

# Teacher–student negotiations during context-based chemistry reform: A case study

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#### Abstract

Teachers participating in curricular reforms, especially reforms based on constructivism, are expected to bring about change in their teaching approach. This is often a difficult, complex and intensive process, and demands a radical reculturing of the classroom. This is also the case for social constructivist reforms in chemistry education, which are based on a context-based approach. Educational change is a social and interactional process, and during this change teachers will engage in negotiations with their students about the reform. These teacher–student negotiations have a profound impact on the succeeding of the reform. This study explores the teacher–student interactions during the reform that shape and alter the context-based chemistry approach. We focused on two teachers, of whom it was found in an earlier study that one of them succeeded in implementing the reform, while the other one struggled. By following them for one school year, in which in-depth qualitative data was collected through various instruments, we developed insights about the teacher–student negotiations that influenced the educational reform. Three themes emerged from the data: “agency of learning,” “vulnerability,” and “care.” The differences that were found between the teachers regarding these themes help explain why and how the reform can become a success and why the reform often fails to change classroom practice.

#### KEYWORDS

chemistry education, negotiations, reforms, secondary education, teacher learning

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## 1 | CHANGING TEACHER ROLES IN CONTEXT- BASED CHEMISTRY CLASSROOMS

Teachers who participate in curricular educational reforms are expected to bring about change in daily classroom practice (King, 2012; Osborne, 2007). Changing one's practice is a complex endeavor, especially in the case of constructivist reforms (Goodyear & Dudley, 2015; King, 2012). With respect to this complexity, Windschitl (2002) discerns four frames of references, including dilemmas that teachers often encounter when implementing constructivist reforms, which are: "conceptual," "pedagogical," "cultural," and "political dilemma's." These dilemmas can prevent constructivist ideals from being realized in practice.

This is also the case for reforms in chemistry education, which are based on a context-based approach (Overman, Vermunt, Meijer, Bulte, & Brekelmans, 2014). Context-based chemistry is based on social constructivist theory, and challenges teachers to make personal sense of constructivism (conceptual- and pedagogical-dilemmas), to deal with the views and wishes of multiple stakeholders (political dilemmas), and to make profound changes in the culture of the classroom (cultural dilemmas) (Windschitl, 2002). The so-called reculturing of the classroom (Fullan, 2001), not only concerns the teacher, however it is also related to the students who are taking part in the reforms (Chafi & Elkhousai, 2017). Change in classroom culture demands a "radical reorientation of classroom roles and expectations," and has a profound impact on how the teacher and his or her students relate to one another (Windschitl, 2002). As Levin (2000) explains:

The result will necessarily be more questions and opinions by students about the organization of learning. Students will want to have something to say about how they learn, when they learn, where they learn, and so on. Many matters that have traditionally been assumed to be the purview of the teachers will become instead matters to be discussed and negotiated with students [...]. (p. 161).

There can be multiple reasons why teachers and students will have to engage in interactions about the reform in daily classroom practice. One reason might be that teachers deliberately engage in dialogues with their students to let the reform succeed, for example interactions about ownership of learning. These interactions probably will strengthen students capacities to regulate their own learning, and take on the roles that the reform dictates. Conversely, teacher–student interactions also might originate from disruption and discontent about the reform, and be aimed at maintaining pupils motivation to learn or restoring the relationship between teacher and students. When students do not support or understand reforms, teacher efforts to change practice can be resisted and rejected (Levin, 2000). The way teachers perceive interactions with their students about the reform might have fundamental consequences for the success or failure of these reforms in the classroom, especially when these interactions affect teachers' relationships with their students (Hargreaves, 1998; Overman et al., 2014).

Interactions between the teacher and students concerning reforms is a neglected feature in research to curricular changes (Levin, 2000; Mitra, 2003). This article is a first exploration to the interaction between two chemistry teachers and their students during a first year of reform, as perceived by the teachers. First, we explain the reform context-based chemistry education, after which we will further elaborate on reform as an interactional and social process. Finally, we explore the type of teacher–student interactions about the reform and that shape the reform.

## 1.1 | Context-based chemistry education

The context-based approach in chemistry has been developed to address several problems that traditional chemistry curricula in secondary education are faced with. Gilbert (2006) points out that curricula are experiencing an overload of chemistry topics, that subject matter presented to the students is too fragmented, that students experience difficulties with transferring information within the subject matter they learned, and that students do not see the relevance of the subject in daily life. Similar difficulties are described by Osborne (2007), who adds that contemporary school science rests on several fallacies. For example, Osborne refers to “the foundational fallacy,” that is, the science has to be learned brick by brick to develop a scientific knowledge base. The foundational fallacy is similar to Gilbert’s notion that chemistry’s subject matter is too fragmented. Osborne also mentions “the fallacy of coverage,” which is consistent with the problem of overload that Gilbert (2006) refers to.

In concurrence with the problems in science curricula mentioned above, school science is argued to be detrimental for secondary-school students' attitude toward science (Gilbert, 2006; Potvin & Hasni, 2014), which is underlined by reviews (Osborne, Simon, & Collins, 2003), and also a large-scale study called ROSE (Sjøberg & Schreiner, 2010). The ROSE project surveyed, among other things, students' attitudes toward school science in more than 40 countries from 2002 to 2005, and it was found that, in developed European countries, secondary-school students are not enthusiastic about science subjects. They think science subjects are less interesting compared to other school subjects and do not see the relevance of school science for their daily life. However, the ROSE study also showed that school students acknowledge the importance of science and technology for society, so they specifically refer to *school* science as not relevant. This finding has been confirmed by the ASPIRES study (Archer et al, 2013), in which young students (aged 10–14) indicate that science is relevant, however, they do not aspire to work in the science field.

An important aim of the context-based approach is to stimulate students to acquire a more positive attitude toward chemistry and to improve their chemistry learning (Bennett, Lubben, & Hogarth, 2007; De Jong, 2008). King (2012) defined the context-based approach in science education as follows:

A context-based approach is when the “context” or “application of the chemistry to a real-world situation” is central to the teaching of the chemistry. In such a way, the chemical concepts are taught on a “need-to-know” basis; that is, when the students require the concepts to understand further the real-world application. (p. 53)

Thus, to find a solution to a real-world problem (context), students need to acquire and understand scientific concepts. By using an authentic environment as starting point, the context-based approach aims to “break boundaries between school Science and everyday contexts to increase the social and cultural relevance of Science for students, by making the relationship between social issues and scientific knowledge more prominent” (Wilson, Evans, & Old, 2015). An example of a real-world problem is that of small-groups of students have to design a world-journey, where they have to account for the fact that their trip needs to be “green and sustainable.” During this journey, the students have to take specific conditions into account, for example “to use eight different types of transport.” To design such a world-trip, students need chemical concepts to find solutions for the problems they encounter. When students are dealing with real-world problems that are relevant to their daily life, they develop a more positive attitude toward chemistry (Potvin & Hasni, 2014). This is argued to be in contrast with more traditional chemistry approaches, where the main focus is on learning chemical concepts before looking at technological or societal applications (Bennett et al., 2007).

## 1.2 | Change as an interactional and social process

The subject content is not all that needs to be offered differently to the students, as the way chemistry is taught also has to be changed (King, 2012; Windschitl, 2006). Context-based chemistry teaching is characterized as student-centered or as the adoption of an “active learning approach” (Bennett, Gräsel, Parchmann, & Waddington, 2005). As a consequence, “teaching about contexts and issues of science calls for a broader range of teaching and learning approaches than a traditional course” (Bennett & Holman, 2002, p. 168). In many studies on student-centered learning, the role of the teacher has been conceptualized as one of facilitator, guide, coach, tutor, or a similar metaphor (Goodyear & Dudley, 2015; Pedersen & Liu, 2003). In concurrence, tasks of student-centered teachers include encouraging students to construct their own knowledge and understanding; stimulating conceptual change; engaging students in active, collaborative discovery; motivating students to take ownership over their own learning; and helping students to handle difficulties without solving these difficulties (Biggs, 1999; Lindblom-Ylänne, Trigwell, Nevgi, & Ashwin, 2006; Pedersen & Liu, 2003).

It is not only the teacher that is expected to change his or her beliefs and ideas on what science learning is, the students also have to. In context-based chemistry students are expected to play an active role in the learning process. For example, they are expected to co-construct knowledge by collaborative inquiry, problem-solving and discourse-based interactions, and to take ownership of the learning process and regulate this process. This means that the teacher's role, as well as the roles of the students, is expected to change considerably compared to traditional approaches to science education (Bennett & Holman, 2002; King, 2012; Schwartz, 2006). According to Windschitl (2002), these changes raise questions such as:

What behaviours and attitudes are encouraged or discouraged? What is the relationship between students and teacher? Who has power to make decisions, who does not, and how are these power relationships maintained? [...]. (p. 150)

Because of these questions, frictions about the roles and expectations might occur during the reform, and lead to misunderstandings and lack of clarity in the classroom. Frictions are especially likely to occur during constructivist reforms because “students may prefer learning environments that are designed to cohere with their existing conceptions rather than those designed to generate constructive friction and challenging existing conceptions of learning and teaching” (Evans & Kozhevnikova, 2011, p. 137).

This means teachers will get into dialogue with their students about the reform, to find a solution to overcome these problems. One way of getting into dialogue is by means of so called “negotiations” (Frelin & Grannäs, 2010).

## 1.3 | Negotiations during change

Frelin and Grannäs (2010) refer to negotiations between the teacher and students as “the communication they engage in to settle (small) disagreements in order for activities to proceed as planned” (p. 360). In this study, we elaborated on the definition of Frelin and Grannäs. We suggest that negotiations do not only take place in situations to overcome disagreements, and we put negotiations in broader perspective, defining them as the process of teacher–student interaction in which the goal is to find mutual agreement to proceed with activities in daily classroom practice. Frelin and Grannäs (2010) studied teacher–student negotiations in “normal” classroom situations, and found that, under regular circumstances, there is not much space during the lesson to negotiate the content of the

lesson. Students appeared to surrender to this authority and just accept the situation as it is. As explained before, during educational changes in the classroom, these negotiations appear more often, as the teacher and students find themselves in different situations than they are used to. Negotiations with students about the reform can shape and alternate the reform itself.

Teaching is, by its very nature, a social profession, whereby the interaction of the teacher with students is of critical importance (Borko, 2004; Frelin & Grannäs, 2014; Hargreaves, 1998; King, 2012). Hargreaves (1998) argues that teachers make considerable emotional investments in their relationships with their students, and educational reforms affect these relationships. The relationship with their students is one of the most important components of their work (Hargreaves, 1998), which teachers will not easily ignore during reform, especially when the reform threatens this relationship. In an earlier comparative study (Overman et al., 2014) that focused on students' perceptions of different aspects of their teacher's teaching, it was found that students in context-based chemistry classrooms perceived the interpersonal relationship with their teachers to be less positive than students in more traditional chemistry classrooms. In this light, the way the teacher and his or her students engage in these so-called negotiations about the reform might be of considerable importance for maintaining or enhancing good teacher–student relations and stimulating student learning in the classroom.

In this study, negotiations that teachers and students engaged in during reform are the central focus, based on teachers' perceptions of them. We followed two teachers who indicated that they engage in negotiations with their students in their first year of implementing a context-based chemistry curriculum. Consequently, we focus on the following questions:

- In what type of negotiations do teachers and their students engage while implementing a context based chemistry curriculum in secondary school, from a teacher's perspective?
- What are the differences in the perceived teacher–student negotiations between teachers?

## 2 | METHODOLOGY

### 2.1 | Context of the study

This study is part of a larger research project in which 16 teachers, who taught the fourth grade of Senior General Secondary Education (HAVO) classes, voluntarily participated in context-based chemistry reforms. Secondary education in the Netherlands is compulsory for the ages from 12 till 18, and is offered to students at different levels. HAVO is one of the two levels that prepares students for higher education and last 5 years. Students in the fourth grade of HAVO are approximately 15–16 years old. These teachers were indicated as “exemplary teachers” by the project coordinator of the context-based chemistry reforms. The teachers took part in the reforms voluntarily, and were personally motivated to implement the context-based curriculum in their classrooms. Smylie, drawing upon the work of Yee (1990) refers to this type of teacher as “high-involvement” teachers, which are teachers who “are pioneers who actively seek change, and who venture intentionally into ambiguous and potentially stressful situations” (Smylie, 1999, p. 80).

All teachers and their students filled in questionnaires about their perceptions of the curriculum emphases stressed in the classroom, the teaching activities employed, and the interpersonal relationship between the teacher and their students. With 10 of these teachers, we held a video-stimulated interview about a characteristic chemistry lesson they had given.

## 2.2 | Selecting the teachers: William and Neill

On basis of the questionnaires and these interviews, we purposefully selected two teachers for this in-depth study, on the basis of their comparability. These teachers are comparable in characteristics such as teacher experience, and age, however they experienced the reforms in very different ways. Our purpose is to get in-depth and detailed insight in where these differences come from in their perceived interactions with their students. We will refer to these teachers as Neill and William (pseudonyms). We used a “mixed purposeful sampling” strategy to select William and Neill (Onwuegbuzie & Leech, 2007), which means that we actually combined two different sampling strategies, namely a “critical case strategy” for the selection of Neill, and an “extreme/deviant case strategy” to select William. These sampling strategies and accompanying criteria are explained in detail below.

A first criterion to select Neill and William was that we regarded them as “contrasting cases,” or “polar types” (Eisenhardt & Graebner, 2007). By selecting polar types, one is able to more easily observe contrasting patterns in the data. We found William and Neill to have had very different experiences of being a context-based chemistry teacher in daily classroom practice. These differences came to the fore from the results of the questionnaires and during the video-stimulated interview that was held with the teachers. These differences are considered fundamental for this study, as they might point to different types of interactions between the teachers and their students.

Neill mentioned difficulties that many teachers experience when adopting a student-centered approach, such as student resistance (Keeley, Shemberg, Cowell, & Zinnbauer, 1995), struggling to revert to traditional practices (Tobin, Tippins, & Hook, 1994), and finding ways to regulate the students' learning process (Smylie, 1999). In our study, we regard Neill to be a “critical case,” which has been described by Patton (2002) as “a case that can make a point quite dramatically.” According to Patton, a “clue to the existence of a critical case is a statement to the effect that ‘if it happens there, it will happen anywhere’” (p. 236). In our study, this means that we think that what happens to Neill when adopting a context-based approach might also happen to other teachers in the same situation.

William expressed how his students valued that they got more freedom and responsibility for their own learning, and how they were enjoying collaborative learning. Actually, he was the only teacher in our sample of teachers that engaged in the context-based reforms who was truly enthusiastic about how context-based learning worked out in his classroom. Therefore, in our study, we consider William to be an “extreme or deviant case.” Patton (2002) described a deviant case as “information rich because they are unusual or special in some way, such as outstanding successes or notable failures” (p. 231).

A second criterion for the selection is that these two teachers might be considered as, “information rich cases” or “good informants” (Erlandson, Harris, Skipper, & Allen, 1993; Patton, 2002, p. 82). We quote Patton, who argues that “information rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry” (p. 230). This is one reason why we selected Neill and not one of the other teachers in our sample who struggled with context-based learning. In describing the essence of a good informant, Erlandson and colleagues use a quote of Merriam (1988): a good informant is “one who expresses thoughts, feelings, opinions, his or her perspective, on the topic being studied.” (cited in Erlandson et al., p. 91). William and Neill were really open during the interviews and did not hesitate to mention what they thought and how they felt about their students and themselves, including less positive experiences and feelings of failure and frustration.

A final criterion to select William and Neill was that, although they differed in the way they adopted a context-based approach, their personal characteristics and the context in which they taught were, in some ways, quite comparable. They were both around the same age, and they had around



the same amount of teaching experience. William had 31 years of teaching experience and Neill 33, and both had a bachelor degree for teaching chemistry. Both William and Neill taught chemistry in the fourth grade of senior general secondary education. Furthermore, William and Neill were supposed to bring about change in their classrooms by themselves. They both worked in a school environment that might be considered as quite traditional. Some colleagues of these two context-based teachers even still taught chemistry in a more traditional way.

### 3 | THE INTERVIEWS

#### 3.1 | The video-stimulated interview

The first interview we conducted with the teachers was a video-stimulated interview about a chemistry lesson they had given. This means that the stimulus for the interview is provided by watching a video-taped lesson of the specific teacher (Yinger, 1986) together with the researcher. We used this video-stimulated technique to let William and Neill *reflect-on-their-actions*. According to Muir (2010), the video stimulated recall “refers to a collaborative inquiry between the teacher and researcher, with the dialogue focused on thinking about aspects of practice” (p. 439). According to Yinger (1986), a reflection-on-action technique makes it possible for teachers to make sense of specific teaching episodes, whereby implicit theories, beliefs, and understanding of the teacher about these episodes may be elicited, which was the goal of our study. The video-stimulated interviews with William and Neill were immediately held after the lesson that was video-taped. The interviewer and the teacher watched the video together and the video was stopped during moments that were meaningful to the teacher, and where the teacher wanted to explain something. These interviews were audio recorded and transcribed afterward.

During the video-stimulated interviews with William and Neill, we got the first insight into teacher–student interactions in a context-based chemistry reform. The video-stimulated interview, which concerned the daily classroom practice of William and Neill provided the basis for further interviews. The interactions that were discussed during the video-stimulated interview mostly considered the question of how to activate students to engage in learning.

#### 3.2 | In-depth interviews

To get a more elaborated view of the teachers' perceptions of their interaction with their students during the reforms, we conducted three more in-depth interviews with each of them. The purpose of an in-depth interview is “to hear what the participant has to say in his own words, in his voice, with his language and narrative” (Lichtman, 2006, p. 143). Before interviewing, we had identified topics that we wanted to be covered during the interview. These topics were used as guidelines for the interview and included what teachers do: (i) to activate their students' learning in context-based chemistry; (ii) why activate their students in this way; and (iii) how they experienced the interaction with their students. We further asked them to illustrate their reflections by means of concrete examples in daily classroom practice.

Each interview lasted approximately 1½ to 2 hr. We used different strategies for questioning (Lichtman, 2006), mostly elaboration and probing strategies, as we wanted to get detailed insight in the teachers' perspectives. We verbally carried out member-checks with the teachers, after each interview, to verify the trustworthiness of our data.

### 3.3 | Analyses of the interviews

In the analyses of our data we made use of the interpretative data analyses procedure as advocated by Miles and Huberman (1994), and we followed the stages of data reduction, data display, and conclusion drawing and verification. Meaning was derived out of the data using an iterative process in analysis. We chose to perform a cross-case analysis of William and Neill, with the aim of illustrating the different ways these two different chemistry teachers try to implement context-based chemistry in their classrooms.

### 3.4 | Data analysis

A grounded theory approach was used for this study. According to Bowen (2006), grounded theory is “generated by themes, and themes emerge from the data during analysis, capturing the essence of meaning or experience drawn from varied situations and contexts” (p. 13). After each interview that was held with the teachers, we selected utterances of William and Neill where they referred to negotiations with their students that were related to the context-based chemistry reform.

The first author coded the utterances of William and Neill and shared her interpretations with two other researchers. One of these two researchers is the first author's daily supervisor and the other researcher a colleague. These researchers indicated which parts were unclear, and critically questioned the first author on why a certain interpretation has been used. Then, the coding process started over again.

In analyzing the interview data of William and Neill, we found three themes concerning the daily negotiations between the teachers and their students during context-based chemistry reform: “agency of learning,” “vulnerability,” and “care.” The theme “agency of learning” refers to situations where the teachers negotiate the “ownership of learning” with their students. Who is responsible for their learning at what moment? “Vulnerability” has to do with negotiating the uncertainties and doubts that are a consequence of the reforms. “Care” refers to the personal affective investments that a teacher makes in the relation with his students during the reform. These negotiations about the reform process take place for the sake of keeping the teacher–student relation good.

In the data reduction process, we first selected utterances about the ideas the teachers had concerning “agency of learning,” “vulnerability,” and “care.” It appeared that William and Neill had different understandings about what “agency of learning,” “vulnerability,” and “care” meant in the context-based classroom. The second step in the coding process was to select utterances of the teachers where they explained the negotiations that they were involved in with their students concerning these themes. We found William and Neill to be entangled in different negotiations with their students, on which we will elaborate in the subsequent paragraph.

## 4 | RESULTS

### 4.1 | Teacher–students negotiations concerning agency of learning

Both William and Neill acknowledge that there is a shift in agency concerning their students' learning. Instead of the teacher being the one who tells the students what to do and how to learn, students must become able to regulate their own learning process. Both teachers argue that they and their students need to get accustomed to this change in agency. However, William and Neill appeared to understand “agency of learning” in different ways. Furthermore, the type of negotiations the teachers engaged in appeared to be different. In Tables 1 and 2, the results are presented as follows: (i) the



notion of “agency of learning” the teachers have; and (ii) the teachers' perceptions of the type of negotiations that they engage in with their students. The types of negotiations are illustrated by key excerpts from the interviews.

#### 4.2 | Neill's notion of and negotiations on agency of learning

Neill's understanding of agency can be summarized as “being independent from the teacher”:

In this reform you aim for more independence from the teacher [...] As a teacher you have to address your students to take this responsibility for their own learning.

Neill acknowledges that “the road to independence is a process, however, a difficult one.” Neill indicates it is a constant struggle to get his students to the stage where “they become responsible for their learning”:

Well, and I had to think about, what should I do to get my students independent? How do you start? How can you, well, cherish this independence on the one side and, on the other side, keep a good overview of their learning process. And, referring to that, well, in a sense, I just put my blinkers on and just experienced what happened. And, at certain points, I interfered because I thought “well, this is something that I cannot do to my students.”

Neill perceives his students as “passive learners,” who do not take initiatives themselves and strongly depend on the teacher during the lesson. He wants his students to become “responsible learners.” However, Neill also indicates that one cannot blame the students for their attitudes, as “students are conditioned to be passive from their first year at secondary school.” Therefore, one of the main tasks for the teacher is to make students aware of their own responsibility for learning.

The difficulties Neill experienced with his students come to the fore in the negotiations he engages in with them. Neill uses different strategies to “convince” his students that being independent is (in the end) beneficial for their personal development as a student. These negotiations we named “confronting” and “controlling” negotiations. Neill experiences confrontations about who is responsible for the learning of the students, and, at the same time, he has to control whether his students eventually take this responsibility, which Neill illustrates as follows:

I call upon my students like “hey, you can choose not to do it but on the test you have to perform. I don't have any pity with you then.” And then they find out I really don't have pity with them, after they failed the test. Well, and students who do not have any discipline, who find that hard, they make a poor show and they don't give in because they say “you are the one who has to explain, you are the teacher.” But then I say “I only have to do something when you can indicate which help you need. You first have to know what you find difficult and why you can't solve it, before I help you.

When he notices that his students experience difficulties, and that confronting them did not lead to the desired results, Neill decides to take the lead and takes over responsibility. He does not want his students “to flounder.” Neill assumes his students are too young to totally self-regulate their own learning and therefore need help from the teacher:

Students just have to know what is expected from them....that has to be clear, they like that, they need that.. And so ehm...the direction of their activities must be clear. They

have to learn to do it themselves. I ehm, I don't have the illusion they are already able to do it themselves in the fourth grade. [...] You don't have to throw them into the deep when they are 16 years old. They are not able to. Research already showed that 16 years old are not able to do that themselves. But you have to prepare them for their next study.

In Table 1, Neill's results concerning "agency" are presented.

TABLE 1 Neill: Notion and type of negotiations concerning "agency"

Notion of agency	Key excerpts
<i>Independency</i>	
Neill often mentions verbs like "independency," "taking initiative," and "responsibility." Neill expects his students to become "responsible participants" in his lessons, and wants his student to take initiative for their learning. We found that agency, in Neill's terms, means most of all "becoming independent from the teacher":	<i>That is an effect of this context-based chemistry in my opinion, that you force students to call upon their own creativity so to say, and to avoid dependency. Dependency is detrimental for people. [...] and with these renewals you try to let your students to become more independent of the teacher [...] they need that in their further life, in their further education.</i>
<i>Type of negotiation</i>	
<i>Confronting</i>	
During the interviews, Neill uses verbs like "confronting," "poking," "making aware," and "pulling." Neill wants to make his students aware of their own responsibility for their learning, and "confronts" them with (the consequences of) their study behavior.	<i>So, I try to confront them with their own study behavior. Just in a conversation like "you did not do you work. Don't you think it is important? How are you going to do well on the test"? And with these type of questions I try to make students aware of their own behavior, to reflect critically...and they have to decide what they are going to do. [...]So, I ask my students "you have had to learn something, can you tell me what you have learned?" So, as a teacher I am a lesson behind so to say.</i>
<i>And then they have to calculate CO2. At a test, they will get other fuels where they have to calculate with. I tell them: "when you don't cooperate, and when you don't contribute to the solution of the problem, you will have a problem at the test. Then it is your problem.</i>	
<i>Controlling</i>	
Neill describes situations in which he noticed that students did not do what he expected, and then took strong control over their work, by taking the lead and taking over work of the students. Neill uses verbs like "following directions," and "meeting expectations":	<i>With respect to their study assignment I discussed with them how a presentation should look like, and emphasized how they should motivate their choices based on chemical arguments. The first question I got from a rather bright student concerned transesterification, and it was clear this student did not understand anything about it. So, I asked other students about the content, and it appeared none of the students could explain what was meant. So, I decided, very old-fashioned, to give a frontal instruction about the subject matter, and explained chemical concepts like isomers, alkanes, alcohol, and carboxylic acids. To give them the opportunity to understand the subject matter and to go on with their presentation.</i>
<i>Ehm, also the way acids and bases are presented, the way that students got instruction by the context-based chemistry method was completely different than they were familiar with. And I changed the assignment and the text a bit, so that they got sufficient opportunity to learn the basic knowledge. And well, this is an example about how I changed learning material so that my students could understand the subject content.</i>	

### 4.3 | William's notion of and negotiations on agency of learning

In the interviews that were held with William, William refers to agency of learning as “the interdependence between students and between the teacher and students”:

What I think is the key of this context-based chemistry education is “how to deal with collaborative learning.” You cannot accomplish the tasks as individual, you really need one another

William does not regard collaboration as only “means” for students to reach certain learning aims, but regards it as a “learning process in itself”. William argues that by supporting his students to collaborate they will become more independent of their teacher, and become responsible for their own learning. In the situations that concern agency, William explicitly indicates that he anticipated guiding the students to their autonomy, and makes it a topic during the lessons.

William perceives his students as “knowledge owners,” who can learn from each other, and whom he can learn from himself:

I say that all the time to my students: I learn something from you.

William is convinced that his students are able to think critically, however, as a teacher you have to guide your students in this process. Therefore, William developed tools for his students to guide them to engage in collaborative learning, such as planning boards, and instruments to evaluate their group work.

In the teacher–student negotiations William describes, the focus is on “boundary setting” and on “empowering students.” William indicates that, in the end, he is in charge of what happens in the classroom, since he sets the boundaries wherein his students can move freely. Furthermore, William thinks his main task is to make students aware of the opportunities they themselves have to learn. William's results concerning “agency of learning” are described in Table 2.

TABLE 2 William: Notion and type of negotiations concerning “agency of learning”

Notion of agency	Key excerpts
<i>Interdependency</i>	
William mostly emphasizes the interdependency between students when learning, and focuses on how students have to change their roles in relation to each other. He often mentions verbs like “freedom,” “space,” and “collaboration.” William thinks both himself as well as his students have to cope with becoming interdependent, self-regulated learners:	<i>And what I find most important...actually I think this is the key word in context-based chemistry, or with this new way of learning: How do you cope with collaborative learning, as a teacher and as a student? And these contexts-based chemistry groups are so big, you cannot do it on your own and so you have to...you become dependent on one another as students, so you have to make appointments, and right, with this way of working, they have to plan their learning themselves, they become able to regulate themselves, and they become able to call upon each other.</i>
<i>Type of negotiation</i>	Key excerpts
<i>Boundary setting</i>	
William deliberately creates situations in which self-regulated behavior is expected from the students, and where self-regulation is the central focus. He sets the boundaries for their learning. Thereby, William developed tools so students become able to plan and monitor their learning. William uses verbs as “setting standards,” and “clarifying expectations”:	<i>In the classroom I set the standards: what they have to do..what are the aims, you have to know and to be able to do this and that at the end.. These are high standards, however, the how...how you are going to walk the road, I do not have anything to say about that. [...]However, it is very clear what is expected from them, what they have to reach for. They know how they will be assessed...So, I strongly regulate their learning at the beginning, and in this way I give them certainty and assurance they need.</i>

(Continues)

TABLE 2 (Continued)

Notion of agency	Key excerpts
	<p><i>William describes the planning format his students work with: "We work with a planning format, with these flap-over posters and ehm horizontally these posters are divided in three columns:: to do," "busy with," and "done." And in the rows you see the weeks. And we work with these yellow stickers. And ehm, with these stickers they plan. So ehm, every week you put a sticker on what to do, what are you busy with during the lesson and at the end you put a sticker on done or back to "to do." And so I get insight in their learning process.</i></p>
<p><i>Empowering</i></p> <p>William empowers his students by making them aware of their abilities and qualities. William uses verbs like "activating," "motivating," and "paying attention." William explicitly pays attention to this in his lessons, and even makes it a topic during the lessons. Furthermore, William empowers his students by pointing out that they are knowledge owners by explicitly paying attention to share their knowledge in the classroom:</p>	<p><i>I activate them to form groups on basis of their core qualities. So ehm, when students have read out loud their core qualities I tell them "guys, pay attention because I am going to choose 7 students who think their core qualities are organizing and leading" etcetera. They are going to be the leaders of the groups and they have to choose other students with different qualities which you need to come to a good product in the end. The leaders have to motivate why they choose someone in their group.</i></p>
	<p><i>And then a girl said like "well" ..they were collaborating and one of these girls, Elise who sits here, she said, "well, you know what we can do, I have a nice idea. When I put this idea on paper, like a start, and you are going to comment on that." "Hey that's a good idea," said the boy there, Matthew, "and then I will" .. And well, they activated each other's' thinking in some kind of way, and I heard that because it was quiet and I said "guys listen." I said "I just learned something from you. Would you like to share that with the rest of your classmates?" She did not know what I meant, so I told her "I only say one word 'a start'. 'O yes, yes'. So she told the class what she told before. And her idea stimulated others to come up with own ideas."</i></p>

#### 4.3.1 | Teacher–student negotiations concerning vulnerability

Both William and Neill refer to uncertainties and vulnerability in their interactions with students that are brought into the classroom with the context-based chemistry reform. They both acknowledge that moments occur in their teaching where you simply do not know what to do as a teacher, and acknowledge that, as a teacher in the context of reforms, you are a learner as well. Being vulnerable, as teacher and as students, meant something different for both teachers. Whereas Neill finds it difficult to expose his vulnerability to his students, William deliberately demonstrates his vulnerability toward his students, and, in a way, embraces vulnerability. Furthermore, Neill as well as William notice that their students are sometimes uncertain about whether they proceed in the right way concerning the reforms. Neill indicates that he just accepts that his students are uncertain, and perceives uncertainty as inherent in reforms. William also thinks that reforms bring uncertainties, however, William deliberately anticipates these uncertainties by providing students with reflective consultation moments, where they can discuss their progress with William.

#### 4.4 | Neill's notion of and negotiations on vulnerability

Neill indicates that the context-based chemistry reforms come with uncertainties for both himself and his students, and explains that both he and his students experience difficulties in actually "knowing who has to do what when."

What I find most difficult is that sometimes students didn't understand where I wanted to go with them. I let them go and ehm...well the average havo (higher general secondary education) student normally strongly depends on the teacher and ehm they think like "just come on with your story and we listen as much as we can" and now they have to take initiatives themselves and then you wonder like "do they get the message or not?"

This excerpt shows that, due to the reform, for Neill's students, it was not always clear what was expected of them, and Neill felt insecure about whether his students understood the point. Thus, Neill thought that uncertainties were inevitable during the reforms. Furthermore, Neill explains that he thinks vulnerability is important for his personal development as a context-based teacher. He explains that, during professionalization meetings with colleagues of other schools, it is very valuable to share difficulties one experienced during the reform:

...and, thus, this vulnerability, you have to dare to show that, that sometimes things are difficult. And in these professionalization groups, you can help each other.

Conversely, Neill found it difficult to show students his vulnerability in the classroom, and argues it might even work against him because his students might take advantage of the situation by pointing out that this new chemistry method is not beneficial for them:

Well I can be vulnerable but, at the same time, I hold my reservations towards my students. I listen to my students but, while renewing and aiming at a certain direction with this reform, students can be critical, and then I have to argue against these critics, and they did not agree [...]. And I took a stand, I did not want to compromise during this experiment. I wanted to test it fully, as I had in mind.

The negotiations Neill described concerning "vulnerability" included "convincing" students that the context-based reform was effective for them, and "not giving in" to students criticisms. Results of the teacher–students negotiations concerning vulnerability can be found in Table 3.

TABLE 3 Neill: Notion and type of negotiations concerning "vulnerability"

Notion of vulnerability	Key excerpts
<p><i>Uncertainty</i></p> <p>For Neill, vulnerability is strongly related to uncertainty. Neill indicates to be careful in showing his vulnerability in the classroom, for the reason he sometimes feels "attacked" by his students in implementing the context-based renewals. Neill often mentions verbs like "get a grip on," "take a leap of faith," and "lead with one's chin" referring to his own position in the context-based renewals. He had to overcome uncertainties. When it comes to his students. Neill uses verbs like "accepting uncertainty" and "floundering." Neill accepts he and his students feel uncertain from time to time, and thinks this is inherent in change processes.</p>	<p><i>Well ehm, everytime you have to take the leap of faith, and afterwards you can reflect on how you reached the shore... And there are always things that went well and went less well, so it is a process of continual reflection [...]. And I was quite unscrupulous by saying to my students...ehm I stick to the plan in my way of teaching. I just accepted that my students felt highly uncertain I just indicated that they (students) were responsible for their learning. And when they asked me "tell us what we should do" I responded "No I won't" and I hold on to the context-based renewals.</i></p>

(Continues)

TABLE 3 (Continued)

Notion of vulnerability <i>Type of negotiation</i>	Key excerpts Key excerpts
<p><i>Convincing</i></p> <p>During the interviews, Neill uses verbs like “convincing” and “persuading.” Neill deals with the uncertainty of his students by convincing them that the new method is beneficial for them, especially when they enter higher education.</p> <p>Furthermore, Neill also explains he had to become convinced himself about the new chemistry method.</p>	<p><i>Look, I listen to my students, right? However when I am taking part in an educational renewal I do not want to compromise. Students are allowed to criticize the method, however I always parried their arguments with counter-arguments. [...] I want to test this new method fully...well and what I think, in their whole life, in their next study, they have to deal with these kind of demands. In higher professional education they have to regulate their own learning at a high level... The chance my students will become drop-outs in their advanced education has to be reduced. Thereby, autonomy is not only important at school, it is important in your life as a whole.</i></p> <p><i>So, ehm well...I had to teach in a completely different way, and to get convinced myself that this way was a good way for the students. However, materials were not complete, and I had to alter a lot. And renewals, that means that things go differently than before, and students have to get accustomed to this new way of working.</i></p>
<p><i>Not giving in</i></p> <p>Another negotiation Neill used was “not giving in” toward his students. During the interviews, Neill mentions verbs like “rigid” and “to stand firm.” Neill refers to himself as “critical follower,” which means he wants to implement the new chemistry method as intended, and he does not want to compromise. The difficulty was that his students then did not understand why Neill implemented the context-based chemistry method.</p> <p><i>And they did not like it because they had to approach it differently than they were used to[...] and their teacher, he did not give in, and they felt frustrated about that.</i></p>	<p><i>What I find most difficult is that sometimes students didn't understand where I wanted to go with them. I let them go and ehm...well the average havo student normally strongly depends on the teacher and ehm they think like “just come on with your story and we listen as much as we can” and now they have to take initiatives themselves and then you wonder like “do they get the message or not?” And ehm, I was rather reckless by saying ehm “I don't give in a bit in this way of teaching.” I just accept these students feel very uncertain, and I indicated “you stay responsible</i></p> <p><i>Despite of my instruction concerning isomers, alkanes and alcohols, only 30% of the students had done their homework. This meant “war” with the teacher. Only students who had done something with my explanation were allowed to ask questions about the subject matter.</i></p>

#### 4.5 | William's notion of and negotiations on vulnerability

William understands vulnerability as inherent in reforms for both himself as his students. However, where Neill avoids being vulnerable among his students, William uses his vulnerability to improve his teaching. William exposes his vulnerability toward his students, by deliberately indicating that “he does not know everything,” and that the reforms are a joint concern. According to William, he and his students construct education together, so William takes the role of his students into account:

Well, I have to. Look, I can think that what I do is right...but I want feedback from my students. I love this new way of working...but at the same time this is a trial, and I am not sure how it is going to unfold...so students help me to develop, and while developing you learn more about yourself.

William perceives himself as a “learner-between-learners,” and perceives the context-based chemistry reform as a joint process. William takes his students seriously by asking them systematically for feedback about their experiences with context-based education:

I asked my student to give me feedback, positive aspects and negative aspects, about context-based chemistry, and their collaboration [...] I analyzed their feedback, deducted the main points, the strengths and weaknesses.

So, one of the negotiation strategies William deliberately uses is “consulting” his students, and, in doing so, he exposes himself as also being a learner.

Another negotiation strategy William uses in the classroom is to get into dialogue with his students about the importance of trust. William recognizes that collaborative learning involves uncertainties for students, and has thought about ways to cope with these uncertainties. William gives lessons about trust and cooperation to his students, and gets into dialogue with students regarding how they can trust each other while collaborating in the context-based classroom:

It is all based on trust...you give them trust and explain at forehand what they can expect [...] I make demands, these are high demands. I get in a conversation with them about why trust is important when collaborating, and why collaborating might add to their learning.

William illustrates this as follows:

I prepared a lesson about collaborative learning and trust, a full lesson of 1 ½ hour, about trust and collaboration. In this lesson I discuss these topics with the children. I ask them “what is trust?” and I give them assignments about trust. I ask them questions: “when can you trust one another,” “what can you do so that another one can trust you” and so on. Then I talk with them about collaboration. “When do you need each other?” “Why is it helpful?” “When is it helpful”? I let them think about their core qualities (“core quality,” “pitfall,” “challenge,” “allergy”). Then, we are going to compose groups on basis of their core qualities.

We refer to this negotiation strategy as “communicate trust.” Results are presented in Table 4.

TABLE 4 William: Notion and type of negotiations on “vulnerability”

Notion of vulnerability	Key excerpts
<i>Shared vulnerability</i>	
William acknowledges that change is a vulnerable process, for both himself as for his students. William explicitly pays attention to vulnerability by demonstrating that he does not know everything himself. William perceives himself as a learner among learners (his students). William often mention words like “learning” and “confirm.”	<i>I say that all the time to my students “I learned a lot from you guys.” I think my students like that. I think that it's a kind of confirmation that I do not know everything. That a teacher who stands in front of the classroom does not know everything. And they know, they are uncertain and they do not know a lot yet...they are learning too.</i>
<i>Type of negotiation</i>	
<i>Consulting</i> William takes the opinion of his students very seriously for his own learning, and asks them to give feedback on the new chemistry method. In this way, he can assess what students think about the context-based chemistry renewal. William uses verbs like “learning,” “feedback,” “trial,” and “developing.”	<i>I collected positive and negative points of how students perceive the chemistry lessons and this is what students say about it: “it is clear, strong, fair, gives us freedom, gives us trust, you have to regulate your own work, you can monitor your study yourself, everyone can do what he or she can do well [...] negative points: sometimes it is too difficult. I would like to start with ten minutes lecture every lesson, the danger is you are going to postpone your work, I need more help now and then. [...] So, I am going to analyse their feedback, also my own reflections.</i>

(Continues)



TABLE 4 (Continued)

Notion of vulnerability	Key excerpts
	<p><i>Some students didn't find the right solution. And then I ask them: "Guys, help me. How do you think? What happened? [...] Potassium nitrate isn't the same as nitric acid. KNO<sub>3</sub>, it contains no H, so it can't be an acid". And I just don't understand what went wrong, cause I thought I explained it well. So I ask them: "tell me please, where is the missing link?"</i></p>
<i>Communicating trust</i>	
<p>William gives his students trust and certainty by explicitly giving attention to the importance of trust when you have to cooperate. Furthermore, William shows his students he trust them by "letting go" as he calls it himself. Sometimes, William indicates, this causes uncertainty, however more for the teacher than for his students.</p>	<p>William gives a lesson about trust and cooperation to his students: "I only can tell what I do...when I start with cooperative learning, so to say, I start the lessons with a powerpoint presentation which I discuss with my students. The powerpoint is named: trust and cooperation. So I asked them" what is trust"? "Do you need it?" "How can you trust others when you cooperate?" "How can other students trust you?"</p>
	<p><i>After holiday I came back to school and then... I felt tempted to interfere... like ehm, they are busy for a while now and my students entered the classroom and they immediately hang up their planning posters and got to work. However, I felt a bit uncomfortable so I started to walk around and asked them questions like "ehm guys, do you know what you are doing, and what you need to proceed?" And they responded: "yes, don't worry, we are fine." And they went on but I still felt uncertain. However I realized that it was my problem, not theirs. And so, I really had to let them go, to give them freedom.</i></p>

#### 4.5.1 | Teacher–student negotiations concerning care

Neill and William both express that they care a lot about their students. They also indicate that the context-based chemistry method brings about changes in the role of the teacher, which has implications in how they relate to their students. Neill values the interactions with individual students about personal matters most. Neill emphasizes that taking an interest in the individual characteristics of the student is essential in maintaining a good relationship. Thus, Neill shows interest in students as individuals. William also cares about his students, and emphasizes that, as a teacher, you should perceive students as individuals. In contrast with Neill however, William takes specific care of his students as *learners*. This means that William focuses on the students' personal qualities that are valuable for their learning and collaborative learning. His students need to be aware of their qualities to constructively collaborate and become conscious about who they are as learners.

#### 4.6 | Neill's notion of and negotiations on care for his students

During the interviews, Neill repeatedly highlighted his care for his students:

In the classroom, what I find most important, is the interpersonal aspect. And besides that, I sell chemical goods. I do that in my own way. And I am proud of my subject, of course, however what I mostly enjoy is that you really can mean something for your students.

For Neill, the interpersonal contact with his students is of great importance and, in our study, we found one type of negotiation Neill indicated to use in the classroom to maintain positive relationships with his students, namely "showing personal interest":

Just to show interest, like, for that student playing soccer is important, or that student goes to a pop festival. So, I ask this student "which artist do you like?" Just these little personal considerations, that is so important for the relationship with my students. To let them notice that I am really interested in them as individuals.

During the interviews, Neill frequently mentioned individual cases as examples, especially students who experienced difficulties in the classroom or at home, and who Neill tried to help. Neill is willing to explore with his students how they can proceed with studying while experiencing difficulties in their personal life. He takes pride when students overcome their problems. Referring to his relationship with his students during the context-based chemistry reform, Neill indicated that the reform was not always beneficial for his relation with his students, and sometimes were even detrimental. Therefore, a second negotiation Neill engaged in with his students was “restoring relationships.” In one of the interviews, Neill states that:

I just know that when you start reforming your education, things happen where the class will be annoyed about, and they will show their frustrations to the teacher, to me. [...] and then I wonder “what should make the students feel better? And then I tell them not to worry about the results [...] and I have personal talks with them about their daily life, cause talking with young people, that is so inspiring, believe me.”

Results are presented in Table 5.

TABLE 5 Neill: Notion and type of negotiations concerning “care”

Notion of care	Key excerpts
<i>Personal care</i>	
<p>Neill mentions several times that he finds the interpersonal relation or connection with his students most important. In the interviews, the personal contact Neill values with his students are mostly isolated from the subject chemistry. Neill refers to interpersonal moments before, during or after the lessons. During the interviews, Neill frequently mentioned individual cases as example, especially students who experienced difficulties in the classroom or at home, and who Neill tried to help. Verbs that Neill uses a lot in this context are “personal interest,” and “bond of trust” however, when it comes to student learning, Neill finds it sometimes difficult to show care. Neill experiences much resistance from his students when it comes to the context-based method, and he has to “push-and-pull” to get his students to learn.</p>	<p><i>In my role as teacher I mostly value the interpersonal contact I have, however I doubt if I am such an inspirer for the subject chemistry, I don't know that for sure. I have doubts about that [...] I am an individual, as teacher, with heart and soul. And though I think that it is good what I am doing in the classroom, how I implement the renewals...I am not sure if the students saw that either. Ehm..sometimes I am afraid I was too much an enemy for them, who pushed too hard [...] And although I still like to teach, because the interpersonal interaction with my students is something fun, it is hard to “seduce” these students to engage in self study, that takes so much energy.</i></p>
<i>Type of negotiation</i>	
<i>Showing personal interest</i>	
<p>The negotiation strategy Neill uses mostly is showing personal interest toward students. Neill gets into small conversations with his students about their personal interests, their well-being, and tries to give them support to keep going when they find things difficult</p>	<p><i>Just these small conversations, these little moments of attention, then you can create a bond of trust with the children en that is very important. You have to show them you are really interested in them as individuals, especially when you are a supervisor of the students. In the fourth grade they can feel sad and miserable, and then, at their graduation you see the same student being proud and then you think “yes, I contributed here and there and now she has confidence.”</i></p> <p><i>And I really find that much more important that they ehm... they become a good citizen, a good human being, than that they get a good degree for chemistry. Of course I like it when they get a good degree, but I find that other aspect 1,000 times more important.</i></p>
<i>Restoring relation</i>	
<p>In getting his students to learn according to the context-based chemistry method, Neill frequently experiences friction. Neill finds it tiring to constantly activate his students to do their work, and feels frustrated about this struggle. Neill indicates that sometimes he and his students found themselves in a so-called “war-zone.” However, Neill acknowledges he did not always find the resources to give them constant support, and then gives up.</p>	<p><i>I should have communicated more to the students about it. I had to invite them more, to get on with their learning, and actually they should have had the permanent idea that I support them, to give them a chance to make mistakes. And sometimes I could not bring that up anymore [...] it costs so much energy to put in these futile things, all these small struggles about who has to do what.</i></p>

#### 4.7 | Williams notion of and negotiations on care for his students

William also expressed the importance of having a good interpersonal relationship with his students. Just like Neill, William acknowledges that showing personal interest in students is very relevant, and treats his students “as individuals.” We called the negotiations he uses “seeing students.”

Well, sometimes I say, and I think this is very important, I really find that important.  
Look, I have a class of 30 students and these are 30 individuals. I see every child.

While also showing personal care, William takes a slightly different approach to this than Neill. William is particularly interested in the personal capabilities of his students:

Last week a colleague of mine asked me about my drive in the classroom and I answered: “ehm...to get the best out of the children, to acknowledge their capabilities.”

Furthermore, William emphasizes that these capabilities, or so called qualities, must be related to study skills and knowledge, and, most importantly, students must become aware of their own and each other's capabilities in the classroom. We called this type of negotiation “taking interest in student's personal *learning*.” Results are presented in Table 6.

TABLE 6 William: Notion and type of negotiations concerning “care”

Notion of care	Key excerpts
<i>Care for students as</i>	
William explains for his students it is important to be seen as “human beings” and as learners. Verbs William uses a lot are “respect,” “love,” and “individuals.” William is convinced that his students feel respected by “seeing them as they are as individuals, and as the learners they are.” William perceives his students as fully-fledged participants in the classroom.	<i>I asked my students the same type of difficult questions you asked me, and I asked them: What did I specifically do? “Well, you name things about me that really tells something about me. Yes, you treat us like humans. You see me.” [...] I love humans, I love children.</i>
<i>Type of negotiation</i>	
<i>Seeing students</i>	
Several times during the interviews William refers to the point that he values his students as “human beings.” He sees them as knowledge owners in the classroom. William uses verbs like “proud” and “growth.” William further indicates it is not only valuable for his students to be seen by himself, however also by each other. He wants all his students to be seen.	<i>At a certain moment, a girl in the 3th grade said: you can tell something about every student here in the classroom, and what you say just makes sense. I think this is one of my strengths: I see what happens in the classroom. The students in my class, the way they feel, well you have to adjust to that.</i>
<i>Taking interest in students' personal learning</i>	
William perceives and treats his students as full participants in his classroom, and expects them to have valuable contributions in classroom conversations and building knowledge. William uses verbs like “free, giving confidence, and personal learning.” William negotiates the subject matter with his students, as well as how to learn it in a very equal way. William relates to them as equals.	<i>Well, and at the moment one students tells another student “I choose you in my group cause you're very good in calculations,” you saw that child growing at that moment and feeling proud cause she was valued for being smart. And this happens all the time, these students make each other compliments, and they “grow.” This is what I hear from my students: “You have confidence in us, and let us free.” And that's the key: to trust students, to give them freedom, and that they learn thing about themselves So, ehm, they have to write down 5 personal qualities that are related to their study skills...that was a mistake I made in the beginning, that I asked them to write down personal qualities without relation to the subject. I want them explicitly to think about how they can contribute in the classroom.</i>

This study is a first attempt to gain insight in the type of teacher–student negotiations that occur during the implementation of a context-based curriculum, from the perception of two chemistry teachers. With this study, we aimed for a deeper understanding of what possible difficulties and successes context-based teachers experience during these negotiations with their students, by answering the following research questions:

- In what type of negotiations do teachers and their students engage while implementing a context-based chemistry curriculum in secondary school, from a teacher's perspective?
- What are differences in the perceived teacher–student negotiations between the two teachers?

Regarding the first research question concerning the type of negotiations that the teachers and their students engaged in during their first year of the context-based chemistry reform, there were negotiations focused on (i) agency of learning; (ii) vulnerability; and (iii) care for their students.

In answering the second research question, we found Neill and William to engage in different teacher–student negotiations during reform. Both teachers acknowledged that context-based chemistry called for different thinking and behavior compared to more traditional chemistry teaching, both from themselves as teachers and from their students. With reference to “agency of learning,” Neill's understanding about the concept was that students should become independent as learners. Neill indicated that his students experienced difficulties with that, and, therefore, engaged in so-called “confronting” and “controlling” negotiations. Neill confronted his students with their behavior when they did not “take their responsibility to learn” and, conversely, had to exert control to try to ensure his students stayed on track. Sometimes, Neill felt the urge to take over some of their tasks, such as by making a plan for them. Neill reported that sometimes his students were “floating,” and that, therefore, he wanted to help them.

William's understanding of “agency of learning” was mostly focused on “interdependency,” both between students and between the teacher and his students. According to William, students really “needed one another” in their learning. The kind of negotiations that William engaged in with his students included “boundary setting” and “empowering” negotiations. William suggested that, as teacher, he had the responsibility to create the setting wherein his students could learn. Furthermore, William emphasized the importance of making students aware of their own possibilities and ideas in order for their learning to proceed.

The second type of negotiation we found was “dealing with vulnerability.” Both teachers acknowledged that context-based changes in their classrooms implied vulnerability for both the teacher and the students. Neill explained during the interviews that he acknowledged that his students felt uncertain and that this was an inherent feature of reforms. According to Neill, students did not always see where he was going and, therefore, he had to convince his students the reform was beneficial for them. Thereby, Neill illustrated that he sometimes struggled “not to give in” to his students' pleas to “explain to them what to do,” or to revert to more traditional practices.

William experienced the reform endeavor as a shared endeavor, and reported to have explicitly expressed this vulnerability in the classroom. William made a shared experience of dealing with vulnerability by consulting students about what their feelings and ideas were about the context-based chemistry reform, and by emphasizing the importance of trust in cooperative learning.

The last type of negotiation that came forward in this study, namely “care,” appeared to be of the utmost importance for both teachers. During the interviews, Neill and William frequently expressed how they cared for their students. Neill mostly referred to personal care toward his students, by

showing personal interest in their lives. He valued these moments of personal contact, whereby he asked students about their interests and problems. At the same time, Neill indicated that he had to invest in keeping a good relation with his students during the reforms. Neill asked himself “did my students not see me too much as an enemy, who forced them to learn in a different way?” Neill sometimes indicated that he felt too tired to be patient with his students, and their learning.

William argued that “seeing students” is important, in the way that, as teacher, you have to see what your students need, and how they contribute to the learning in the classroom. Moreover, William proposed that he found it important to treat his students as equals and to value their potential. Thus, three themes concerning teacher–student negotiations in context-based chemistry reform emerged from the data analysis process, whereby we found both teachers to engage in different negotiations with their students, which, we argue, can have important consequences for the success or failure of reform. In the following section, we will discuss these findings, and their value for further research.

## 5 | CONCLUSION/ DISCUSSION

In the context-based chemistry reforms, not only the role of the teacher changes, also the students are expected to fulfill different roles. As a consequence of this reculturing of the classroom (Fullan, 2001; Windschitl, 2002), a new equilibrium has to be found in the interaction of the teacher with his or her students. According to Dinan-Thompson (2001), curriculum change implies interaction between different actors in the reform process:

Curriculum change occurs in social and political environments. The interactional nature of change between student-teacher, teacher-teacher, teacher-administration, and teacher-stakeholder brings a micro-political perspective to change processes. Micropolitical studies in education demonstrate that personal and systematic relations cannot be discounted in the syllabus-curriculum-policy construction and implementation process (Ball, 1987; Sparkes, 1990; Blasé and Anderson, 1995; Datnow, 1998). In fact, if they are ignored then it is most likely that educational change processes will fail (Sparkes, 1990; Datnow, 1998). (p. 7)

The importance of the interactional nature of change, specifically the interactional nature of change between the teacher and his students, came forward in this study. In this study, it appeared that both teachers are aware of the idea that their role and the roles of the students are required to change.

The main finding of this study is that although both teachers thought that the context-based curriculum would be beneficial for students' learning, in the sense that they both felt a need for change, which is a very important incentive for implementing educational reforms (Southerland, Sowell, & Enderle, 2011; Woodbury & Gess-Newsome, 2002), their self-reported negotiations appeared to be very different.

First, we conclude that teachers cannot solely rely on curriculum materials to implement change, which is underlined by Schneider, Krajick, and Blumenfeld (2005) and Sherin (2002). Schneider et al. (2005) indicate that, although curriculum materials are “created to initiate changes on a large scale, directions alone are not sufficient for most teachers to implement effective practices for the reason that approaches with ambitious learning goals for students remain complex and challenging to enact” (p. 286). Sherin (2002) adds to this by proposing that curriculum materials are not always effective agents of change, due to the fact that teachers do not use this material as intended. However, we want to add to this notion that curriculum material is always interpretable in several ways. Teachers have to make the new curriculum their own, and have to find their way of implementing this in their classrooms. In fact,

curriculum developers expect teachers to use the curriculum in a certain way, however, we suggest it is the curriculum material itself that may cause diffusion. For example, when it is stated in the tutorial for teachers that students should engage in self-regulated learning and their job is to act as coach, how this self-regulated learning should take place, how it should be guided, and what it means to be a coach are often not defined at all (see also Goodyear & Dudley, 2015). In this study, both teachers were committed to the context-based chemistry reform, and used the same curriculum material. In practice, however, the teachers entered into different interactions with their students. In the case of Neill, this was not always beneficial for both the teacher and students, and even caused friction. William, conversely, indicated his students appreciated the new curriculum, and even worked harder.

Second, a change in teachers' thinking in line with the intended curriculum (Van Den Akker, 2013) may not be sufficient to change existing practices in a way that is beneficial for the learning and wellbeing of students and the teacher in the classroom. Literature on reform stresses the importance of changes in teachers' thinking and sense-making, which is thought to be of fundamental importance for the success of the reform (Spillane, Reiser, & Reimer, 2002; Windschitl, 2002). Both Neill and William adopted key principles inherent in context-based chemistry, such as the self-regulation of students and the teacher as facilitator or coach (Van Rossum & De Gruijter, 2010). However, the way that each of the teachers understood these concepts was substantially different. For example, where Neill emphasized the independence of his students concerning agency, William stressed the importance of interdependence. These different understandings had a profound impact on their self-reported classroom negotiations. We think, in line with Goodyear and Dudley (2015), that, as researchers, we have to think about what concepts such as "self-regulation," "agency," "cooperative learning," and similar concepts of social constructivist learning theories actually mean for *teaching* students, and gain insight into the mechanisms underlying teacher–student interactions. For example, a difference we found between the two teachers who participated in this study was that William had thought about what teacher–student interactions he preferred during the implementation of the curriculum *in advance*, and subsequently developed strategies he could use in the classroom. Furthermore, William had developed *tools* which he could use to regulate his students' collaborative learning, and by which he could guide his students' learning, such a planning boards, tools to order their thinking, and evaluation and feedback forms for their group work. Actually, he made the learning process central in his lessons, and had quite developed ideas of concepts such as "self-regulation" and "collaboration." William was further aware of the moments during the lessons where students took initiatives and valued their ideas, by making these explicit and gave his students opportunities to share their knowledge. Oldfather (1992) refers to this kind of teaching as "sharing the ownership of knowing," which she defines as "a dynamic of classroom interaction in which a teacher's constructivist epistemological stance facilitates students' sense of their own construction of meaning, and the integrity of their own thinking" (p. 3). To do so, as a teacher, you have to recognize these moments and be able to know what to do during these moments, so as to empower the students. William shows he did not merely rely on the developed curriculum material (the point we illustrated earlier in this conclusion), but rather adjusted the curricular materials in line with his own advanced ideas about collaborative learning. We want to point out, however, that, like Neill, most teachers do not have these developed ideas when they start reforming.

Neill explicitly stated that "he was a lesson behind, so to say," and referred to himself as a "critical follower." Neill had no explicit ideas about how to get his students to regulate their own learning, although he was committed to testing "the new method fully, without compromising." No doubt he wanted his students to become responsible for their own learning and to become creative thinkers. Subsequently, Neill engaged in discussions with his students about their "resistance to learn," which, we argue, led to both Neill and his students experiencing frustrations. His students had difficulties to



take the initiative for learning, and did not demonstrate “eagerness to learn,” in Neill his own words. The type of students that Neill describes has been described as “externally regulated students” (Könings, Brand-Gruwel, van Merriënboer, & Broers, 2008). According to Könings et al. (2008) “externally regulated students largely depend on the teacher and the learning environment for the regulation of their learning processes. The environment determines what must be learned and how it must be done” (p. 652). The opposite of students with an external locus of control are self-regulated students, who take their own initiatives for learning. For externally regulated students, it might be quite difficult to become self-regulated, and responsibility for learning should be gradually handed over from the teacher to his or her students. However, the only solution Neill may have had was to confront his students with their behavior, or to return to traditional practices, since this was the repertoire that Neill was familiar with. These teachers, therefore, need more guidance during implementing the reforms in daily classroom practice, and get time to reflect on their interaction with their students to understand what happens and why it happens in the classroom.

Last, we want to emphasize the importance of the teacher–student relationship, and how reforms might affect this relationship. Neill values his interpersonal relationship with his students most, and refers to it as “taking personal interest in students' lives.” In Neill's opinion, the reforms were sometimes detrimental for his relationships with his students. He suggested “students might have seen him as an enemy who forced them to do things they did not want to.” When, in the perception of the teacher, a reform might threaten the relation with their students, it is quite understandable that they return to practices where they are familiar with. William explicitly perceived his students as learners, and, for him, learning was an inherent aspect of his relationship with his students. He valued them for their qualities in learning, and his drive was to make his students conscious of their capabilities. This is a fundamental different stand to Neill's, who perceived the relationship with his students as mostly taking shape outside the lesson, during informal conversations. These informal conversations are indisputably important; however, they seem insufficient to help students with their learning. According to Hargreaves (1998), the emotional investments teachers make in their relationships with their students are ultimately important. In line with this, Hargreaves found that teachers are inclined to use traditional teaching practices, since these strategies contribute to feelings of happiness, provide a sense of safeness in the classroom, and diminish feelings of powerlessness. In this light, it is completely understandable that teachers choose not to use reform practices for the benefit of their students.

With this study, we want to stress the importance of taking the (perceived) interactional nature of curriculum change into account (King, 2012; Osborne, 2007). When designing reform, in the intended curricula hardly any attention is given to changes in interactions between the teacher and his or her students. We suggest that the interactions that teachers and students engage in during reform might contribute to or be detrimental to the success of the reforms. Especially when the relationship between the teacher and his or her students might be at stake, reforms are more inclined to fail.

This research is a first exploration to teacher–student interactions during chemistry reforms with two teachers, which has implications concerning the breadth of our findings. Although we believe these two teachers very strongly illustrate in what type of negotiations one can engage in during reforms, and how these negotiations shape and alter the reforms in the classroom, we suggest further research is needed to study actual teacher–student negotiations during reform. Particular interesting would be to focus on which negotiations are beneficial for both the teacher and his or her students.

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## REFERENCES

- Akker, J. (2013). Curricular development research as a specimen of educational design research. In T. Plomp & N. Nieveen (Eds.), *Educational design research: Illustrative cases* (pp. 52–71). Enschede: SLO, Netherlands Institute for Curriculum Development.
- Bennett, J., Gräsel, C., Parchmann, L., & Waddington, D. (2005). Context-based and conventional approaches to teaching chemistry: Comparing teachers' views. *International Journal of Science Education*, 27(13), 1521–1547.
- Bennett, J., & Holman, J. (2002). Context-based approaches to the teaching of chemistry: What are they and what are their effects. In J. K. Gilbert, O. de Jong, R. Justi, D. F. Treagust, & J. H. van Driel (Eds.), *Chemical education: Towards a research-based practice* (pp. 165–184). Dordrecht: Kluwer Academic Publishers.
- Bennett, J., Lubben, F., & Hogarth, S. (2007). Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. *Science Education*, 91(3), 347–370.
- Biggs, J. (1999). What the student does: Teaching for enhanced learning. *Higher Education Research & Development*, 18(1), 57–75.
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3–15.
- Bowen, G. A. (2006). Grounded theory and sensitizing concepts. *International Journal of Qualitative Concepts*, 5(3), 12–23.
- Chafi, M. S., & Elkhouzai, E. (2017). Reculturing pedagogical practice: Probing teachers' cultural models of pedagogy. *International Journal of Educational and Literacy Studies*, 5(1), 78–85.
- De Jong, O. (2008). Context-based chemical education: How to improve it? *Chemical Education International*, 8(1), 1–7.
- Dinan-Thompson, M. (2001). *Investigating educational change: A study of curriculum construction and implementation in Health and Physical Education* (Unpublished PhD thesis). University of Queensland Australia.
- Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, 50(1), 25–32.
- Erlanson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods*. Newbury Park, CA: Sage Publications.
- Evans, C., & Kozhevnikova, M. (2011). Styles of practice: How learning is affected by students' and teachers' perceptions and beliefs, conceptions and approaches to learning. *Research Papers in Education*, 26(2), 133–148.
- Frelin, A., & Grannäs, J. (2010). Negotiations left behind: In-between spaces of teacher-student negotiations and their significance for education. *Journal of Curriculum Studies*, 42(3), 353–369.
- Frelin, A., & Grannäs, J. (2014). Studying relational spaces in secondary school: Applying a spatial framework for the study of borderlands and relational work in school improvement processes. *Improving Schools*, 17, 135–147.
- Fullan, M. (2001). *The new meaning of educational change* (3rd ed.). New York: Teachers College Press.
- Gilbert, J. K. (2006). On the nature of context in chemical education. *International Journal of Science Education*, 28(9), 957–976.
- Goodyear, V., & Dudley, D. (2015). "I'm a facilitator of learning!" understanding what teachers and students do within student-centered physical education models. *Quest*, 67(3), 274–289.
- Hargreaves, A. (1998). The emotions of teaching and educational change. In A. Hargreaves, A. Lieberman, M. Fullan, & D. Hopkins (Eds.), *International handbook of educational change* (pp. 558–575). Dordrecht: Kluwer.
- Keeley, S. M., Shemberg, K. M., Cowell, B. S., & Zinnbauer, B. J. (1995). Coping with student resistance to critical thinking: What the psychotherapy literature can tell us. *College Teaching*, 43(4), 140–145.
- King, D. (2012). New perspectives on context-based chemistry education: Using a dialectical sociocultural approach to view teaching and learning. *Studies in Science Education*, 48(1), 51–87.
- Könings, K. D., Brand-Gruwel, S., van Merriënboer, J. J. G., & Broers, N. J. (2008). Does a new learning environment come up to Students' expectations? A longitudinal study. *Journal of Educational Psychology*, 100(3), 535–548.
- Levin, B. (2000). Putting students at the centre in education reform. *International Journal of Educational Change*, 1(2), 155–172.
- Lichtman, M. (2006). *Qualitative research in education: A user's guide*. Thousand Oaks, CA: Sage.
- Lindblom-Ylänne, S., Trigwell, K., Nevgi, A., & Ashwin, P. (2006). How approaches to teaching are affected by discipline and teaching context. *Studies in Higher Education*, 31(3), 285–298.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Sage Thousand Oaks, CA.
- Mitra, D. L. (2003). Student voice in school reform: Reframing student-teacher relationships. *McGill Journal of Education*, 38(2), 289–304.
- Muir, T. (2010). Using video-stimulated recall as a tool for reflecting on the teaching of mathematics. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia* (pp. 438–445). Fremantle: MERGA.
- Onwuegbuzie, A. J., & Leech, N. L. (2007). A call for qualitative power analyses. *Quality & Quantity*, 41(1), 105–121.
- Osborne, J. (2007). Science education for the twenty-first century. *Eurasian Journal of Mathematics, Science and Technology Education*, 3(3), 173–184.
- Osborne, J. F., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049–1079.
- Overman, M., Vermunt, J. D., Meijer, P. C., Bulte, A. M. W., & Brekelmans, M. (2014). Students' perceptions of teaching in context-based and traditional chemistry classrooms: Comparing content, learning activities, and interpersonal perspectives. *International Journal of Science Education*, 36(11), 1871–1901.
- Patton, M. Q. (2002). Two decades of developments in qualitative inquiry. *Qualitative Social Work*, 1(3), 261–283.

- Pedersen, S., & Liu, M. (2003). Teachers' beliefs about issues in the implementation of a student-centered learning environment. *Educational Technology Research and Development*, 51(2), 57–76.
- Potvin, P., & Hasni, A. (2014). Interest, motivation and attitude towards science and technology at K-12 levels: A systematic review of 12 years of educational research. *Studies in Science Education*, 50(1), 85–129.
- Schneider, R. M., Krajick, J., & Blumenfeld, P. (2005). Enacting reform-based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching*, 42, 283–312.
- Schwartz, A. T. (2006). Contextualised chemistry education: The American experience. *International Journal of Science Education*, 28(9), 977–998.
- Sherin, M. G. (2002). When teaching becomes learning. *Cognition and Instruction*, 20(2), 119–150.
- Sjøberg, S., & Schreiner, C. (2010). *The ROSE project: An overview and key findings*. Oslo: University of Oslo.
- Smylie, M. A. (1999). Teacher stress in a time of reform. In R. Vandenberghe & A. M. Huberman (Eds.), *Understanding and preventing teacher burnout: A sourcebook of international research and practice* (pp. 59–84). New York: Cambridge University Press.
- Southerland, S. A., Sowell, S., & Enderle, P. (2011). Science teachers' pedagogical discontentment: Its sources and potential for change. *Journal of Science Teacher Education*, 22(5), 437–457.
- Spillane, J. P., Reiser, B. J., & Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research*, 72(3), 387–431.
- Tobin, K., Tippins, D. J., & Hook, K. S. (1994). Referents for changing a science curriculum: A case study of one teachers change in beliefs. *Science & Education*, 3(3), 245–264.
- Van Rossum, J., & De Gruijter, J. (2010). Contexten in de Groene Leerlijn voor Havo Scheikunde. *NVOX*, 3, 104–106.
- Wilson, F., Evans, S., & Old, S. (2015). Context-led science courses: A review. *Research Matters: A Cambridge Assessment Publication*, 19, 7–13.
- Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research*, 72(2), 131–175.
- Windschitl, M. (2006). Why we can't talk to one another about science educational reform. *Phi Delta Kappan*, 87, 348–355.
- Woodbury, S., & Gess-Newsome, J. (2002). Overcoming the paradox of change without difference: A model of change in the arena of fundamental school reform. *Educational Policy*, 16(5), 763–782.
- Yee, S. M. (1990). *Careers in the classroom: When teaching is more than a job*. New York: Teachers College Press.
- Yinger, R. J. (1986). Examining thought in action: A theoretical and methodological critique of research on interactive teaching. *Teaching and Teacher Education*, 2(3), 263–282.

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