the camera had little influence on their behaviour or the behaviour of the students. They also indicated that the observed lessons were representative of the lessons they normally teach. General information on the interaction fragments and utterances per teacher is presented in Table 1. The teachers differed in the amount of fragments and utterances. The findings will be discussed per teacher below.

3.1. Marc

Marc was observed to constantly walk around the classroom and react to student questions. If the students had no questions, he would approach those groups which he thought might need help. Only 22 interaction fragments that satisfied the criteria of context (one-to-one and small-group), content (subject-matter) and length (minimal 2 teacher turns and 2 student turns) were found for analysis. In 15 of these 22 interaction fragments, the interaction was initiated by the students. The time spent on whole-class interaction (about 50%) and those interactions that were not related to the subject-matter were excluded from the analyses.

3.1.1. Contingency

Of the 22 interaction fragments for Marc, 8 (36%) were coded as contingent and 14 (64%) as non-contingent. This difference was not significant[3], $\chi^2(1, N = 22) = 1.14$, $p = .14$. In most of the non-contingent interactions, Marc initiated the help more or less immediately without first gathering information on the student's current understanding. In some cases, the current understanding of the student(s) was probed but not used in Marc's provision of support. Marc also did not always help the students when they indicated that they needed help; this kind of interaction was coded as non-contingent.

[3] A one-dimensional chi-square "goodness of fit" test was performed in which the ratio of contingent/non-contingent interactions was tested against the ratio of 50/50 which would be expected if there were no effect.

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In the interview, Marc mentioned completion of assignments as an important goal in his lessons. He was, therefore, sometimes hurried and found it easier and quicker to be directive; this means that at times he did not further consider information provided by students or gathered on students.

3.1.2. Diagnostic strategies

Of a total of 199 teacher utterances and groups of utterances recorded in the three lessons, 22 (11%) were coded as diagnostic strategies. Marc mainly diagnosed the knowledge and understanding of the students using questions such as ''Does this climate occur in North America?'' and ''What kind of trees are these?'' However, not all interaction fragments contained diagnostic questions. This teacher did not use the means of ''read the work of students'' as a diagnostic strategy. Of the 22 uses of a diagnostic strategy, 12 (55%) occurred in the contingent interactions and 10 (45%) in the non-contingent interactions (see Fig. 2).

3.1.3. Checking of a diagnosis

Marc was found to check his diagnosis only once in all of the selected interaction fragments. This was when he checked to see if the students knew where the land climate was located and, thus, asked the students the question ''You know where it is located in America, don't you?''

3.1.4. Intervention strategies

Given the large number of intervention strategies found to occur in the fragments for all three teachers, only those intervention strategies with an occurrence of 2% or more will be discussed here and in the following. In Marc's contingent interactions, he was found to make less use of instructing related to the approach for a task, explaining of general principles, and questions regarding the subject-matter than in his non-contingent interactions (see Fig. 2). Explaining of the subject-matter, in contrast, was used relatively more often in his contingent interactions than in his non-contingent interactions. In the interview, Marc indicated that he wanted the students to perform within a short period of time and therefore asked a lot of controlling questions. This may explain the relatively greater occurrence of questions regarding the subject-matter in interactions, which were non-contingent. In his contingent interactions, Marc showed a moderate variation in the use of intervention strategies.

3.2. Bert

Bert walked around the classroom during most of his lessons although he sometimes sat behind his desk and students would then come up to him with questions. A total of 42 interaction fragments were selected which is considerably more than the amount of Marc. In 33 of the 42 interaction fragments the interaction was initiated by a student. The time spent on whole-class interaction (about 20%) and those interactions that were not related to the subject-matter were excluded from the analyses.

3.2.1. Contingency

Of the 42 interaction fragments for Bert, 21 (50%) were coded as contingent and 21 (50%) as non-contingent. This difference was not significant[3], $\chi^2(1, N = 42) = 0$, $p = 1$. In the non-contingent interactions, Bert mostly started giving support without gathering information on the current understanding of the students first. Once, for example, he modelled an entire assignment without knowing what the student could and could not do herself. He did not, thus, take only parts of

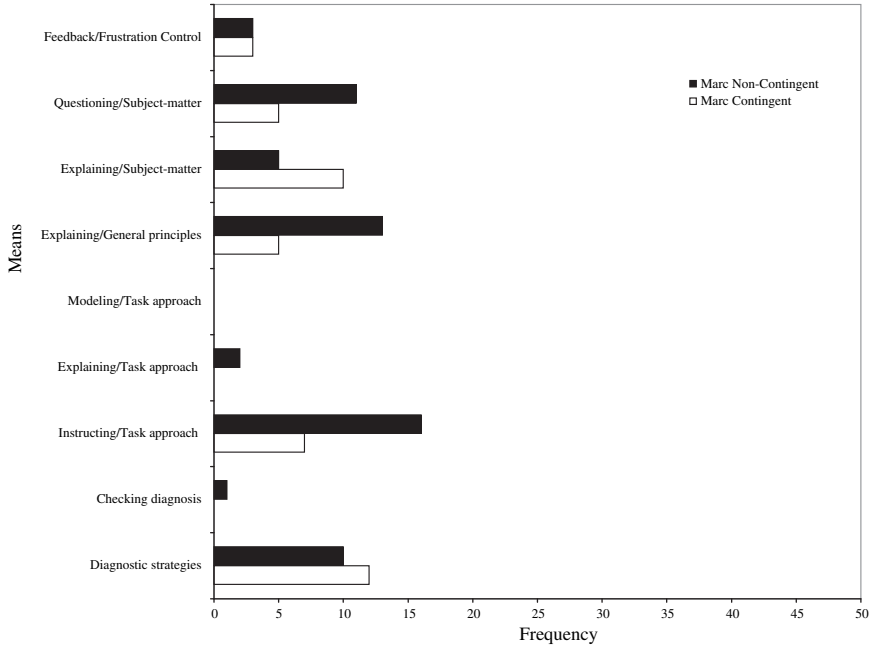

Fig. 2. Frequency of diagnostic strategies, checking of a diagnosis and different intervention strategies for Marc.

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the assignment over in accordance with the needs of the student but, rather, took the entire assignment over.

In the interview, Bert reported adaptation of his support when he sees that students think differently than expected. This shows him to be flexible in his teaching and may, thus, make his teaching relatively contingent.

3.2.2. Diagnostic strategies

Of the 437 teacher utterances or groups of utterances, 41 (9%) were coded as diagnostic strategies. The teacher diagnosed the knowledge of the students by reading their work and posing diagnostic questions. Examples of such questions are "What countries are currently at war?" and "What kinds of beliefs are there?" The task approaches of students were not diagnosed by this teacher. Of the 41 diagnostic strategies, 35 (85%) occurred in contingent interactions and only 6 (15%) occurred in non-contingent interactions (see Fig. 3).

3.2.3. Checking of a diagnosis

Bert checked his diagnosis relatively often: A total of 8 times. An example of such a check is "So you're an only child?" All of Bert's diagnostic checks occurred in contingent interactions.

3.2.4. Intervention strategies

Bert was found to make relatively less use of instructing with regard to task approach, modelling of a task approach, and explaining of subject-matter in contingent interactions than in non-contingent interactions. Explaining of subject-matter and questions regarding the subject-matter, in contrast, were used relatively more frequently in his contingent interactions than in his non-contingent interactions (see Fig. 3). In his contingent interactions, Bert displayed much variation in the use of intervention strategies.

3.3. Freddy

In those lessons in which the students had to do assignments in their workbooks, Freddy sat behind his desk and the students could come up to him with questions. Occasionally, he made a systematic round through the classroom to see if any students had questions. In the project lesson (i.e., lesson 4) which was conducted in the computer room, Freddy walked around constantly. Only 18 subject-matter-related interaction fragments were selected for analysis in the three lessons of Freddy. In 14 of the 18 interaction fragments for Freddy, the interaction was initiated by the students. The time spent on whole-class interaction (about 50%) and those interactions that were not related to the subject-matter were excluded from the analyses.

3.3.1. Contingency

Of the 18 interaction fragments, 5 (28%) were coded as contingent and 13 (72%) as non-contingent. This difference was significant[3], $\chi^2(1, N = 22) = 2{,}72$, $p = .05$. In the non-contingent interactions, Freddy mostly provided immediate support without gathering information on the current understanding of students. It sometimes appeared to be the case that Freddy wanted the students to find things out for themselves and therefore sent them back to their seats or simply walked away without having helped a student.

3.3.2. Diagnostic strategies

Of the 178 teacher utterances and groups of utterances, 9 (5%) were coded as diagnostic strategies. Freddy mainly

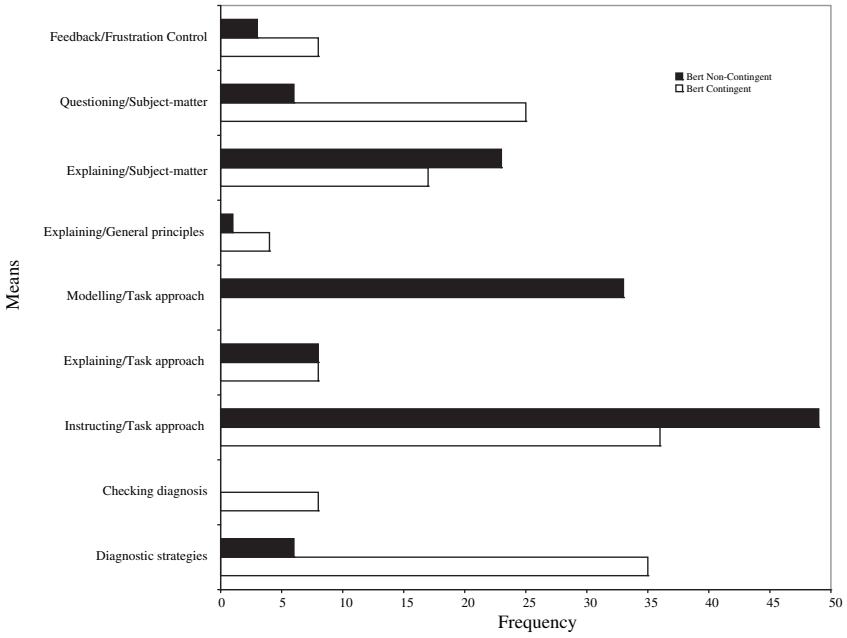

Fig. 3. Frequency of diagnostic strategies, checking of a diagnosis and different intervention strategies for Bert.

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diagnosed the knowledge and understanding of the students by posing questions such as ''What is an interview question?'' or ''What kind of questions do we usually use in interviews?'' Freddy rarely used the means of ''reading the work of students'' as a diagnostic strategy.

In the interview, Freddy reported often assuming that a student's problem stems from not having read a text or not understanding a text. He, therefore, typically provides support on the basis of this idea and does not check the understanding of the students prior to this. This predisposition may explain the relatively small number of diagnostic strategies used. Of the only 9 diagnostic strategies, 6 (67%) occurred in the contingent interactions and 3 (33%) in the non-contingent interactions (see Fig. 4).

3.3.3. Checking of a diagnosis

Freddy did not check his diagnosis in any of the interaction fragments whatsoever.

3.3.4. Intervention strategies

Freddy was found to make relatively less use of instructing with regard to task approach and more use of questions regarding the subject-matter in his contingent interactions when compared to his non-contingent interactions. In his contingent interactions he showed little variation in the use of intervention strategies; he only used three types of strategies.

4. Discussion

The presented model provided us not only with a reliable tool to analyse scaffolding interactions, it also provided more insight into the process of scaffolding. Although the data of the present study does not allow proper hypothesis testing, nevertheless the pattern of the three teachers' instructional practices suggests that Hypothesis 1 (i.e., more instances of contingent teaching than of non-contingent teaching) was not confirmed. Only one of the teachers showed marginally more contingent than non-contingent interactions even though the teachers worked in innovative schools where they are expected to scaffold the students and thus show many contingent interactions.

Hypothesis 2 (i.e., that non-contingency would be mainly associated with absence of intervention strategies, not with the absence of diagnostic strategies) was only partly confirmed by this study. In two thirds of the non-contingent interactions the teacher did not use a diagnostic strategy. In the other non-contingent interactions the collected knowledge about the student's understanding was not used in supporting the students. Non-contingency was, thus, associated with lack of diagnostic strategies more often than expected. By using diagnostic strategies and checks on the diagnosis the teacher gains insight into students' understanding and this allows him or her to act contingently. Many cases, in which verification of what the student said might have been useful but was not undertaken, were found to occur and to involve a miscommunication as a result. The statement ''I don't get it'' was not uncommon, for example, in the teacher–student interactions, but often no diagnostic strategy and/or check of the more specific diagnosis of the student's lack of understanding took place.

Hypothesis 3 (i.e., that the more the teacher's contingent interactions are the greater the variation in scaffolding approaches used will be) was confirmed. Freddy, who showed the least contingent interactions, also showed the least variation in scaffolding approaches in his contingent interactions.

We sought to reveal the patterns of contingent teaching and non-contingent teaching in the teachers' interactions in terms of diagnostic strategies, checks on diagnoses and various

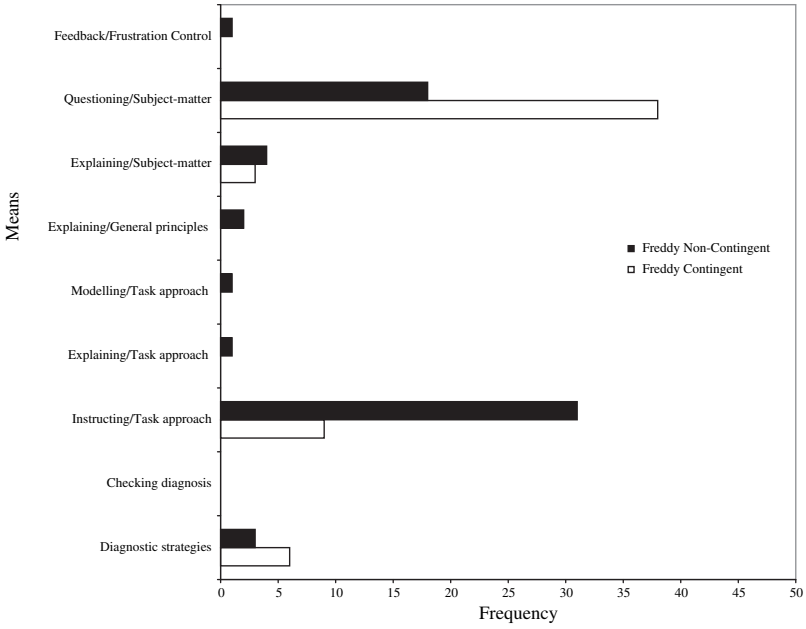

Fig. 4. Frequency of diagnostic strategies, checking of a diagnosis and different intervention strategies for Freddy.

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intervention strategies. Except that diagnostic strategies, checking of the diagnosis and a variation of intervention strategies seem to be related to contingent teaching as stated above, three other patterns of strategies were distinguished.

First, only 9% of all teacher utterances included diagnostic strategies, that is, 7% in contingent interactions and 2% in non-contingent interactions. Especially when the interaction was initiated by the teacher himself the use of diagnostic strategies was rare. Although the teacher might have used other, non-verbal cues or prior knowledge of the student to form a diagnosis, our model suggests that a diagnosis should be checked upon with the students. Elbers et al. (2008) mention three possible reasons for the rarity of diagnostic strategies: (a) teachers base their support largely on beliefs which they have about what is difficult for students (Freddy), (b) time-constraints (Marc), and (c) explanation without a phase of diagnosis may simply be ingrained in the role of the teacher.

Second, a reduced use of instructing with regard to the approach to a task (A3.3) and an increased use of questioning with regard to the subject-matter in contingent interactions was found compared to non-contingent interactions. When teaching contingently teachers are, thus, seen to act less directive and not pursue only their own agenda but, instead, respond adaptively to the needs of students.

Third, teachers' intervention strategies with the intention of recruitment did not occur at all in the teacher–student interactions. This could be due to the type of interactions selected for analysis as the recruitment of attention and interest can be presumed to occur mostly at the beginning of a lesson when the teacher introduces a new task to the whole class.

Scaffolding presumably reflects what good teaching is: being responsive to a learner and supporting a student within his/her ZPD. Linking the theory of informal formative assessment to scaffolding has proven a good starting point for research on scaffolding. The model that was developed by combining these two strands of research was very useful in analysing and understanding the complex process of scaffolding. This model enabled us to study both the diagnosis of students' knowledge (and checking this diagnosis) and the use of (contingent) intervention strategies in coherence which is rare in the scaffolding literature. In our opinion, these steps cannot be considered separately because they are interdependent. While scaffolding was rare, performing diagnostic strategies was an important feature of the scaffolding of contingent teaching interactions, as Puntambekar and Hübscher (2005) also contended.

4.1. Limitations and future research

We have to note that the findings of this study cannot be generalised to the entire population of teachers of innovative schools because only three teachers participated in our study. However, keeping the number of participants low enabled us to study the process of scaffolding into greater detail.

Another limitation regards the possible effect of the subject-matter. The nature and the content of a lesson can possibly influence the opportunities of a teacher to interact contingently with students. When students are asked to perform a writing assignment, for instance, teachers have a clear resource for the diagnosis of a student's understanding by reading the written product. In the present study, all of the teachers taught lessons in which the students had to write. The nature of the teacher–student interactions in circumstances where this is not the case or the influence of the content of the lesson on the scaffolding possibilities may therefore be interesting for future investigation. It would also be interesting to measure the quality of student learning in relation to the scaffolding behaviour of the teacher. It could be expected, based on earlier studies (Murphy & Messer, 2000; Pratt & Savoy-Levine, 1998; Wood et al., 1978) that students of teachers who teach contingently outperform students of teachers who teach less contingently.

Given the role which diagnosis of student's understanding was found to play in contingent teaching in this study, future research on scaffolding should not only focus on the support provided by a teacher but also on the ways of prior diagnosis of student knowledge and understanding.

The checking of a diagnosis occurred surprisingly little, possibly due to time constraints. Additional research is required to shed more light on this scarcity. Of course, clarification or verification of one's diagnosis is not always necessary — in contrast to the establishment of a diagnosis. Nevertheless, not checking one's tentative diagnoses may be risky as teachers may assume an unjust diagnosis at times.

Although innovations have been implemented in many schools in the Netherlands and particularly in prevocational education to date, professional development programs are not necessarily conducted in such schools to prepare teachers for their new role. The findings of the present study can certainly contribute to the development of such a program, and the proposed model can help in this development. The model can be used to not only make teachers more aware of how the process of scaffolding works but also help them discover the individual needs and understanding of students.

Finally, the present findings can be used for student development purposes as well. The quantity and quality of the student information gathered by a teacher depends upon not only the teacher and whether diagnostic strategies in teacher–student interactions are utilised but also on the willingness and ability of students to communicate about their knowledge and concerns. Training students on how to better explain what they already know and what their questions are to teachers may thus be a very useful domain — in addition to the professional development of teachers and teacher scaffolding of student learning — for future research and development.

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Appendix A. Framework of analysis for scaffolding intentions and means

Scaffolding means	Scaffolding intentions					
	Student's metacognitive activities	Student's cognitive activities		Student's affect		
	Task approach (A)	General principles (B)	Subject-matter (C)	Recruitment (D)	Frustration control (E)	Miscel–laneous (F)
1. Diagnostic strategies						
1.1. Questioning						
1.2. Reading						
2. Checking diagnosis						
2.1. Questioning						
3. Intervention strategies						
3.1. Feedback						
3.2. Hints						
3.3. Instructing						
3.4. Explaining						
3.5. Modelling						
3.6. Questioning						
100. Miscellaneous						

Appendix B. Descriptions of the intervention strategies of scaffolding means of scaffolding means

	Means	Description	Example
1	Feedback	- Direct evaluation of the behaviour/work of the student	- Yes, that is actually the same (T2) - And if you switch those, it's correct (T3)
2	Hints	- The teacher gives a hint with respect to subject-matter - The teacher deliberately does not supply the entire solution or detailed instructions.	- One word (T2) - You can start by looking in that book (T1)
3	Instructing	- The teacher provides information so that student knows what to do or how to do it - Request for a specific action (e.g., a rhetorical question can serve as instruction)	- And now you look to see if you can find more dates (T2) - You have to read that text to answer this question (T3)
4	Explaining	- Provision of information on why (e.g., why is a certain task approached in a particular manner)	- Yes, but Mohammed was not the son of God (T2) - So a survey question is always a closed question which can be answered with Yes or No or perhaps "a," "b," " c" or "d" (T3)
5	Modelling	- The teacher demonstrates behaviour (verbal or non-verbal) for imitation - Modelling is about the process and not the product	- How did you find something in an atlas again? You can go to these long lists (demonstrates this while talking) (T2)
6	Questioning (assisting)	- Prompting of student to think - Request for a specific reaction	- And if you think about the English names of the days, what is that day called? (T2) - What kind of tree is that (T1)
100	Miscellaneous		- Stephan, can you come here please? (T3) - Okay, just keep that with you (T2)

T1 = Marc, T2 = Bert, T3 = Freddy refer to the three teachers participating in the study, respectively.

Appendix C. Descriptions of the scaffolding intentions

Intention	Description	Example
Task approach (A)	- The teacher takes over parts of the task with respect to approach used in current student activities or future activities - The teacher will mainly use the means of instructing and hints to do this	- Try to look that up as well and you can use those sources: Where did it start and here: Where did it end? Try to make a story out of this information (T2) - Well, what does it say in the subject material about that? You can fill it out with that information, ok? (T3)

(*continued on next page*)

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(*continued*)

Intention	Description	Example
General principles (B)	- The actions of the student or similar examples provided by the teacher are placed in a structural framework - The teacher offers general principles (e.g., summaries or explanations of concepts) to provide a structure for the student to place their learning experiences in	- Because in the subject index you have to search by subject (T1) - Density of population is always […] the number of inhabitants per square meter (T1)
Subject-matter (C)	- The teacher takes over parts of the task with respect to the subject-matter currently being considered by the student; - The teacher will mainly use the means of explaining and modelling to do this	- This is the temperature and this is the precipitation (T1) - Friday? There is a goddess named Freia and that became Friday, ok? In such a manner, the Germanic gods live on in the names of the days of the week, yes? (T2)
Recruitment (D)	Motivation and arousal of students' interest in a learning task	
Frustration control (E)	- Motivation using rewards and punishment - Reduction of frustration on the part of student	- Yes, that is very clever (T1) - You have worked very well (T3)
Miscellaneous (F)		- Sorry, I poked you (T1) - You should see if you can borrow one from another group (T3)

T1 = Marc, T2 = Bert, T3 = Freddy refer to the three teachers participating in the study, respectively.

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