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Scaffolding Student Understanding in Small-Group Work: Students' Uptake of Teacher Support in Subsequent Small-Group Interaction

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Providing contingent or adaptive support (i.e., scaffolding) is effective. Yet it is unclear how it promotes students' learning. In this mixed-methods study, we investigated to what extent the effect of contingent support for students' learning is mediated by the extent to which students take up teachers' support in subsequent small-group work. We define *contingent support* as support that contains adapted levels of teacher control or regulation based on the learner's level of understanding. To explore the research question, we analyzed all interactions from 35 lessons of 7 secondary social studies teachers and 7

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small groups of students. Logistic multilevel mediation analyses showed that the likelihood of students formulating accurate answers during small-group work was higher when students applied the teacher's support in subsequent small-group work (as opposed to ignoring that support). However, the contingency of a teacher's support did not affect students' uptake or the accuracy of their answers. Additional qualitative analyses showed that students' uptake of contingent support was sometimes hampered by untimely fading of the support. Moreover, we found that contingent support that was then gradually faded was the most effective in fostering students' uptake of a teacher's support.

INTRODUCTION

Scaffolding (i.e., temporary support that is adapted to a student's understanding), is known to be effective for student learning (van de Pol, Volman, & Beishuizen, 2010). Yet how scaffolding promotes students' learning remains unclear. Understanding how scaffolding affects student learning helps to more clearly conceptualize the notion of scaffolding and can give more concrete direction to interventions aimed at promoting student learning.

In this study, we sought to shed light on a possible mechanism that can explain how scaffolding affects learning: students' uptake of teachers' support. *Student uptake* refers to students applying a teacher's support, and we make a distinction between two levels: (a) applying a teacher's support and (b) copying/ignoring a teacher's support (cf. Barron, 2003). Scaffolding takes into account students' prior knowledge and connects closely to this prior knowledge, which makes applying a teacher's support easier for students (Wittwer & Renkl, 2008). Scaffolding thus may promote the degree to which students take up teachers' support. The degree to which students take up teachers' support is known to promote students' learning as new information is integrated into the students' existing knowledge schemes (Webb & Farivar, 1999; Webb, Ing, Kersting, & Nemer, 2006; Wittwer & Renkl, 2008).

In the current study, we investigated to what extent scaffolding affects students' learning and to what extent this effect is mediated by the degree to which students take up their teacher's support. We recorded how students, working in small groups, responded to their teacher's support after the teacher walked away from the group. This small-group setting is especially suited for studying students' uptake, as students often externalize their thinking in small-group work.

Scaffolding

Borrowed from construction work, the metaphor of *scaffolding* refers to assistance that "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, Bruner, & Ross, 1976, p. 90). The idea of scaffolding is frequently linked to Vygotsky's sociocultural theory (e.g., Vygotsky,

1978). Vygotsky states that learning takes place first on the social plane (in interaction with others) before it is internalized on the psychological (individual) plane. Learning is often guided by others, preferably by a more knowledgeable other such as a teacher. Specifically, Vygotsky's concept of the zone of proximal development is closely linked to the idea of scaffolding. The zone of proximal development represents the distance between what a learner can do independently and what he or she can do with the help of a more knowledgeable other. Scaffolding can be seen as support (with certain characteristics) that is given within the zone of proximal development. The metaphor of scaffolding has been used in research on dyadic interactions (e.g., Wood, Wood, & Middleton, 1978), on interactions between a teacher and small groups of students (Van de Pol, Volman, Oort, & Beishuizen, 2014), and on whole-class teaching (Smit, van Eerde, & Bakker, 2013). In a review, Van de Pol et al. (2010) defined *scaffolding* as support that is characterized by adaptivity or contingency of support, fading of support over time, and transferring of the responsibility for learning or a task to the student. The most central characteristic of scaffolding is that of contingency (i.e., the degree to which support is adapted to a student's understanding; Van de Pol et al., 2010). This characteristic is considered a necessary condition for scaffolding to occur. If support is not contingent, scaffolding is not taking place.

Contingency and Student Learning

Support is contingent when a teacher increases control or regulation when a learner fails and decreases control or regulation when a learner succeeds (Wood et al., 1978). A high level of control or regulation is, for example, giving a hint or providing the answer. A low level of control or regulation is, for example, asking an open question. Diagnosing students' prior knowledge is an essential part of bringing about contingent support (Corno, 2008; Davis & Miyake, 2004). That is, to be able to adapt support to a student's prior knowledge, it is essential that one knows what that prior knowledge is.

Empirical research has shown that contingent support is effective in fostering student learning in different contexts such as tutoring and parental support (Mattanah, Pratt, Cowan, & Cowan, 2005; Murphy & Messer, 2000; Pino-Pasternak, Whitebread, & Tolmie, 2010; Pratt & Savoy-Levine, 1998). In the context of small-group work, teachers need to deal with multiple students at a time, which may complicate diagnosing students' understanding and being adaptive, as students may have different levels of understanding. Yet also in this context, scaffolding appears to be effective for student learning (e.g., Van de Pol, Volman, Oort, & Beishuizen, 2015).

Several studies suggest that it is mainly the contingency of teacher support that determines the effectiveness of the support. Webb et al. (2009) showed that when teachers used students' initial thinking in their probes for explanation, students gave additional explanations beyond their initial explanations. A study by Meloth and Deering (1999) showed that support was only effective when the teacher listened to the students' ideas before providing support. Chiu (2004) showed that teacher

support often had a positive effect on students' problem-solving behavior after the teacher left. It appeared that the effect of their support on on-task behavior and problem solving was greatest when teachers evaluated the group's progress and understanding, as the teachers could adapt their support to the needs of the students. Even though the teacher's support was not necessarily adaptive to every student within a group, in subsequent group work, students collaboratively formulated an answer and helped each other, drawing on what the teacher had said.

In summary, the process of scaffolding, and more specifically the contingency of support, has been shown to promote students' learning. Yet it is unclear how contingency affects student learning. As contingency may enhance the possibility of students applying teachers' support, and as the degree to which students take up teachers' support is known to stimulate their learning, we suspect that students' uptake may play an important role in the way in which the contingency of support affects students' learning. In the next section, we first discuss the link between scaffolding and uptake and then discuss the link between uptake and student learning.

Teacher Support, Uptake, and Student Learning

The degree to which support is adapted to or contingent on students' understanding has been identified as an important factor that facilitates uptake (Wittwer, Nückles, Hübner, & Herbert, 2005; Wittwer & Renkl, 2008). Contingent support takes into account students' prior knowledge. It should be provided at the right time when students need support, which can make further processing of the new information easier for students. In the case of small-group work, this means that the prior knowledge of several students needs to be taken into account.

Whether students are able to apply and integrate information provided by their teacher into their ongoing work appears to be crucial for student learning (Webb, Nemer, & Ing, 2006; Webb & Farivar, 1999). Previous studies have shown a positive relationship between students' uptake of teachers' instructional moves and student learning (Jadallah et al., 2011; Lin et al., 2015). When applying support, students often mirror teachers' behavior or helping style (Gillies, 2011; Jadallah et al., 2011; Webb, Nemer, & Ing, 2006). Such mirroring is assumed to catalyze the students' interaction. For example, Lin et al. (2015) wrote, "Once a teacher stimulates one student to generate relational thinking, other students in the group spontaneously generate relational thinking collaboratively at an accelerating rate without further teacher support" (p. 625). However, to our knowledge, no study has investigated students' delayed uptake of the content of a teacher's support (e.g., an explanation of the meaning of a particular concept) after the teacher has left a group of students and how this affects students' learning. Yet based on the aforementioned studies, we may expect that teachers' support serves as a catalyst for further student interaction. That is, while interacting with a group of students, a

teacher may help with a particular problem, and students may apply that support to the task at hand or to new tasks in subsequent small-group interaction.

Applying support leads to more profound student understanding as the new information is actually integrated into the students' existing knowledge schemes (Wittwer & Renkl, 2008). By applying the support provided, students are better able to continue working constructively and extend and deepen their understanding (Wittwer et al., 2005; Wittwer & Renkl, 2008). The link between student uptake and student learning has only been addressed and studied in the context of individual student learning. Yet we do not have reason to assume that it works differently in small-group work. In studying teachers' scaffolding of small-group work, one crucial issue is to examine whether support offered by a teacher is taken up by the group members.

Ignoring or copying teachers' support, as opposed to applying support, results in an illusion of understanding (Chi, 2000; Chi, de Leeuw, Chiu, & LaVancher, 1994). Ignoring explanations or suggestions means that students do not discuss or mention the provided explanation or they overtly reject the explanation/suggestion. Students continue working in their own way and do not incorporate the explanation given by the teacher in their ongoing work. Copying (or repeating) teachers' explanations or suggestions means that students use the explanation/suggestion to come to an answer but without discussing it; students merely copy the explanation/suggestion into their workbooks. When copying support, students think that they understand the task because they can provide an answer on their worksheet. However, they do not process the explanation thoroughly and do not integrate the teachers' explanation into their existing knowledge scheme. When ignoring teachers' support, the same happens, in that students do not integrate teachers' explanations into their existing knowledge schemes. Therefore, copying or ignoring teachers' support is expected to be less effective than applying that support.

The Current Study

Previous research on small-group work has shown that the quality of students' interactions significantly shapes students' learning (e.g., Hogan, Nastasi, & Pressley, 1999; Volet, Vauras, Salo, & Khosa, 2017). Yet it is less clear how teachers can support students' learning in the setting of small-group work (e.g., Webb, 2009). In the current study, we investigated to what extent contingency of support affects students' learning and to what extent this effect is mediated by the degree to which students take up their teacher's support.

We analyzed teacher–student interactions and student–student interactions of seven groups of students (selected from seven secondary school classes) and their

teachers ($N = 7$) during five consecutive lessons (the total number of lessons was 35). We investigated the students' uptake of the teachers' support related to subject matter during subsequent student–student interaction (i.e., after the teacher had left the group). When investigating students' understanding, we focused on the accuracy of student answers provided during small-group work.

In the current study, we addressed the following research question: To what extent does contingency of teacher support affect students' understanding during independent small-group work, and to what extent is this effect mediated by the degree to which students take up teacher support? For the purposes of this study, we define *contingent support* as support that contains adapted levels of teacher control or regulation based on the learner's level of understanding. Support is considered contingent when a teacher increases control or regulation when a learner fails and decreases control or regulation when a learner succeeds (Wood et al., 1978). Based on the theoretical background outlined above, we formulated the following hypotheses:

1. Contingency of support is positively related to students' uptake of support.
2. Students' uptake of support is positively related to the accuracy of students' answers.
3. Contingency of support is indirectly related to the accuracy of students' answers via the degree of uptake.

METHODS

Participants

We analyzed teacher lessons stemming from a larger data set of 17 teachers. We only had complete data needed for this study from seven teachers (data were missing for several reasons, including technical issues and teachers' apparent reluctance to allow recordings among students). All teachers taught eighth-grade social studies in lower secondary vocational education (student age = 12–14). The teachers participated in a professional development program to develop strategies for scaffolding instruction (for more details, see Van de Pol et al., 2014). The teachers of the target groups were five men and two women—Daan, Gert, Laureen, Suzan, Ron, Nilson, and Mats—who varied in years of teaching experience (between 2 and 15 years). The mean class size was 29.12. The target groups (one within each class) consisted of four students each and were of mixed gender.

Context

The participating classes completed a five-lesson project on the European Union (EU) that we had developed in a previous study (Van de Pol et al., 2015). The two main goals of the project were for students to understand (a) to what extent the EU influences their current and future daily lives and (b) the reasons for founding the EU and how the EU has developed since its foundation.

The five lessons were conducted once a week for 5 weeks. Each lesson lasted 50 min. Working groups of four students each completed four assignments. First, they designed a children's brochure containing examples of what the EU means to children's daily lives while using key concepts. Second, they worked on a poster in which they explored and explained the foundation and development of the EU through time and space during two lessons. Third, the students thought about the meaning of the EU and its regulations for their future working lives and wrote two letters: one about the advantages of the EU for people with certain professions and one about the disadvantages of the EU for people with certain professions. Finally, the students worked on an assignment titled "Which Word Out" (Leat, 1998) to further deepen their understanding of the key concepts of the project. From a list of key concepts, students chose three related concepts and then indicated which of the three concepts could be left out and why. In each assignment, students had to use several of the 29 key concepts that were listed and defined in the materials. These concepts were related to the EU and economics (e.g., internal market, member states, import taxes, customs).

Materials

Data

We transcribed all interactions that the target students had within their groups and with their teachers during the audio-recorded lessons (35 lessons in total, five per teacher). These transcripts served as the main data sources for the current study. We coded a total of 13,316 (teacher and student) interaction turns.

The structure of the data was as follows. Each lesson consisted of teacher–student episodes and student–student episodes. A teacher–student episode or student–student episode was defined as an interaction on the same topic, and each episode thus consisted of a variable number of turns. We conceptualized a turn as everything one person said until another person started talking. The first author determined the beginning and ending of each episode in all lessons, and an assistant checked the beginning and ending of each episode and indicated inconsistencies (among all turns, the assistant noted inconsistencies in fewer than 1% of the cases). All inconsistencies were checked and resolved through discussion. An example of a teacher–student episode and a subsequent student–student episode can be found in the Results section.

Support Content Theme

We determined the themes of the actual content-related support in each teacher–student episode. A content theme is a summary of the support, relating to a certain theme, that the teacher has provided. So if, for example, a teacher helped students to understand the concept of an internal market, we summarized the actual content of the help (internal market). Determining the support content themes was necessary to be able to proceed with the analysis of uptake. To be able to determine what students took up, we needed to specify the actual help provided. We did not apply a quantitative interrater reliability procedure here because of the qualitative nature of the content themes (i.e., the content themes were not predefined and emerged from the data). To ensure reliable coding, an assistant identified all support content themes and the first author checked all themes. The assistant and the first author discussed all inconsistencies (0.1% of the cases) until they reached agreement. Often these were very small adjustments (e.g., adding "disadvantages" to the support content theme "discussing advantages of the EU for a golf player").

Contingency of Support

We coded the contingency of support for each teacher–student episode using the contingent shift framework (Van de Pol, Volman, Elbers, & Beishuizen, 2012; based on Wood et al., 1978). To establish the contingency of support, we conducted several rounds of coding.

Teacher's Degree of Control. First, we coded all teacher turns with regard to the degree of control that was exercised in the support provided. The *degree of control* refers to the extent to which a teacher regulates students' thinking when supporting students. The degree of control ranged from 1 (lowest degree of control; e.g., asking an open question) to 5 (highest degree of control; e.g., giving the answer/solution/explanation). (See Table 1.)

Table 2 shows a sequence of a teacher turn, a student turn, and a teacher turn (i.e., a three-turn sequence). The teacher's support in line 1 contains a very open question and is therefore coded as the lowest level of support (1). The teacher's support in line 3 is somewhat more controlling and gives a direction and is therefore coded as low control (2). To establish interrater reliability, two coders independently coded 16% of the data, resulting in a Krippendorff's alpha of .80 (Krippendorff, 2004).

Students' Understanding During Teacher–Student Interaction. Second, we coded every student turn within the teacher–student interaction with regard to the degree of understanding. A student's understanding was coded as poor understanding (0) when the student demonstrated or claimed poor or no understanding (e.g., what the student said was evaluated as incorrect by the teacher within the teacher–student interaction, the student was not able to formulate an answer, the student

TABLE 1
Levels of Teacher Degree of Control (Adapted From van de Pol et al., 2014)

Category	*Description*	*Code*
Miscellaneous	The teacher turn is about the task approach (e.g., giving students instructions to look something up or to discuss something together), is unclear/unfinished, allocates a turn to a student, asks students to repeat something, or is about practical matters.	999
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 go together?")	1
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?")	2
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?")	3
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.")	4
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.")	5

requested an explanation). For example, the understanding of Student 1 in the excerpt in Table 2 is poor, because working safely is not a reason why a secretary could be in favor of the EU. A student's understanding was coded as partial understanding (1) when the student demonstrated or claimed partial understanding (e.g., when the student omitted a part of what was considered by the teacher to be the correct answer). A student's understanding was coded as good understanding (2) when the student demonstrated or claimed good understanding (e.g., providing a correct answer).

TABLE 2
Example of a Three-Turn Sequence and Coding of Teacher Control, Student Understanding, and Contingency

Line	*Actor*	*Turn*	*Control*	*Student Understanding*	*Contingency*
1	Teacher	"Yes, so why is a secretary in favor of the European Union?"	Lowest (Level 1)		
2	Student 1	"Because she eh, maybe eh, because she works safely"		Poor	Contingent
3	Teacher	"Well, I think, think of something. What could it be related to Student 3? Why would a secretary be really happy with the European Union?"	Low (Level 2)		

Finally, a student's understanding was coded as no understanding can be determined (999) when none of the aforementioned codes could be assigned (e.g., the student did not finish his or her sentence, so it was unclear what the student meant; the student read aloud from the book). To establish interrater reliability, two coders independently coded 13% of the data, resulting in a Krippendorff's alpha of .82 (Krippendorff, 2004).

Contingent Shift Principle. Third, we applied contingency rules to three-turn sequences consisting of a teacher turn, a student turn, and a subsequent teacher turn (see Hermkes, Mach, & Minnameier, 2018; Van de Pol, Volman et al., 2012). These rules basically reflect the contingent shift principle of Wood et al. (1978). Contingency is determined by comparing the increase or decrease in teacher control or regulation relative to a student's understanding. Sequences of three turns (i.e., a teacher turn, a student turn, and a teacher turn) are thus considered to establish contingency of teacher support. Table 3 contains the main contingency rules used (see Van de Pol et al., 2014, for an extended version). Support is contingent when (a) a teacher increases control upon poor student understanding (see Table 3, line 1), (b) decreases control upon good student understanding (see Table 3, line 6), (c) increases control upon partial student understanding (see Table 3, line 2), (d) keeps the level of control constant upon partial student understanding (see Table 3, lines 8, 11, and 14), or (e) keeps the level of control highest upon poor understanding or lowest upon good understanding (see Table 3, lines 10 and 15). In all other cases, teacher support is considered not contingent. The three-turn sequence in Table 2 is, for example, considered contingent because the teacher increases control upon poor student understanding. Note that contingency is thus determined very locally and with regard to the student who is talking at a specific moment. If there were two turns

TABLE 3
Main Contingency Rules (cf. Van de Pol et al., 2014)

	Three-Turn Sequence(Teacher Turn–Student Turn–Teacher Turn)			
Line	*Level of Teacher Control, Teacher Turn 1*	*Level of Student Understanding*	*Level of Teacher Control, Teacher Turn 2*	*Contingency*
1	1–4	Poor	More in control than in Turn 1	Contingent
2		Partial		Contingent
3		Good		Not contingent
4	2–5	Poor	Less in control than in Turn 1	Not contingent
5		Partial		Not contingent
6		Good		Contingent
7	2–4	Poor	Same level of control as in Turn 1	Not contingent
8		Partial		Contingent
9		Good		Not contingent
10	5	Poor	5	Contingent
11		Partial		Contingent
12		Good		Not contingent
13	1	Poor	1	Not contingent
14		Partial		Contingent
15		Good		Contingent

Note. Teacher's degree of control: 0 = no control, 1 = lowest control, 2 = low control, 3 = medium control, 4 = high control, 5 = highest control. Student understanding: 0 = poor understanding, 1 = partial understanding, 2 = good understanding.

of two different students in between two teacher turns, we created two separate three-turn sequences, each containing one of the student's turns. These two three-turn sequences were coded as contingent or noncontingent separately. In the analyses, we used an overall contingency score for an entire teacher–student episode, namely, the percentage of contingent three-turn sequences relative to all three-turn sequences within the teacher–student episode.

Uptake

We used the following categories of uptake: (a) ignore, (b) copy/repeat, and (c) apply (cf. Barron, 2003). We assigned the code "ignore" when the support given was not used (i.e., the support was not mentioned at all) or was explicitly rejected (i.e., students mentioned or considered the support given but then decided not to use it). We used the code "copy/repeat" when the students only repeated, mentioned, or copied the support given (e.g., an explanation) without applying it in their discussion. We assigned the code "apply" when the students actually used, applied, or discussed the support provided. The unit of analysis was a support content theme. Within each student–student episode we decided whether each of the support content

themes provided in the preceding teacher–student episode was ignored, repeated, or applied. For instance, if a given teacher–student interaction consisted of three episodes (and thus three support content themes), and this teacher–student interaction was followed by two student–student episodes, we coded for each of these student–student episodes whether each of the three support content themes was ignored, repeated, or applied. To establish interrater reliability, two coders independently coded 28% of the data, resulting in a Krippendorff's alpha of .81[1] (Krippendorff, 2004).

Accuracy of Students' Answers During Small-Group Work

We determined students' understanding during small-group work by coding the accuracy of the answers that students provided within each of the on-task student–student episodes. The unit of analysis for coding the accuracy of students' answers was a student–student episode. For each episode, we decided whether the students' final answer was (a) incorrect (low or no understanding), (b) partially correct (the students' answer contained elements that were correct, but the answer was not complete), (c) correct, or (d) unclear (this was the case when students did not formulate an answer, when students only discussed the task approach, or when it was not clear from the audio recording or students' written work what their final answer was). In the analysis, we only included the episodes in which students generated an answer. We only coded students' final answers, not the preliminary answers that they discussed in their groups. To establish interrater reliability, two coders independently coded 57% of the data, resulting in a Krippendorff's alpha of .73.

On Task

We coded each student turn within a student–student episode as on task or off task (Skinner, Kinderman, & Furrer, 2008). We considered a turn to be on task when it addressed the subject matter of the project and off task when it addressed other matters, such as personal matters. Two coders independently coded 36.9% of the data to establish interrater reliability, resulting in a Krippendorff's alpha of .87. In our analysis, we only used the on-task student–student turns. We were only interested in those occasions in which students had the opportunity to apply or ignore/copy support, and therefore we omitted the off-task turns.

Relevance of Support

For each student–student episode, we coded whether each of the support content themes provided in the teacher–student interaction that preceded the student–student episode was relevant to the task that the students discussed in the student–student

[1]We always double-coded at least 10% of the data. When the total number of units was somewhat lower, we coded more than 10% (up to 45.2%) of the data.

episode. If the support provided in a teacher–student interaction was not relevant to the task students addressed during a subsequent student–student interaction, it would not be surprising that the students would ignore the support. To account for this artefact, we coded the relevance of the support of the teacher–student interaction for each of the subsequent student–student interactions and included this variable in our analysis. The support was coded as relevant (1) if it could possibly be relevant to the task under discussion within the student–student episode. It did not matter whether students actually referred to the support content theme in their student–student episode. The point was whether the support could possibly be relevant to this task. If this was not the case, we assigned the code not relevant (0). To establish interrater reliability, two coders independently coded 45.2% of the data, resulting in a Krippendorff's alpha of .81.

ANALYSIS

To investigate our research question we used ordinal logistic multilevel regression analysis with mediation (see also Chiu & Lehmann-Willenbrock, 2016). That is, we investigated to what extent contingency of teacher support affected students' understanding during independent small-group work and tested whether this effect was mediated by the degree to which students took up teacher support. Level 1 was a student–student episode and contained the variables uptake (0 = ignore/repeat, 1 = apply[2]), accuracy of students' answers (0 = incorrect, 1 = partially correct, 2 = correct), and relevance of the teacher support to a given student–student episode (0 = not relevant, 1 = relevant). Level 2 was the teacher–student episode level and contained the variable contingency of support (a continuous variable representing the percentage of contingent three-turn sequences relative to the total number of three-turn sequences within an episode). We also included students' average understanding during teacher–student interaction (which we coded as part of contingency) as a covariate to account for students' understanding during the teacher–student episode (using the average of all student understanding codes within a teacher–student episode), which was also a Level 2 variable. Level 3 was the lesson in which the teacher–student and student–student episodes took place. These lessons were nested within teachers, but we did not have enough clusters to include teacher as a fourth level. Therefore, we accounted for the nesting within teachers by including teacher dummy variables (cf. McNeish & Stapleton, 2016). We conducted our analysis in Mplus Version 7.4 using the command type is complex two level.[3]

[2]The code "repeat" only occurred twice in our data, which did not enable statistical analysis. We therefore collapsed this code with the code "ignore," as repeating teachers' explanations only results in an illusion of understanding, which is also assumed to happen on ignoring teacher support.

[3]For Level 3 we used type = complex, as we only wanted to correct for nesting at this level.

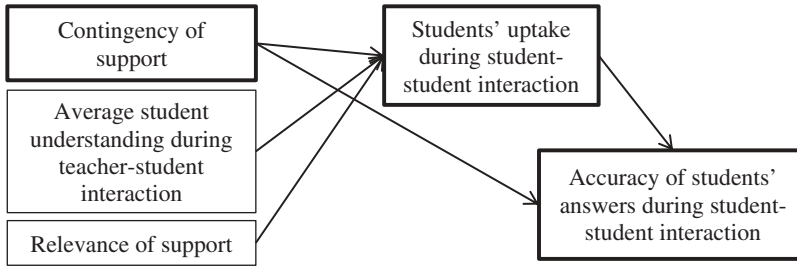

FIGURE 1 Analytic model.

Figure 1 shows the model that we tested. We controlled for the effect of students' average level of understanding during the teacher–student episode. Students with a higher prior level of understanding may be better able to integrate and apply support with their existing knowledge schemes and thus apply the support. Furthermore, we controlled for the relevance of the support provided in the teacher–student episode to the task at hand in the student–student episode. If the support was not relevant to the task at hand, students would presumably not apply the support.

RESULTS

Descriptive Statistics

In Table 4, the averages, standard deviations, and frequencies for the main variables in this study are presented.

The Relationship Between Contingency, Uptake, and Student Accuracy

An intercept-only model with no predictors showed that 36.09% of the variance was located at the lesson level (Level 3), 0.43% was located at the teacher–student episode level (Level 2), and 63.48% was located at the student–student episode level (Level 1). The results of the mediation model of the effect of contingency on students' understanding via students' uptake of teacher support can be found in Table 5. Contrary to what we expected, we did not find an effect of contingency on students' uptake (Hypothesis 1). As expected, we did find a positive effect of uptake on the accuracy of students' answers (Hypothesis 2). For a 1-unit increase in uptake (going from copy/repeat to apply), we expect a 0.25 increase in the log odds of moving from a given level of accuracy of students' answers to any higher category when all other variables in the model are held constant. Finally, contrary to what we expected, we did not find an indirect effect of contingency on the accuracy of

TABLE 4
Averages, Standard Deviations, and Frequencies for the Main Variables in the Study

Variable	*Laureen*	*Suzan*	*Daan*	*Gert*	*Mats*	*Ron*	*Nilson*	*Total/ Average*
Level 2: TS episodes								
Number of content-related TS episodes[a]	6	3	4	5	9	4	6	37
Average number of turns (student + teacher turns) in TS episodes	47.88 (14.04)	21.56 (5.13)	63.61 (24.09)	41.62 (17.59)	15.29 (6.70)	32.38 (14.93)	29.28 (21.24)	35.95
Contingency								
Average percent contingency (*SD*)	.55 (.14)	.66 (.07)	.54 (.13)	.69 (.13)	.77 (.17)	.72 (.27)	.54 (.21)	.64
Average level of student understanding during TS (*SD*)	0.88 (0.42)	1.74 (0.30)	1.10 (0.19)	1.06 (0.20)	1.51 (0.60)	1.14 (0.34)	0.85 (0.49)	1.18
Level 1: SS episodes								
Number of SS episodes following a TS episode	12	8	13	10	8	16	17	84
Average number of on-task turns in SS episodes (*SD*)	12.96 (11.64)	19.11 (13.91)	23.78 (14.36)	27.62 (29.32)	7.64 (9.64)	9 (7.38)	10.04 (7.73)	15.74
Uptake of teacher support								
Number of SS episodes coded as ignore/copy	17	8	13	11	12	24	23	108
Number of SS episodes coded as apply	8	1	5	2	2	2	2	22
Accuracy of students' answers								
Number of SS episodes with an incorrect answer	3	2	4	1	1	5	5	21

Number of SS episodes with a partially correct answer	11	7	14	6	6	14	16	74
Number of SS episodes with a correct answer	11	0	18	6	7	7	4	53
Relevance								
Number of SS episodes in which the teacher support was relevant	18	0	5	10	13	23	21	90
Number of SS episodes in which the teacher support was not relevant	7	9	13	3	1	3	4	40

Note. TS = teacher–student; SS = student–student.
[a]Followed by at least one SS episode.

TABLE 5
Results of the Mediation Model of the Effect of Contingency on the Accuracy of Students' Answers via Uptake of Support

Effect	*b*	*SE*	*Odds Ratio*	*p*
Direct effects on accuracy				
Thresholds				
Accuracy1	−2.29	1.03		.026
Accuracy2	0.95	1.01		.346
Uptake	0.25	0.11*	1.29	.017
Contingency	0.83	1.11	2.29	.457
Teacher Dummy 2	−2.05	0.62*	0.13	.001
Teacher Dummy 3	−1.02	0.58	2.77	.077
Teacher Dummy 4	0.90	1.25	2.45	.473
Teacher Dummy 5	0.36	1.57	1.43	.819
Teacher Dummy 6	−0.34	0.49	0.71	.487
Teacher Dummy 7	−0.44	0.57	0.64	.441
Direct effects on uptake				
Threshold: Uptake1	3.46	4.39		.431
Contingency	−2.97	5.19	0.05	.567
Average student understanding during teacher–student episodes	2.36	1.81	10.59	.192
Relevance	6.37	1.94*	1.16	.001
Teacher Dummy 2	−2.55	4.33	12.77	.556
Teacher Dummy 3	−4.95	3.95	0.01	.211
Teacher Dummy 4	−2.94	3.57	19.92	.410
Teacher Dummy 5	−1.58	4.04	1.55	.696
Teacher Dummy 6	−2.74	3.80	15.49	.471
Teacher Dummy 7	−3.33	3.89	27.94	.392
Indirect effect				
Contingency	−0.75	1.43	2.12	.599

*$p < .05$.

students' answers (Hypothesis 3). In these analyses, we controlled for students' average level of understanding during the teacher–student episode and for the relevance of the teacher–student support to the given student–student episode. The relevance of support appeared to be in itself predictive of students' uptake. For a 1-unit increase in relevance (going from not relevant to relevant), we expect a 6.37 increase in the log odds of moving from repeat/ignore to apply when all other variables in the model are held constant.

Additional Exploratory Qualitative Analyses

Uptake was related to the accuracy of students' answers and thus seemed important for students' learning. However, contingency was not related to students' uptake. To

explain this unexpected finding, we conducted further qualitative analyses. To be able to explain why contingency of support did not foster students' application of support, we selected all combinations of teacher–student episodes containing contingent teacher support (contingency >50%) and subsequent student–student episodes in which the students ignored relevant support ($n = 7$). In five of these seven sets, we could distinguish a common theme, that is, the untimely fading of support. Although the teacher's support was contingent (with regard to the level of regulation provided in the teacher–student episode relative to students' understanding in the teacher–student episode), the teacher seemed to fade the support too soon, handing over the responsibility for the task to the students when they did not know how to proceed. This may be a reason why students were unable to apply the teacher's support. In the other two sets, we could not distinguish a clear factor that seemed to hamper students' application of the contingent support.

We also distinguished two indicators of this untimely fading: (a) a lack of teachers checking students' understanding before walking away and/or a lack of students demonstrating understanding at the end of the teacher–student episode and (b) students' frustration and demonstration of a lack of understanding at the beginning of a subsequent student–student episode. Often these two indicators co-occurred.

Here we provide two examples of this untimely fading.[4] The first example (Example A), from Laureen's class, stems from the fourth lesson of the project, in which students needed to come up with advantages and disadvantages of EU regulations for different professions using the concepts that were addressed in the project (e.g., import duties, export).

Example A, Teacher–Student Episode, Part 1

In this first part of this teacher–student interaction, students questioned the relationship they were supposed to be drawing between a profession and the EU, but they did not yet understand how, as we can see, for example, in line 22, in which Student 3

1 Student 1: Miss, I have, eh written down here what everyone wants to become … but here [in the book] it says: "Think of three reasons why people with this profession are in favor of the EU. You can choose which profession you select." …
2 Teacher: So what do they mean with this question? What are you going to do?
3 Student 4: It needs to be related to the economy and yourself.
4 Teacher: Excuse me?
5 Student 1: With the European Union.
6 Student 4: With the EU and yourself.
7 Teacher: And what of yourself?
8 Student 4: That profession.

[4]All transcripts have been translated from Dutch by the researchers.

9 Teacher: Okay
10 Student 4: But what does my profession have to do with the EU, I don't know that.
11 Teacher: And which profession did you choose?
12 Student 4: Secretary.
13 Teacher: Secretary. Well, what is the question?…
14 Student 2: Three reasons.
15 Student 1: No, "think of three reasons why people with this profession are in favor of the EU."
16 Teacher: Yes, so why is a secretary in favor of the European Union?
17 Student 4: *(gestures that she doesn't know)*
18 Student 1: Because she eh, maybe eh, because she works safely.
19 Teacher: Well, I think, think of something. What could it be related to Student 3? Why would a secretary be really happy with the European Union?
20 Student 3: Money.
21 Teacher: Money. Explain that to me.
22 Student 3: She can make a lot of money.
23 Teacher: She can make a lot of money. And is that because of the European Union?…
24 *(silence of 7 s)*

indicated that an advantage of a secretary is that one makes a lot of money. In the next section, we see that the teacher posed questions to help students understand what kind of relationships they were supposed to draw between their chosen profession and the EU.

Example A, Teacher–Student Episode, Part 2

In this second part of this teacher–student interaction, the teacher provided a lot of regulation by asking steering questions. The teacher provided details of the meaning of import taxes in line 27 and then continued to make more suggestions in line 35

25 Teacher: Tell me something. I could also, I know that Student 2 wants to sell cars, what is an advantage of the European Union for him?
26 Student 2: No import duties.
27 Teacher: Well, that's already one [advantage]. A secretary does not have to do with that. But I think it is a nice example. He does not have to pay import taxes for his cars, which he for example imports from Italy …
28 Teacher: Where is your company located?
29 Student 2: In The Netherlands …
30 Teacher: Where do you work as a secretary?
31 Student 4: Also here.
32 Teacher: And you will continue doing that for years?
33 Student 2: No, also in other countries.
34 Student 1: Oh, maybe if you get older.
35 Teacher: Maybe, but is it possible? Can you say "Hey, I am a secretary and I am a bit bored here"?
36 Student 2: She can also work in other countries within the European Union.
37 Teacher: Yes, isn't that an advantage?

38 Student 4: *(nods yes)*
39 Teacher: Imagine that we do not have the profession secretary anymore here, we abandon it. What will you do?
40 Student 4: To another country.
41 Teacher: You can have a look in another country. He already mentioned one for his cars, so you can write that one down too.

and again in line 39. Still, despite the teacher's regulation, students continued to show low understanding, as can be seen in the next part of the example.

Example A, Teacher–Student Episode, Part 3

Here students showed that they still did not really grasp the main issue, as they could not make the transfer from one profession to the other. In line 42, for example, Student 3 asked whether working in other countries in the EU is also easy for pharmacist assistants. In addition, the students again came up with a disadvantage of the profession itself without relating it to the EU. In line 47, for

42 Student 3: And pharmacist assistant? Does the same go for pharmacist assistant?
43 Student 1: Miss, also for pro soccer player?
44 Teacher: Why, they can also work everywhere right?
45 Student 1: Oh, also, eh
46 Teacher: Well, think about it together, what could be a disadvantage?
47 Student 2: You can go bankrupt.
48 Teacher: Is that only possible in the European Union?
49 Teacher: Discuss, the four of you.

example, Student 2 suggested that a disadvantage of the EU is that one can go bankrupt. The episode ended with the teacher stating that they had to discuss within their group (line 49). The students' understanding was not checked before the teacher walked away, although the students demonstrated that they did not understand the task (lines 42–43 and 47). In subsequent student–student episodes, in which students ignored the teacher's support, students showed frustration and a lack of understanding. This may have hampered their uptake of the support. In the first student–student episode after the teacher–student episode, in which students ignored the teacher's support, students said that the teacher had scared them and made them angry; they seemed to be frustrated (which was not the case yet before the teacher arrived). The following excerpt illustrates this point. This excerpt shows how the students interacted within their group after the teacher had left.

Example A, Student–Student Episode

This student–student interaction shows that the teacher faded her support too early. The students still did not understand what kind of relationship between the

EU and their chosen profession they needed to provide. They still came up with

1 Student 4: She scared me.
2 Student 1: She makes me angry. Let's just come up with [swear word] many reasons, ready.
3 Student 1: I'll just go to sleep, ready.
4 Student 4: What else does a secretary have.
5 Student 2: Disadvantage or advantage?
6 Student 1: Advantages.
7 Student 2: If you get scouted a lot by clubs.
8 Student 4: That is an advantage for him, not for the EU.
9 Student 1: That's what I mean. He doesn't know it himself
10 *(silence of 10 s)*
11 Student 4: I think these questions are hard.
12 Student 1: I do not understand them.
13 Student 4: … What is a disadvantage of a secretary?
14 Student 1: Short skirts.
15 *(silence of 15 s)*
16 Student 3: Such silence.
17 Student 1: I'll be this. *(inaudible)*
18 Student 4: You see, he starts again.
19 Student 4: Student 4, don't pant like that.
20 Student 2: Yes, I don't know.
21 *(laughing)*
22 Student 4: Yes sometimes a lot at the same time.
23 Student 3: Yes, a lot at the same time and you have to keep track of everything.
24 Student 4: Yes but if you want to be a secretary, you have to be able to do that. Because I can do it. So do you want to say that I'll be a bad secretary or what?

advantages of the profession itself instead of advantages of the EU for people with certain professions (e.g., line 10).

The second example (Example B), from Daan's class, also stems from the fourth lesson of the project. In this example, the teacher also faded the support while the students' understanding was still poor.

Example B, Teacher–Student Episode

In this interaction, the teacher's questions became a bit more specific when students showed low understanding or stayed at the same level upon partial understanding, which is considered contingent. But again, it becomes clear that

1 Teacher: Student 3, can you explain it?
2 Student 3: Of eh.
3 Student 4: That last one.
4 Student 3: Yes, when just a few countries joined, we could not yet eh.
5 Teacher: But what countries?
6 Student 3: Well, not many countries have joined the EU.
7 Teacher: So then you could only in. Well, what?

8 Student 3: Well it was foreign country so to say. Now the countries collaborate.
9 Teacher: And why is that easier for you as a professional golf player?
10 Student 3: Oh! *(surprised)* yes, I don't know that either.
11 Teacher: But you did write it down. What does it mean?
12 Student 3: I did not write it down
13 Teacher: Who did?
14 Student 4: We had this whole story but I don't remember it anymore.
15 Teacher: But because you did not write it down, you forgot it. Now you think: you work together with other countries, and so? That is the EU. But why is that an advantage, that's what I want to know.
16 Student 3: I wouldn't know that.
17 Teacher: Well, then you need to think about it. Did you also check the concepts and the sources? What could be advantages and disadvantages?
18 Student 1: Yes.
19 Teacher: And you couldn't come up with anything?
20 Student 1: No.
21 Teacher: Well, then you have to look at these again. Because the answer is in there.
22 Student 1: Yes.

the students struggled with the task. The students explicitly indicated that they did not know the answer (e.g., line 20). They indicated that since the foundation of the EU, the EU countries have collaborated (line 8). However, the students could not link this to advantages for a golf player (e.g., line 10). By the end of the episode, the students indicated that they did not understand the issue although they had studied the lesson materials (line 20). Nevertheless, the teacher faded his support and transferred the responsibility back to the students (line 21). When the teacher walked away and the students interacted within their group, the students ignored the teacher's support, as can be seen in the following excerpt:

Example B, Student–Student Episode

In this example, the students seemed frustrated and demoralized. For example, they indicated that they did not want to do the assignment anymore (lines 12 and

1 Student 3: I think I have found it.…
2 Student 4: What did we have again for the first one? We had this whole story and it was correct.
3 Student 3: It is correct.
4 Student 4: Not anymore.
5 Student 1: That's what he says [the teacher].
6 Student 3: I remember, with a chauffeur or something.
7 Student 4: What?
8 Student 3: No.
9 Student 4: I really do not remember what we had.

10 Student 3: The answer is correct. Give me the correction fluid.
11 *(silence of 13 s)*
12 Student 2: I don't want to do this anymore. We don't do anything right anymore.
13 Student 4: I really don't know any advantage anymore.
14 Student 1: Also not a disadvantage.
15 Student 4: Do you know an advantage?
16 *(silence of 5 s)*
17 Student 3: But you also don't really come up with advantages! It's my profession of course but still.
18 Student 4: Yes but you know more about it.
19 Student 3: Yes, but I don't know that yet.
20 Student 4: Don't you play against other countries?
21 Student 3: No, not yet.
22 Student 4: So you've never played against people from other countries.
23 Student 3: Yes.
24 Student 4: There you go.
25 Student 3: But not super far away.
26 Student 1: Germany is not far away, but it is another country.
27 Student 4: Four minutes left.
28 *(silence of 25 s)*
29 Student 3: Guys, I don't feel like doing this anymore.
30 Student 3: I want to go home, good idea? Then go.

29), which was not the case in the student–student interaction previous to the teacher–student interaction. This may have hampered their uptake of the support.

Applying Contingent Support

To check whether untimely fading indeed played a role in students' inability to apply support, we checked whether this untimely fading did not occur in instances in which students applied contingent support (contingency >50%). We selected those sets of teacher–student and student–student episodes in which the provided support was contingent and students applied the (relevant) support. There were seven such sets. In none of the interactions in these sets did the teacher fade the support prematurely, as indicated by teachers checking students' understanding and students demonstrating their understanding before the teacher walked away and/or students being able to proceed after the teacher had left.

A first example (Example C) stems from the first lesson of the project. In this lesson, students worked on the creation of an information pamphlet that should have made clear what children, in their everyday lives, could notice as a result of EU policies. Students had access to 12 newspaper articles that each represented an example. The newspaper articles discussed in this example were

(a) stricter environmental regulation (the EU deciding to invest more in green energy such as wind energy), (b) dog and cat fur (the EU deciding to prohibit the importing of dog and cat fur), and (c) stricter fishing regulations. First, students had to decide to which category (representing the major focus areas of the EU) the newspaper article belonged and thus what the major theme of the article was (options were the environment, peace, welfare, rights, and safety). Second, they had to describe how the regulation discussed in each of the newspaper articles affected their daily lives. These descriptions formed the basis for the pamphlet.

While working on this assignment, Laureen walked by and read what one group of students had written down. She found that they did not indicate what the heating up of the earth had to do with their own daily lives. She helped the students by giving them the following explanation:

> Yes, you live on the earth, yes. So you have to, what is the problem and maybe that's also in the text, what is the problem if the earth heats up? You can figure that out and write it down. So you have to write down what it means for you. So you could write down, I live on the earth and the EU will make sure that this earth is not heating up anymore because not so many gasses can be used anymore. So then it is clear what it means for you. So in every sentence, I want to read what it has to do with you. So not in general. So have a good look at your sentences. You are doing well, because you have a good division of labor.

Here the teacher showed how to reason and apply the support of "what does it have to do with you" to the newspaper article the students were working on (the heating of the earth). She thus highly regulated the interaction upon low students' understanding, which is considered contingent. The support content theme of this episode was summarized as "the EU makes sure the earth does not get hotter and it relates to me because I live on earth/what does it have to do with you."

This teacher–student episode was directly followed by another teacher–student episode in which the support content theme was summarized as "importing cat fur is prohibited and that means I can't buy a cat fur coat anymore" and "what does it have to do with you." The support in this teacher–student episode was contingent. When one of the students in this subsequent teacher–student episode asked a question about another newspaper article (on dog and cat fur), the teacher handed over some of the regulation to the students. She also applied the support of "what does it have to do with you" to the task together with the students, as can be seen in the following excerpt:

Example C, Teacher–Student Episode

1 Student 4: So this is not right?
2 Teacher: You can also discuss that within your group, right? Can you read aloud what she has written down there?
3 Student 1: "From the end of 2008, the EU countries cannot import cat or dog fur anymore"
4 Teacher: Okay and what does that have to do with Student 4?
5 Student 2: Maybe she thinks, eh, yes I don't know. She does not have a cat or a dog
6 Teacher: She does not have a cat or a dog. But maybe she does want a nice cat or dog fur coat
7 Student 1: I don't know
8 Teacher: Can she?
9 Student 1: That is possible. Everything is possible
10 Teacher: But is it possible according to this sentence?
11 Student 1: No
12 Teacher: Why
13 Student 1: Because the EU does not want to import anymore
14 Teacher: And where does Student 4 live?
15 Student 1: In the EU, in The Netherlands so
16 Teacher: So you cannot import cat or dog fur anymore. So you cannot buy a coat of cat or dog fur anymore so your dog or cat is not dying anymore. It is about what it means for you.… so then you write down I cannot
17 Student 4: Cat fur *(student writes)*
18 Teacher: … *(reads the student's work)* yes, that's how you write that down.

Here the teacher asked the students to help one another and to think aloud about what it meant for their daily lives that the importing of cat fur was prohibited, which enabled her to monitor the students' understanding (line 2). Furthermore, she checked the students' understanding by reading the students' work (line 18). After this teacher–student episode, yet another question occurred about another paper article. At this point, the teacher transferred the regulation to the students. She challenged the students to try and figure it out for themselves by saying, "Student 3, please discuss within your group. Please do that first so I can help them [another group] as well and I will be back to check if you're alright."

In the student–student episode that followed, the students turned to the next newspaper article, which was about how EU regulations limit the fishing quota. Students had to determine what this regulation had to do with their own daily lives. In doing so, they applied the teacher's support of "what does it have to do with you" that was provided in the teacher–student episode, as can be seen in the following extract:

Example C, Student–Student Episode

1 Student 4: Hey Student 1 check if you know [Article] 9. Check if you know 9.
2 Student 1: Hard one, right?
3 Student 4: Um, "fishermen in France are upset because the EU restricted their fishing"
4 Student 1: What does that mean for me?

5 Student 4: You don't eat fish right?
6 Student 1: No … Oh! Maybe that means for me that …
7 Student 4: Tuna …
8 Student 1: Yes, I do eat that.…
9 Student 4: So that's fish … but I don't know what is has to do with you if you don't eat fish. Just pretend you eat fish
10 Student 1: Yes, now what? Okay now I eat fish. Now what?
11 Student 4: You do eat fish and "fishermen in France are angry because the EU restricted their fishing"
12 Student 1: Oh! So in other words, in other words, I eat less fish!
13 Student 4: Yes!

In this student–student episode, the students did not just repeat the general principle provided, they actually applied it in discussing the paper article. They concluded that restrictions on fishing meant that they would eat less fish (line 12). The application of the teacher's support resonated even further than the first student–student episode after the teacher–student episode. In the third student–student episode after this teacher–student episode the students applied the support together as well. The students talked about regulations for "unhealthy commercials." In formulating an answer, Student 3 stated, "I think it is good, wait, I think it is good that they don't make unhealthy commercials anymore for, um, yes, because," to which Student 1 replied, "Because other children, no no, because *I* could gain weight because it is unhealthy or *I* can get diseases." Here we can see that Student 1 corrected himself and applied the support. He clearly showed that he understood what it had to do with his personal life, which was one of the main goals of the lesson. In these student–student episodes, the students thus applied the support and were able to work on the task. The support did not seem to be faded too early. The responsibility seemed justly transferred to the students.

A second example (Example D) in which students applied contingent support stems from Ron's fourth project lesson, in which students had to come up with advantages and disadvantages of EU regulations for different professions. As can be seen in the following excerpt, the teacher exercised high regulation while the students claimed low understanding, which made the support contingent:

Example D, Teacher–Student Episode, Part 1

1 Students: *(have their hands raised, talk to another group of students)*
2 Teacher: How many concepts did you use?
3 Student 3: We have had a look and we can, about the agriculture.
4 Student 4: *(points in the booklet and counts)*
5 Student 3: Here, import taxes does not apply to our professions.
6 Teacher: What profession did you choose?
7 Student 3: Eh, I have.
8 Student 4: Top-class athlete and technician.

9 Student 3: Yes.
10 Teacher: Top-class athlete, where do you get your top-class products that you need.
11 Student 3: Oh, yes!
12 Teacher: To exercise your sport as good as possible.
13 Student 4: Oh yes!
14 Student 3: Export.
15 Teacher: First those import duties.
16 Student 4: Oh yes.
17 Student 3: Import duties that is tax over products, right?
18 Teacher: Yes.
19 Student 3: Yes.
20 Student 4: Do or don't we have that in the EU?
21 Teacher: We don't.
22 Student 3: No.
23 Student 4: Okay.
24 Student 3: You don't need to pay taxes.
25 Teacher: It does not cost money to get really good products or whatever products from country A to country C. Well, except for the petrol.

In this part of the example, the teacher provided quite high regulation (e.g., by providing the answer; lines 21 and 25). This is considered contingent, as the students' understanding was poor. Then, toward the end of the episode, the students claimed good understanding. In the second part of the interaction, the teacher transferred the responsibility for the task back to the students.

Example D, Teacher–Student Episode, Part 2

1 Student 3: Okay, let's do that one too.
2 Student 4: We can.
3 Student 3: No, we use professional products of course.
4 Student 4: *(writes down)* We use professional products that we through import and export. No those professional products can be easily exported from other countries because there are no import duties.
5 Student 3: What did you say?
6 Student 4: Wait a minute. No, eh, we use professional products eh, that, because we, that, because there is no.
7 Student 3: No, because there is no.
8 Student 4: No import duties, we can easily import these from other countries.
9 *(Student 4 talks to another group for about 30 s)*
10 Student 3: Because there are no import duties, easy to get from other countries.
11 Student 4: No import. Because we also need to use that.

In this part of the teacher–student interaction the teacher transferred the responsibility back to the students by asking them to complete the assignment (line 32). The students showed confidence in being able to complete the task by indicating that it would take them 5 min (line 33). When the teacher walked away, the students applied the teacher's support, as can be seen below:

Example D, Student–Student Interaction

26 Student 3: Okay, so we have import duties, and export. Guaranteed price.
27 Teacher: You can skip that one if you want.
28 Student 3: Okay, then we have three, not, yes, we miss one I mean. We already have the others.
29 Student 4: We will try to use the others as well. [they mean the other concepts]
30 Teacher: And if you have time left you can also think about the disadvantages.
31 Student 3: It shouldn't get too weird. *(laughs)* …
32 Teacher: He, eh, please complete this one *(points in their book)* as good as you can and when you're ready then you can think about the disadvantages.
33 Student 3: Yes, that will take us 5 minutes, we will make a sentence.

In this student–student episode, in which the students applied the teacher's support, the students were able to continue working on the task. They understood from the teacher–student episode that within the EU there are no import duties and applied that in their work. For example, Student 4 wrote down that professional products can be easily exported from other countries because there are no import duties (line 4). The fading of the teacher's support did not seem untimely, as the students were able to continue working.

DISCUSSION

The study reported here is the first to investigate the role of uptake in the scaffolding process, linking teacher–student interactions to subsequent small-group student interactions. We investigated to what extent contingent support affected students' learning and to what extent this effect was mediated by the degree to which students took up their teacher's support.

We were not surprised to find that applying support was more effective for students' learning than ignoring support. Previous studies on individual student learning have shown that applying support fosters students' learning (e.g., Wittwer et al., 2005; Wittwer & Renkl, 2008). The current study shows that this link is also present in the context of small-group work. Finding out what type of teacher support may promote students' uptake is thus important. However, contrary to what we expected, contingency of support did not affect the degree to which students applied the support. Finally, there was no mediational effect of contingency on accuracy via uptake.

We conducted a follow-up qualitative analysis to try to explain why contingency of support did not affect students' uptake and found a clear common factor in interactions in which students ignored contingent support: untimely fading of support. Although the support was contingent during the teacher–student interaction, the teachers' monitoring of students' understanding at the end of the teacher–student interaction seemed crucial. In the instances in which students ignored contingent support, teachers did not monitor students' understanding at the end of the interaction and/or students did not show demonstrations of (not) understanding. In subsequent student–student interactions, students often showed a lack of understanding and/or frustration.

Our conclusion is substantiated by the fact that this untimely fading was not present in instances in which students applied teachers' contingent support. In these instances, students demonstrated understanding during the (end of the) teacher–student episode and/or teachers actively monitored this understanding. This often happened just before teachers walked away from the group so they could check whether it was right to walk way. Adding to previous studies that have shown that listening to students before interacting with them is important (e.g., Meloth & Deering, 1999; Webb et al., 2009), this study shows that a smooth and timely transfer from teacher–student interaction to student–student interaction is crucial.

The importance of a teacher checking students' understanding in the scaffolding process before walking away is underlined by previous research in which researchers and teachers together designed a professional development program aimed at promoting contingent teaching (Van de Pol et al., 2012). In the professional development program of that study, a model of contingent teaching was introduced by the researchers that consisted of (a) diagnosing students' understanding, (b) checking the diagnosis (checking with students whether the diagnosis was correct), and (c) providing support. The teachers in that study also suggested a fourth step needed to be added, that is, (d) checking students' understanding, which was added to the model. This step occurred mainly at the end of teacher–student interactions and may have facilitated a smooth transition from teacher–student interaction to student–student interaction. However, much previous research on scaffolding has only focused on the contingency aspect of scaffolding (e.g., Pino-Pasternak et al., 2010; Van de Pol et al., 2015), and these previous studies suggest that it is mainly the contingency of teacher support that determines the effectiveness of the support in fostering students' learning (Chiu, 2004; Meloth & Deering, 1999; Webb et al., 2009). Yet the current study supports the idea that in addition to contingency, timely fading is a crucial aspect of effective scaffolding in fostering students' uptake of a teacher's support. Our quantitative analysis showed that the contingency of support by itself did not affect students' uptake or the accuracy of their answers. However, our qualitative analyses showed that contingent support improved students' uptake when it was

faded in a timely manner. That is, when support was contingent and when the support was faded in a timely manner, uptake of the support took place. Our findings therefore differ from those of some previous studies (e.g., Pino-Pasternak et al., 2010; Van de Pol et al., 2015) in that contingent support alone is not enough to assist students' uptake.

Limitations and Future Research

Although the current study contributes to understanding of the scaffolding process, this study also has some limitations. First, we used a relatively small data set. Although we coded a large corpus of teacher and student turns (N = 13,316), the final number of teacher–student interactions and student–student interactions and the total number of teachers (N = 7) and students (N = 28) was somewhat limited.

Second, we only determined the uptake of support during the student–student interactions that directly followed a particular teacher–student interaction (i.e., until the students were helped again by the teacher). However, it might well be, especially given that the five lessons were interconnected, that students applied support later in the same lesson or even in subsequent lessons (cf. Mercer, 2008). Future research might therefore benefit from measuring this more remote uptake.

Third, given the evidence from previous research, it would be interesting to investigate the separate and joint effects of teacher support and the quality of student within-group interaction on student outcomes. Previous research has shown that the quality of discussion within student–student interaction crucially determines the effects of small-group work (Howe, 2010; Mercer & Littleton, 2007; Van Boxtel, Van der Linden, & Kanselaar, 2000). Only a few studies relating teacher support and within-group dynamics are available (e.g., Gillies, 2011); more systematic and large-scale studies are needed to shed light on these joint effects. For example, it may be the case that students who use a teacher's support (i.e., uptake) also have higher quality discussions, which contributes to better understanding.

Finally, further research may explore to what extent effects of support on uptake and student learning are different for teacher-initiated and student-initiated interactions. Some studies suggest that intervening might be most effective when no student can answer the question and the support is thus a response to a request for help (e.g., Cohen, 1994; Ding, Li, Piccolo, & Kulm, 2007).

Conclusion and Implications

In theory, this study sheds light on the process of scaffolding and how it may affect students' learning. Students' application of a teacher's support seems to form the link between scaffolding (i.e., contingent support that is faded in a timely manner) and students' learning. This study shows that in the context of

small-group work, students' application of a teacher's support was beneficial for students' learning. Application of support thus appears to play an important role in students' small-group learning process. However, in general, the degree of student uptake was relatively low. Making students aware of how to apply support might therefore be an important practical implication of this study in order to promote the degree of uptake. In the current study, students were not informed about the new way the teacher was trying to provide help for their learning. However, informing students about this and explaining that the teacher's contribution during teacher–student interaction could be seen as an integral part of the ongoing small-group discussion that could improve the quality of their discussion could encourage students to take up the teacher's support. In addition, the results of this study suggest that teacher–student interaction in which the teacher provides contingent support and then fades that support in a timely way is most likely to lead to students applying that support. Teaching teachers how to provide this kind of support thus also seems to be an important practical implication. Encouraging teachers to check students' understanding thoroughly by eliciting demonstrations of understanding may be a useful way of achieving this.

Our study highlights the practical educational importance of two important defining characteristics of scaffolding: contingency and fading. To be effective, teachers need to provide scaffolding support that is contingent on the learning needs of the students, but teachers also need to maintain that support until students have reached a suitable level of understanding to be able to apply it.

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