Educational Research and Evaluation: An International Journal on Theory and Practice

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/nere20

The effects of guided elaboration in a CSCL programme on the learning outcomes of primary school students from Dutch and immigrant families

Fleur Ruth Prinsen [a], Jan Terwel [b], Bonne J.H. Zijlstra [c] & Monique M.L. Volman [c]

[a] Utrecht University, Utrecht, The Netherlands

[b] VU University, Amsterdam, The Netherlands

[c] University of Amsterdam, Amsterdam, The Netherlands

Version of record first published: 04 Dec 2012.

To cite this article: Fleur Ruth Prinsen , Jan Terwel , Bonne J.H. Zijlstra & Monique M.L. Volman (2012): The effects of guided elaboration in a CSCL programme on the learning outcomes of primary school students from Dutch and immigrant families, Educational Research and Evaluation: An International Journal on Theory and Practice, DOI:10.1080/13803611.2012.744694

To link to this article: http://dx.doi.org/10.1080/13803611.2012.744694

Educational Research and Evaluation, 2012
http://dx.doi.org/10.1080/13803611.2012.744694

Routledge
Taylor & Francis Group

The effects of guided elaboration in a CSCL programme on the learning outcomes of primary school students from Dutch and immigrant families

Fleur Ruth Prinsen[a]*, Jan Terwel[b], Bonne J.H. Zijlstra[c] and Monique M.L. Volman[c]

[a]*Utrecht University, Utrecht, The Netherlands;* [b]*VU University, Amsterdam, The Netherlands;* [c]*University of Amsterdam, Amsterdam, The Netherlands*

(*Received 13 June 2012; final version received 17 October 2012*)

This study examined the effects of guided elaboration on students' learning outcomes in a computer-supported collaborative learning (CSCL) environment. The programme provided students with feedback on their elaborations, and students reflected on this feedback. It was expected that students in the experimental (elaboration) programme would show better learning gains and that students from immigrant families would especially benefit. Two hundred primary school students of 9 different schools participated. The research can be characterized as a quasi-experimental study with a pre-test, post-test, control group design. In a multilevel regression analysis, no main effect of the intervention was found. However, there was a significant differential effect of the intervention; students from immigrant families in the experimental programme outperformed their counterparts in the control group. It can be concluded that guided elaboration in a CSCL programme through feedback and reflection is a promising approach.

Keywords: CSCL; outcomes; participation

Introduction

Computer-supported collaborative learning (CSCL) aims at engaging and supporting the active participation of all students in knowledge sharing and knowledge co-construction. It is supposed that CSCL enhances learning, since it provides learners with opportunities to test their ideas against the perspectives of others and to bring to light incorrect assumptions, misconceptions, and conflicting solutions. Learners are required to actively discuss their solutions and solve their conflicts, which is supposed to contribute to conceptual change (Doise, Mugny, & Pérez, 1998). However, some problems with CSCL have come to the fore over the past few years as well. Many studies on CSCL have shown that students for different reasons do not participate very intensely in electronic discussions or that, when they participate, substantial differences in individual participation rates occur (Hara, Bonk, & Angeli, 2000; Hewitt & Tevlops, 1999; Hoadley & Linn, 2000; Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003; Muukkonen, Lakkala, & Hakkarainen, 2005; Nurmela, Lehtinen, & Palonen, 1999). Moreover, the quality of the interactions in

*Corresponding author. Email: frprinsen@gmail.com

CSCL often appears to be less than hoped for (Kirschner, 2002; Kirschner, Buckingham Shum, & Carr, 2003; Stahl, Koschmann, & Suthers, 2006). An often-heard complaint is that the interactions of students working in CSCL remain shallow (e.g., G. Fischer & Ostwald, 2002; Stahl, 2000); contributions are short and not frequently elaborated (Veldhuis-Diermanse, 2002).

There is wide acknowledgement that the success of CSCL is determined by the quality of the interaction process (e.g., Van der Linden, Erkens, Schmidt, & Renshaw, 2000), but CSCL asks a lot from students since an appeal is made on collaboration and communication skills that might not have been addressed previously, let alone practised. Students need to be able to clarify their thoughts, ask each other for explanations, extract information from contributions of fellow students, elaborate their own explanations, encourage each other to participate, and so forth. Therefore, recent CSCL research has focused on the effects of interventions aimed at improving the quality of the interactions between students in CSCL environments (Constantino-Gonzalez, Suthers, & Escamilla de los Santos, 2003; F. Fischer & Mandl, 2005; Strijbos, Martens, & Jochems, 2004; Suthers & Hundhausen, 2001, 2003; Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2003). Apart from other instructional design choices (Strijbos et al., 2004), these interactions can be improved through guiding elaboration (e.g., Van der Meijden, 2005), since elaboration is assumed to facilitate information sharing and the construction of knowledge (O'Donnell & O'Kelly, 1994; Palincsar & Brown, 1989).

In the study presented, we investigate possibilities to improve the learning results of a CSCL programme by improving the quality of students' interaction in CSCL, through providing guidelines and feedback aimed at enhancing elaboration in the students' contributions and having students reflect on the feedback. A second aim of the study was to explore the effect of this intervention on the learning results of different groups of students. We were particularly interested in the question whether we had succeeded in designing a CSCL programme that supports students from immigrant families in contributing to and benefiting from CSCL discussions.

Improving the quality of CSCL interaction

Considerable variations have been noted regarding both the quality of interaction and the learning outcomes of CSCL (Häkkinen & Järvelä, 2006; Lipponen et al., 2003; Strijbos et al., 2004). Even though it appears that high levels of cognitive knowledge construction can be reached in CSCL (Schellens & Valcke, 2006), there still seems to be a lack of positive impact on learning outcomes in some CSCL studies (Dillenbourg & Tchounikine, 2007; Lockhorst, Admiraal, Pilot, & Veen, 2002). There is a good body of research into interventions aimed at improving interactions in CSCL (Lipponen et al., 2003; Saab, 2005; Scardamalia & Bereiter, 1996; Soller & Lesgold, 2007; Suthers & Hundhausen, 2001; Weinberger & Fischer, 2006). The focus of this research has partly been on *indirect measures* for optimizing collaboration processes (e.g., instructional settings, group composition, or assignments), but recently also on more direct attempts to interfere in the ongoing processes (Schellens, Van Keer, Valcke, & De Wever, 2007). Approaches for structuring interactions are gaining interest. Some explicitly study the effects of *process-oriented instructional support* (Strijbos et al., 2004; Weinberger & Fischer, 2006). However, the structuring of collaboration is a complicated task, and

collaboration can be hindered by either too much or too little guidance (Dillenbourg & Tchounikine, 2007).

Elaboration is proposed in the literature as a possible mechanism through which productive interactions and, consequently, learning gains are stimulated (Krol, Janssen, Veenman, & Van der Linden, 2004; Van der Meijden, 2005; Webb & Farivar, 1999). Elaborating includes being explicit, making distinctions, clarifying one's thoughts, providing examples and illustrations, adding details, providing explanations, and justifying one's position. These are some of the activities that hypothetically lead to better learning outcomes of collaborative learning (O'Donnell & O'Kelly, 1994). Palincsar and Brown (1989) combined this perspective with a socio-cultural perspective. In their approach, learning is not simply an outcome of solving problems in collaborative groups but the result of the activities (i.e., elaboration and justification of positions in the discussion) elicited in certain social settings. As early as 1989, Palincsar and Brown were arguing that not enough attention was paid to realizing settings conducive to elaboration, nor to structuring student interactions to promote elaboration. More recently, McCaslin and Burross (2011) also mentioned the importance of guided elaboration in instructional settings that include and go beyond basic facts and skills, integrating close elaboration, related thinking, and more abstract reasoning.

Providing students with *feedback* (Hattie & Timperley, 2007) and having them reflect on the collaborative process is supposed to contribute to realizing such settings. Phielix, Prins, and Kirschner (2010) give a good overview of the positive effects *feedback* can have and show that peer *feedback* and *reflection* on the social performance of individual group members can enhance the performance and attitudes of a CSCL group. Ulicsak (2004) and Dewiyanti (2005) have studied the issue of *reflection* on the collaborative process within a CSCL environment. In the study by Ulicsak, a model was used that incorporated procedural prompting, the assignment of roles, and modelling exchanges, augmented with scaffolding for *reflection* on collaboration skills and *feedback* on self-assessment of these skills. This study found a trend for improved recall, but it is not wholly clear which of the training factors yielded the result. Dewiyanti studied the effect of *reflection* on the regulation of group processes and on knowledge co-construction in a CSCL environment. The group that received prompts to reflect on their group processes oriented more on the task and monitored more actively their group working procedure and their group progress. No significant difference was found as to the effect of reflection on knowledge co-construction.

Student characteristics and CSCL

Primary schools in The Netherlands – especially in the large cities – have considerable proportions of immigrant students, especially from Turkish and Moroccan families, for whom Dutch is not their home language. These students generally perform less in education as compared to students from Dutch origin. Significant differences were found in various aspects of language development and especially in reading comprehension (Droop & Verhoeven, 2003). Also, differences related to socio-cultural background have been found in participation in computer use at school. Students from immigrant families use the computer less for activities like gathering information and preparing papers and more for drill and practice (Volman, Van Eck, Heemskerk, & Kuiper, 2005). In addition, Leseman and De Jong

(1998) and Droop and Verhoeven (2003) reported significant relations between socio-cultural background on language development, especially differences in reading comprehension. The effects stem from various dimensions of home education, like reading opportunity and parental guidance (Leseman & De Jong, 1998, 2001). Minority parents are reading less with their children than other parents do, give their children less autonomy, and indicate less confidence in their interactions with their children. This could possibly be an explanation for the lower scores on reading comprehension for minority students, which in turn is an important predictor of learning gains in several domains.

Although no empirical research into differences in CSCL related to socio-cultural background is available, there are reasons to assume that students from immigrant families will profit less from CSCL. The emphasis on participation in text-based exchanges may make CSCL programmes more challenging for these students. Moreover, immigrant students may encounter difficulties with the type of interactions required in CSCL, either because the academic language required in CSCL is less likely to be typical for the interactions in their families (Leseman & De Jong, 2001; Leseman, Scheele, Mayo, & Messer, 2007) or because the types of communication that are expected in CSCL – like asking why questions or having a different opinion than others – are not stimulated in their home environments (Heemskerk, Brink, Volman, & Ten Dam, 2005; Pels, Nijsten, Oosterwegel, & Vollebergh, 2006).

There are more student characteristics that can be expected to be related to participation in CSCL and benefits in terms of learning gains, which we will shortly review. One such characteristic is *reading comprehension*. Since students are supposed to draw information from study texts and texts written by other students, it should be considered as an important predictor variable in CSCL studies. In addition, effects of learning in general depend for a large part on *pre-knowledge* (Ausubel, 1968; Lou, Abrami, & d'Appollonia, 2001). For learning in collaborative groups (without computer), pre-knowledge has been found to have a facilitating or hindering effect. Leechor (1988) was one of the first researchers who showed that high- and low-achieving students differentially benefit from collaboration in small groups. After this, many studies have shown that high-achieving students are more active, provide more elaborations and explanations, and, as a consequence, benefit more from participation in collaborative learning than their low-achieving counterparts. Following these findings, several studies were conducted to enhance the participation and learning outcomes of students who lag behind (Terwel, Gillies, Van den Eeden, & Hoek, 2001; Webb, 2008).

The present study – guided elaboration

In the present study, we propose *elaboration* as a possible mechanism through which productive interactions and, consequently, learning gains are stimulated (see, e.g., Krol et al., 2004; Van der Meijden, 2005; Webb, 2008; Webb & Farivar, 1999). The instructional support in the experimental programme is based upon the assumption that guiding students to elaborate their contributions by providing feedback and stimulating reflection on the way they construct their contributions may lead to more active examination of resources, increase the amount of information available to the group, and improve the students' quality of thought during the learning process, due to improved engagement and processing of content. Feedback and (meta-cognitive)

reflection on the process of elaboration in a group can lead to the internalization of elaboration procedures which then becomes a self-regulatory process (Prinsen, Terwel, Volman, & Fakkert, 2008). In other words, internalization occurs when processes first performed with others on a social plane are successfully executed by a learner in an independent learning activity (Bereiter & Scardamalia, 1985; Brown & Palincsar, 1989; McCaslin & Burross (2011).

In relation to students from immigrant families, we assume that our feedback and stimulation to reflect on the extent of elaboration of their contributions and the contributions in the group supports them towards better composition of their contributions and to improve their processing of the written resources produced by others. In school, minority children may be more dependent on explicit instruction and guided elaboration than their majority fellow students. Direct instruction appears to cast a wide safety net, including students who are and are not yet ready to profit from instruction (McCaslin & Burross, 2011; Snel, Terwel, Aarnoutse, & Van Leeuwe, 2012). Our intervention aims to compensate for a lack of practice and skill in the type of interactions (use of academic language, questioning, and disputing) required in CSCL, which may bother these students (Heemskerk et al., 2005; Pels et al., 2006).

In this study, students worked in the context of a CSCL programme in which they discussed authentic situations concerning food and health. The intended learning results involved understanding a number of basic principles related to nutrition and health (e.g., energy needs, calories, balanced diet, unsaturated fats).

Research questions and hypotheses

Against this background, the following research question was formulated: *What are the effects of an experimental CSCL programme aimed at stimulating elaborated contributions on the learning outcomes of students compared to their counterparts in a control programme?* The analysis pays special attention to *possible differential or interaction effects* as we investigate the impact of the experimental programme on students from immigrant families and students from Dutch backgrounds (role of socio-cultural background). The variables reading comprehension and pre-knowledge were used as controls.

The central hypothesis was formulated as follows: Students in the experimental (elaborative) programme will show better learning gains compared to their counterparts in the control programme (Hypothesis 1). Furthermore, we test the following hypothesis: While students from immigrant families will achieve less well in the control condition, the learning gains of students from immigrant and Dutch families will be equal in the experimental programme (Hypothesis 2). We expect such an interaction effect between socio-cultural background and programme, because of the demands CSCL makes on communication skills that immigrant children are taught less self-evidently at home. Our experimental elaboration programme aims to compensate for this.

Methods

Design

The research can be characterized as a quasi-experimental study with a pre-test, post-test, control group design. The study was of a quantitative nature; most variables

were assessed by means of questionnaires and tests (see variables and measures section).

Participants

Students of nine primary school classes (Grade 5, average age of students 11 years) participated in the study. The schools were located in the city of Amsterdam (The Netherlands) and surrounding areas, and were selected from a network of schools which all subscribed to a local organization facilitating the schools' computer networks. The participating schools were selected to represent schools with diverse student populations and from different socioeconomic areas in the city. The teachers agreed to dedicate approximately 70 minutes a week over 6 weeks in their regular lesson plan to implementation of our programme. A total of 189 children (91 boys, 98 girls) participated in the study. Nearly half of the children who participated had both parents born in countries other than The Netherlands. This means that half of the participants were from immigrant families. In the control group condition, 103 students participated, and 86 in the experimental group condition. The classes were assigned randomly to the conditions.

Students of each participating class were divided into heterogeneous groups of four by their teachers on the basis of mixed gender, ability, and socio-cultural background. The aim was to have two male and two female students, two Dutch students and two immigrant students, one high-ability, one low-, and two average-ability students in each group.

The participating classes were distributed over the experimental and control conditions by a matching procedure. Pairs were formed of classes with similar distributions of student backgrounds and similar averages in ability (IQ scores). From each pair, one of the classes was then randomly assigned to control condition and the other to the experimental condition (for an explanation of the measures taken, see the variables and measures section). In this way, classes in the two conditions were comparable.

Materials and procedures

A lesson series on the topic of nutrition and health was developed in which groups of four students engaged in Knowledge Forum[1] discussion tasks. Both the students in the control group and those in the experimental group worked with the lesson series and engaged in the discussion tasks. All instructions and procedures were the same, except that the instructions and feedback students received were focused on elaboration in the experimental condition. Below, we will first explain lesson materials and then the support given to students in both conditions, as well as the principles underlying these. We present some examples of materials and interactions. A more extensive description of the programme and the implementation in the classroom was presented in Prinsen et al. (2008).

The curriculum content was situated in an authentic, real-life situation (e.g., Bruner, 1985; Lave, 1988): cooks collaborating in a kitchen, making decisions about what food to buy, what dishes to prepare, and how to prepare the food in a healthy manner. The title of the course package was ''The Smart Chef''. The programme for the students consisted of an introduction lesson in which the teacher introduced the curriculum content and general aim of the lessons to come, and the students were

given time to practise with the Knowledge Forum (KF) programme. Also, a number of ''golden rules'' (see below) were explained and practised with examples on the whiteboard. Three lessons followed (about energy and nutritious substances, reading labels, hygiene) in which students were supposed to conduct a CSCL group discussion on a number of given discussion questions (for an example, see Excerpt 1), after reading a chapter of the textbook. Between the lessons and discussions, two intermediate feedback and reflection lessons were planned.

Excerpt 1: example discussion question

You have read Chapter one of the textbook ''The Smart Chef''. Now you can find the possible answers to the question below. Fill out your answers on this sheet. Make clear sentences and write down everything carefully. Make sure you don't forget anything.

After you have found as many possible answers, you go and sit down behind your computer and tell the people in your group what you've found. Perhaps they found different answers to yours. Might they be right too?

Question (Mind the sugar):Derreck is a new chef in our restaurant. He proposes to put a new recipe on the menu. ''Let's make a chocolate pudding!'' he says ''and then we will add a sugar coating and put a cookie on the top!'' Another chef, Mary, says: ''Yes, Derreck, that sounds great but it is very unhealthy. There is far too much sugar in it and all sugar is bad for you. Sugar is never good for you.'' Is Mary right?

Before each CSCL group discussion, the students were given time to prepare their answers to two discussion questions on their own, by reading parts of the ''Smart Chef'' textbook (about 1,500 words at a time) and writing down their ideas for the discussion. The discussion questions were designed to allow for multiple possible answers, and students' initial thoughts could represent a diversity of ideas. The Web Knowledge Forum software which was used provides several facilities to enhance collaboration between users. Among them, the build-on facility (reacting to a previous note or question by building on to it) and the scaffolds (to be used as sentence openers to help student formulate their initial contributions and reactions to each other) are the ones used in this implementation.

Before the students went to the Knowledge Forum, the teachers explained to the students that the way they reacted to each other in the computerized learning environment was very important. In both programmes, students received some ''golden rules'' for the collaboration process together with some examples demonstrating their advantages.

The golden rules in the control programme (also called the ''collaboration (only)'' programme) were aimed at improving collaboration. The golden rules were:

(1) Everybody should contribute;
(2) read each other's contributions;
(3) ask each other questions;
(4) help each other; and
(5) encourage each other.

The golden rules in the experimental programme (called the ''elaboration programme'' from here on) were developed according to a different set of design principles. They were aimed at stimulating elaboration of the students' contributions.

The golden rules for the elaboration programme were:

(1) When you agree with someone, write down clearly what you agree on precisely.
(2) Provide clear answers (state why you think this or give a clarifying example).
(3) Ask each other (clear) questions.
(4) Be sure to ask for clarification if you don't understand what is said.
(5) When asked, provide an explanation and be sure it is helpful to the other.
(6) It is all right to disagree as long as you explain why you disagree.

Once in the Knowledge Forum, the students' ways of contributing were scaffolded by the following sentence openers: "I think..", "My question is ... ", "That's right, because ... ", "Yes, but ... ", "No, because ... ", "Remark:...", "Explanation:...", "What do you think ... ?" and "An example:...". The scaffolds were available in both the collaboration and in the elaboration programme, but in the elaboration programme they mirrored the golden rules in supporting students to provide constructive and elaborative reactions to each other. The group discussions behind the computer lasted 45 minutes, in which two questions were collaboratively discussed.

In the week following the online discussion, the students received feedback on their group and individual performance. The group feedback was the same in both programmes; the focus of the individual feedback was different for the two programmes. The group feedback was concerned with the use of some of the features of Knowledge Forum (how the display of the discussion was organized on the screen, whether clear titles were given to the contributions), with the students' responsibility to contribute (did the participants give their own answers before reading and reacting to the others), and with the content of the contributions (did the contributions concern the content of the assignment). Although direct feedback was not provided on the content quality of the students' postings, the groups did receive a general remark assessing the proportion of time spent on task and off task. The group evaluations were read out loud in front of all of the participating groups in the classroom. This introduced an element of competition between the groups.

After this teacher-led part of the evaluation, the students joined their group members, and each group received a print-out from their previous week's discussion and their group evaluation form. On the discussion print-out, the teacher/researcher had marked comments next to the printed contributions. In this individual feedback, care was taken to make sure that all students (in both programmes) received at least some positive comments on their ways of contributing to keep them motivated. The focus for this individual feedback was on how well the students were following the golden rules they were given for their collaboration. So, this focus was different in the collaboration programme and the elaboration programme. With his/her feedback, the teacher reinforced appropriate socio-cognitive behaviour and discouraged inappropriate or ineffective behaviours (see Excerpt 2 for an example of the feedback in the elaboration programme in italics, next to the students' contribution).

Excerpt 2: Failure to provide an explanation

Title: **answer to the second question** (by: Tufan)

I would choose this dessert because it tastes better. *Which desert, Tufan?*

Title: **for the answer to question 2?** (by: Manaar)

... yes but why!!!??? *Good thing you are asking for an explanation, Manaar.*

Try to ask nicely.

Title: **also for question 2** (by: Tufan)

I think: just because *Tufan, you have to give an explanation if somebody asks you to explain.*

After the group evaluation was read out loud and the individual evaluations were handed out, the students (in both conditions) received a reflection assignment, asking them to write down and discuss what they, as a group, would like to do differently next time. In this assignment, the students got the chance to integrate the group feedback and the individual feedback that they had received. The small groups collaboratively formulated their intentions for the following lesson by collectively distilling points of improvement or maintenance out of the feedback. The group evaluation was expected to create awareness of the importance of their group process. The individual evaluation was expected to make them (also) feel individually accountable. In the assignment, this awareness was transformed by the students into written intentions for the next discussion. Ultimately, intentions were expected to be translated into actions for improving the group process.

The foregoing design principles were chosen to make both conditions work in classrooms and to realize a meaningful experience for all students involved. The principles are in line with the theoretical background, that is, a socio-cultural and a cognitive elaboration perspective (e.g., Brown & Palincsar, 1989; Gillies & Ashman, 2003; Webb & Farivar, 1994, 1999).

Variables and measures

The control and independent variables were measured as follows. The socio-cultural background of the children was measured by asking the children in which country their parents were born. If both parents were born abroad, the children were considered to come from an immigrant family. These are predominantly Moroccan and Turkish families. Dummy coding was applied to indicate this variable with 1 for students from immigrant families and 0 for students from Dutch and mixed families. During the research period, the children took a test on reading comprehension (Dutch Cito standardized test), to determine their achievement level in reading. Students' pre-knowledge was measured by means of a multiple-choice test administered before the CSCL lessons started. This test contained 19 items, with Cronbach's alpha .63. Initially, three other controls were included in the analyses: Gender, IQ (Standard Progressive Matrices test), and Computer skills. It was found that none of these was significant. Therefore, they were successively removed from the analysis.

The dependent variable, learning outcome, was measured by means of a 28-item multiple-choice test with Cronbach's alpha .70. The multiple-choice test contained items like "Saturated fats are ... a) better for you than unsaturated fats b) fats from plants c) animal fats d) fats you can eat without limitation". The intervention (condition) was indicated by dummy coding marked 1 for the experimental (elaboration) programme and marked 0 for the control (collaboration) programme.

Analyses

The data were analyzed using multilevel regression analyses. The multilevel model accounts for the dependence of the individual outcomes on the groups to which the students belong. Ignoring this dependence would lead to an overestimated confidence in the regression results. Initial analyses on the dependent variable learning outcome showed that the variance at the class level and the level of the learning groups approximately overlapped. Because the current experiment is immediately related to processes taking place at the level of the learning groups, we decided to take the variation between these into account in our analyses.

There were some missing values for the dependent variables, since some children had been ill during the lessons. These were imputed (6% of the students missed the second KF lesson, 6.8% missed the third KF lesson) by taking the mean over the two other lessons and subsequently looking at the trends from the first to the second lesson and from the second to the third lesson. The individual mean scores were adapted according to that trend.

Results

In Table 1, the descriptives of the dependent and the independent variables included in the study are presented. From Table 1, it can be concluded that students in the two conditions were comparable on the predictors Socio-cultural background, Reading comprehension, and Pre-knowledge.

Table 2 presents the initial differences in the relevant variables, separated for socio-cultural background between the two conditions. Table 3 presents the correlations between the variables for the student outcomes.

Initial differences in the control variables between the two conditions were explored with a multilevel analysis, taking account of the nesting of the students within learning groups. All variables were included in a regression analysis by way of accurate control.

Because socio-cultural background is an important category in this study (and further analyses), we also present the descriptives separated according to socio-cultural background.

Initial differences in the relevant variables separated for socio-cultural background between the two conditions were also explored to examine whether the populations in both conditions were comparable. As can be seen in Table 2, the

Table 1. Descriptive statistics for the dependent and independent variables.

	M	*SD*	*Min*	*Max*
Control group ($n = 103$)				
Socio-cultural background	0.47	0.50	0	1
Reading comprehension	43.59	15.02	15	95
Pre-knowledge	10.79	3.08	3	18
Learning outcome	18.49	4.33	9	28
Experimental group ($n = 86$)				
Socio-cultural background	0.45	0.50	0	1
Reading comprehension	46.77	15.93	17	83
Pre-knowledge	11.44	3.17	4	17
Learning outcome	19.26	3.49	11	28

Table 2. Descriptive statistics separated for socio-cultural background.

	Mean (SD)		*Min.*		*Max.*	
	min.	maj.	min.	maj.	min.	maj.
Control group (*n* minority students = 49, *n* majority students = 54)						
Reading comprehension	36.43 (9.28)[1]	50.09 (16.30)	15.0	23.0	57.0	95.0
Pre-knowledge	9.57 (2.68)	11.89 (3.02)	3.0	6.0	15.0	18.0
Learning outcome	16.43 (4.04)[1]	20.35 (3.73)	9.0	10.0	25.0	28.0
Experimental group (*n* minority students = 39, *n* majority students = 47)						
Reading comprehension	42.95 (13.22)[1]	49.94 (17.38)	20.0	17.0	83.0	83.0
Pre-knowledge	10.62 (2.93)	12.13 (3.23)	5.0	4.0	16.0	17.0
Learning outcome	18.95 (3.04)[1]	19.51 (3.83)	12.0	11.0	24.0	28.0

[1]Significant differences in means between the control and experimental groups (tested using a multilevel analysis taking learning group as nesting variable).

Table 3. Correlations between the variables.

	Socio-cult. Backgr.	Reading Compr.	Pre-knowledge	Learning outcome
Socio-cult. Backgr.	1	–.348**	–.320**	–.304**
Reading Compr.	–.348**	1	.602**	.577**
Pre-knowledge	–.320**	.602**	1	.587**
Learning outcome	–.304**	.577**	.587**	1

mean reading comprehension is different between the two conditions for the minority students. There is also a significant difference between the conditions for the minority students on learning outcome.

The relations between the variables will be further explored in a multilevel regression analysis. Both the general effect of the experimental programme on the learning outcomes and the differential effects of the experimental programme for students from Dutch families and students from immigrant families on the learning outcomes are tested.

Effects on learning outcomes

Several possible regression models were explored. In our regression analysis, *z* scores were used for all variables and dummies for socio-cultural background and the programme. A model is presented with learning outcome on the multiple-choice test as dependent variable. First, the control variables have been (stepwise) included, followed by the effect of the experimental programme. Finally, the interaction between Socio-cultural background and the experimental programme was included in the model.

The stepwise model selection process is summarized in Table 4. It shows the subsequent improvements in the fit of the model, as well as the proportion of residual variance at the learning group level (which is also called the intra-class correlation). Interestingly, for Models 4 through 6 this variance is no longer statistically different from zero, meaning that an ordinary linear regression might have been estimated for these models as well.

The following conclusions may be drawn from Table 4. In the most elaborate model, 46% of the variance in learning outcomes can be explained by the five variables included in the final model. In the stepwise procedure, the contribution of Reading comprehension stands out, explaining 25% of the variance. This indicates that in the context of CSCL programmes the initial level of reading comprehension is a strong predictor. Other relatively strong predictors in this stepwise procedure are Socio-cultural background and Pre-knowledge.

Table 5 shows the parameter estimates for the final model (Model 6). The only predictor that is non-significant (at a 0.05 level) is the Socio-cultural background. The contribution of this variable is no longer statistically significant after adding other predictors to the model. Nevertheless, it has been retained in the final model to make the interaction between Programme and Socio-cultural background more clearly interpretable.

Taking into account the effect of the control variables, the effect of Programme indicates that the students from immigrant families in the control group perform

Table 4. Multilevel regression of the predictors on the dependent variable "Learning Outcome".

Model	*R* Square[a] change	*R* Square	χ^2 Change	Sign. χ^2 change	Proportion of residual variance at learning group level
1	0.00	–	–	–	0.28
2	0.01	0.01	1.11	0.292	0.27
3	0.10	0.09	13.10	<0.001	0.22
4	0.35	0.25	53.42	<0.001	0.12
5	0.43	0.08	24.37	<0.001	0.08
6	0.46	0.03	7.59	0.006	0.07

1. Predictors: (Constant).
2. Predictors: (Constant), Programme.
3. Predictors: (Constant), Programme, Socio-cultural background.
4. Predictors: (Constant), Programme, Socio-cultural background, Reading comprehension.
5. Predictors: (Constant), Programme, Socio-cultural background, Reading comprehension, Pre-knowledge.
6. Predictors: (Constant), Programme, Socio-cultural background, Reading comprehension, Pre-knowledge, Interaction between Programme and Socio-cultural background.

[a]Proportion of explained variance at the individual level (Level 1).

Table 5. Coefficients of the multilevel regression of predictors on the dependent variable "Learning outcomes".

Model 6	B	*SE*	*p* value
(Constant)	0.12	0.12	0.336
Programme (control group)	–0.39	0.17	0.024
Socio-cultural background (non-immigrant)	–0.17	0.16	0.312
Reading comprehension	0.30	0.07	<0.001
Pre-knowledge	0.35	0.07	<0.001
Socio-cultural background	0.62	0.22	0.006

*Programme (control group*non-immigrant)

worse compared to such students in the experimental group. The effect of Socio-cultural background indicates that for the experimental condition, there is no significant difference between the students from Dutch and from immigrant families. Finally, the interaction effect shows the effect of programme for students from immigrant families is not paralleled for students from Dutch families. Instead, the Dutch students in the control group perform better than expected (based on the added effects of Programme and Socio-cultural background).

Taking together the (interaction) effects of Programme and Socio-cultural background shows that, while controlling for the effects of other predictors in the model, a similar picture arises as from the means for learning outcome in Table 2. The students from immigrant families do perform better in the experimental condition (compared to the control condition), while the Dutch students do not. Even though the students from immigrant families are worse off in general when it comes to their learning outcomes in a CSCL environment, they profit from being in the experimental programme in which the provision of elaborated contributions is fostered.

The interaction effect can be clearly seen in Figure 1, depicting the estimated means on learning outcome for the combined effects of Programme and Socio-cultural background. These estimates for Model 6 (with non-standardized variables) are based on the average values for the other predictors, and are therefore called the marginal means. They show that an immigrant student who would achieve a score of 17.78 in the control condition (6.35 out of 10) is expected to achieve a score of 19.33 in the experimental condition (6.90 out of 10). On the other hand, a Dutch student that would achieve a score of 19.58 (6.99 out of 10) in the control condition is expected to display a (non-significantly) lower score of 18,67 (6.67 out of 10) in the experimental condition.

Discussion

The results of this study show differences in student learning outcomes in CSCL related to initial level of reading comprehension and pre-knowledge. In addition, as

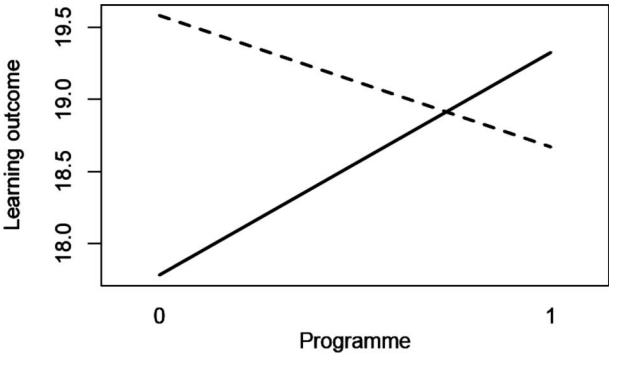

Figure 1. Marginal means of Learning outcome.
Note: The effect of Programme (0 = control, 1 = experimental) for children of immigrants (**solid line**); the effect of Programme (0 = control, 1 = experimental) for children of non-immigrants (**dashed line**). (Based on Model 6 with non-standardized variables.)

indicated by the general effect of socio-cultural background on learning outcomes, students from immigrant families reach a lower mean score on the post-test than students from Dutch families. These conclusions hold true for both the experimental and the control programme. This is consistent with the generally lower performance of immigrant students in Dutch education compared to students from Dutch origin (Droop & Verhoeven, 2003). We also mentioned possible difficulties for students from immigrant families related to the specific character of CSCL: the emphasis on text-based exchanges, the expected use of academic language, and the type of communication required in CSCL, with an emphasis on questioning, disagreeing, and explaining, which may not be stimulated in their home environments.

The literature on both technology-supported learning and small-group learning suggests that the effects of learning depend for a large part on student characteristics (e.g., pre-knowledge) (Lou et al., 2001). However, over and above the effects of student characteristics there is room for educational interventions to improve students' learning outcomes. In terms of learning *gains*, the present study contains good news, especially for the immigrant students in our experimental condition.

The experimental programme, designed to benefit students from Dutch and from immigrant families equally, by providing feedback on student elaboration and having students reflect on the way they construct their contributions, indeed showed an interaction with students' socio-cultural background. It appears that the intervention in which all students were explicitly expected to elaborate their contributions (explain their opinion and explain why they agreed and disagreed with others) only had a positive effect on the learning gains of students from immigrant families.

How can this be explained? We assume that our intervention compensated for the immigrant students' lack of practice and skill in the type of interactions that are required in CSCL; use of academic language, questioning, explaining, and disputing. We assume that the feedback and stimulation to reflect on the extent of elaboration in their contributions has supported the students from immigrant families towards better composition of their contributions and towards improving their processing of the written resources produced by others. When trying to explain the improvement in outcomes for students from immigrant families in the experimental programme, we could also take into account the following. Before the students entered the computer environment, they had to prepare the questions individually. (This is probably one of the reasons why students with good reading comprehension skills do so much better. They retain more information from reading the relevant text in the first place.) The experimental (elaboration) programme might have stimulated the students from immigrant families to better prepare their contributions to the collaborative discourse; finding more relevant information in the text that would be used to better elaborate their contributions. Furthermore, reading other students' answers and reactions constitutes a potentially beneficial learning moment. Since the contributions to the discussion in the experimental programme were generally of higher quality (Prinsen, Volman, Terwel, & Van den Eeden, 2009), the students from immigrant families might have benefited more from reading their fellow students' contributions in the elaboration programme. While raising the cognitive level of collaborative discourse, the greater processing/coverage of content knowledge may have increased the amount of information that was available both in reading and responding to contributions.

Although we had expected the students from immigrant families to benefit more from the experimental programme, we expected that the students from Dutch families would also benefit from the experimental programme. However, no significant main effect of the treatment could be found. Moreover, the Dutch students in the control programme outperformed (even though not significantly) their counterparts in the experimental condition. This unintended tendency could possibly be attributed to the treatment. The strong emphasis on elaboration may have hindered the students from Dutch origin. The strong emphasis on elaboration may be superfluous for these students, and the teacher interventions may have been counterproductive. Here, we see a parallel with training students in other strategies and skills: The higher achieving students often do not benefit because they have their own approach which is already successful. Imposing an additional "cognitive load" of instructions on these students may have slowed down the pace of their learning processes (Hoek, Van den Eeden, & Terwel, 1999; Terwel, 2003).

We would like to suggest some avenues for future research. Follow-up studies might be able to replicate the finding that interventions directed towards improving students' interactions can in fact improve CSCL learning outcomes. Such studies should attempt to include all the interactions that students engage in, not only with each other when contributing their thoughts to the computer database but also the interactions with teachers and with other available (content-related) resources. In examining the extent to which instructional approaches facilitate specific CSCL processes and outcomes of collaborative knowledge construction, it is very important for interaction categories and teacher interventions to be specified and described precisely (Dillenbourg & Tchounikine, 2007). In this way, we may be able to identify key variables that partially account for the positive impact of CSCL (e.g., Schellens et al., 2007).

In our study, a multiple-choice test on the topic of nutrition and health was administered to measure learning outcomes. Although the test covered the most important concepts of the lessons content, it probably did not sufficiently measure everything the students learned. Other, more inclusive, outcome measures, showing what is learned, for example, showing the students' level of understanding and their ability to reason with the facts, would have been more true to this type of learning environment. One could think of individual essays, or authentic transfer tasks.

We wish to suggest that more attention should be paid in CSCL environments to improving the outcomes for poor comprehenders. Relevant support might be provided during the preparation phase (devoted to the collection of text-source information) or with a view to the content, or lack thereof, in group contributions. In our programmes, no direct feedback was given to students regarding correctness in relation to the content of their contributions, given that the intervention focused exclusively on form (e.g., whether students provided explanations when reacting to each other). Clearly, this was a significant limitation in that, normally, students would have been provided with feedback if important content had been missing from their contributions.

The educationist's task is to ensure equal opportunities for all students. Translated to CSCL, this means that all students should be included in the programme and thus have equal access to the social and cognitive opportunities of group work. Such inclusion may require extra attention to finding out how such opportunities are grasped by students who participate less, due either to their socio-cultural background or their academic skills.

This study suggests that attention needs to be paid when new technologies and pedagogies are introduced, since they may require literacies that were not previously fostered in school – or out of school contexts. On a cautionary note, the extent to and the way in which students enact different communication styles and preferences may be related to factors such as the domain and the possible cultural bias in the educational technologies used, apart from the pedagogical focus. In sum, participation in programmes that stimulate elaborated contributions appears to be beneficial for students from immigrant families, who in general seem to profit less from CSCL environments in terms of outcomes. A special training in elaboration while using school language seems beneficial if not necessary for students who are not used to academic language and elaborative ways of communication at home. Although no main effect of intervention on learning gains was found, the differential effect that closes the gap between students from Dutch and from immigrant families is a relevant outcome of this study. The specific compensation for this group of students (approximately half of the whole group) leads us to conclude that supporting students in their elaborated CSCL contributions is a promising approach.

Notes on contributors

Fleur Prinsen is Researcher at the University of Utrecht, The Netherlands. Her research is in the areas of Diversity, Computer Supported Collaborative Learning, and Identity Development in (online) Social Networks. Contact: frprinsen@gmail.com

Jan Terwel is Professor of Education at the VU University, Amsterdam, The Netherlands. His main research contributions have been in the areas of curriculum studies, grouping in education, learning in cooperative groups, and individual learning differences in particularly primary and secondary education. He has been a visiting professor at Stanford University, USA, and the University of Queensland, Australia. Contact: J.Terwel@vu.nl

Bonne Zijlstra is an assistant professor at the Universtity of Amsterdam. He specializes in general research methods and statistics, social network analysis, multilevel modelling, and estimation methods. Contact: B.J.H.Zijlstra@uva.nl

Monique Volman is professor of Education and director of the "Educational sciences" programme of the Research Institute of Child Development and Education of the University of Amsterdam. Main areas in her research are learning environments for meaningful learning, identity development, diversity, and the use of information and communication technology in education. Contact: m.l.l.volman@uva.nl

Note

1. Developed at the Ontario Institute for Studies in Education (OISE). See Scardamalia and Bereiter (1996).

References

Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York, NY: Holt, Rinehart & Winston.

Bereiter, C., & Scardamalia, M. (1985). Development of dialectical processes in composition. In D. R. Olson, N. Torrance, & A. Hildyard (Eds.), *Literacy, language, and learning: The nature and consequences of reading and writing* (pp. 307–329). Cambridge, UK: Cambridge University Press.

Brown, A. L., & Palincsar, A. S. (1989). Guided, cooperative learning and individual knowledge acquisition. In L. B. Resnick (Ed.), *Knowing, learning and instruction. Essays in honor of Robert Glaser* (pp. 393–451). Hillsdale, NJ: Lawrence Erlbaum.

Bruner, J. (1985). Vygotsky: A historical and conceptual perspective. In J. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (pp. 21–34). Cambridge, UK: Cambridge University Press.

Constantino-Gonzalez, M. A., Suthers, D. D., & Escamilla de los Santos, J. G. (2003). Coaching webbased collaborative learning based on problem solution differences and participation. *International Journal of Artificial Intelligence in Education*, *13*, 263–299.

Dewiyanti, S. (2005). *Learning together: A positive experience. The effect of reflection on group process in an asynchronous computer-supported collaborative learning environment* (Unpublished doctoral dissertation). Open University, Maastricht, The Netherlands.

Dillenbourg, P., & Tchounikine, P. (2007). Flexibility in macro-scripts for computer-supported collaborative learning. *Journal of Computer Assisted Learning*, *23*, 1–13.

Doise, W., Mugny, G., & Pérez, J. A. (1998). The social construction of knowledge: Social marking and socio-cognitive conflict. In U. Flick (Ed.), *The psychology of the social* (pp. 77–90). New York, NY: Cambridge University Press.

Droop, M., & Verhoeven, L. (2003). Language proficiency and reading ability in first- and second-language learners. *Reading Research Quarterly*, *38*, 78–103.

Fischer, F., & Mandl, H. (2005). Knowledge convergence in computer-supported collaborative learning: The role of external representation tools. *Journal of the Learning Sciences*, *14*, 405–441.

Fischer, G., & Ostwald, J. L. (2002). Transcending the information given: Designing learning environments for informed participation. *Computers in Education*, *1*, 378–381.

Gillies, R. M., & Ashman, A. F. (2003). *Co-operative learning: The social and intellectual outcomes of learning in groups*. London, UK: Routledge Falmer.

Häkkinen, P., & Järvelä, S. (2006). Sharing and constructing perspectives in web-based conferencing. *Computers & Education*, *47*, 433–447.

Hara, N., Bonk, C., & Angeli, C. (2000). Content analyses of on-line discussion in an applied educational psychology course. *Instructional Science*, *28*, 115–152.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*, 81–112.

Heemskerk, I., Brink, A., Volman, M., & Ten Dam, G. (2005). Inclusiveness and ICT in education: A focus on gender, ethnicity and social class. *Journal of Computer Assisted Learning*, *21*, 1–16.

Hewitt, J., & Tevlops, C. (1999). An analysis of growth patterns in computer conferencing threads. In J. Roschelle & C. Hoadley (Eds.), *Proceedings of CSCL'99: The third international conference on computer support for collaborative learning* (pp. 368–375). Mahwah, NJ: Erlbaum.

Hoadley, C. M., & Linn, M. C. (2000). Teaching science through online, peer discussions: SpeakEasy in the Knowledge Integration Environment. *International Journal of Science Education*, *22*, 839–858.

Hoek, D., Van den Eeden, P., & Terwel, J. (1999). The effects of integrated social and cognitive strategy instruction on the mathematics achievement in secondary education. *Learning and Instruction*, *9*, 427–448.

Kirschner, P. A. (2002). Can we support CSCL? Educational, social and technological affordances for learning. Inaugural Address. In P. A. Kirschner, W. Jochems, P. Dillenbourg, & G. Kanselaar (Eds.), *Three worlds of CSCL: Can we support CSCL?* (pp. 7–49). Heerlen, The Netherlands: Open Universiteit Nederland.

Kirschner, P. A., Buckingham Shum, S. J., & Carr, C. S. (Eds.). (2003). *Visualizing argumentation: Software tools for collaborative and educational sense-making* (pp. 97–115). London, UK: Springer.

Krol, K., Janssen, J., Veenman, S., & Van der Linden, J. (2004). Effects of a cooperative learning program on the elaborations of students working in dyads. *Educational Research and Evaluation*, *10*, 205–237.

Lave, J. (1988). *Cognition in practice*. Cambridge, UK: Cambridge University Press.

Leechor, C. (1988). *How high and low achieving students differentially benefit from working together in cooperative small groups* (Dissertation). Stanford, CA: Stanford University.

Leseman, P. P. M., & De Jong, P. F. (1998). Home literacy: Opportunity, instruction, cooperation, and social-emotional quality predicting early reading achievement. *Reading Research Quarterly*, *33*, 294–318.

Leseman, P. P. M., & De Jong, P. F. (2001). Lasting effects of home literacy on reading achievement in school. *Journal of School Psychology*, *39*, 389–414.

Leseman, P. P. M., Scheele, A. F., Mayo, A. Y., & Messer, M. H. (2007). Home literacy as a special language environment to prepare children for school. *Zeitschrift für Erziehungswissenschaft*, *10*, 334–355.

Lipponen, L., Rahikainen, M., Lallimo, J., & Hakkarainen, K. (2003). Patterns of participation and discourse in elementary students' computer-supported collaborative learning. *Learning and Instruction 13*, 487–509.

Lockhorst, D., Admiraal, W. F., Pilot, A., & Veen, W. (2002). Design elements for a CSCL environment in a teacher training programme. *Education and Information Technologies*, *7*, 377–384.

Lou, Y., Abrami, P. C., & d'Appollonia, S. (2001). Small group and individual learning with technology: A meta-analysis. *Review of Educational Research*, *71*, 449–521.

McCaslin, M., & Burross, H. L. (2011). Research on individual differences within a sociocultural perspective: Co-regulation and adaptive learning *Teachers College Record*, *113*, 325–349.

Muukkonen, H., Lakkala, M., & Hakkarainen, K. (2005). Technology-mediation and tutoring: How do they shape progressive inquiry discourse? *Journal of the Learning Sciences*, *14*, 527–565.

Nurmela, K. A., Lehtinen, E., & Palonen, T. (1999). Evaluating CSCL log files by social network analysis. In C. M. Hoadley & J. Roschelle (Eds.), *Proceedings of the Computer Support for Collaborative Learning (CSCL) conference* (pp. 434–444). Palo Alto, CA: Stanford University.

O'Donnell, A. M., & O'Kelly, J. (1994). Learning from peers: Beyond the rhetoric of positive results. *Educational Psychology Review*, *6*, 321–349.

Palincsar, A. S., & Brown, A. L. (1989). Classroom dialogues to promote self-regulated comprehension. In J. Brophy (Ed.), *Advances in research on teaching* (pp. 35–72). Greenwich, CT: JAI Press.

Pels, T., Nijsten, C., Oosterwegel, A., & Vollebergh, W. (2006). Myths and realities of diversity in child rearing. Minority families and indigenous Dutch families compared. In M. Dekovic, T. Pels, & S. Model (Eds.), *Child rearing in six ethnic families: The multi-cultural Dutch experience* (pp. 213–245). Lewiston, NY: Edwin Mellen Press.

Phielix, C., Prins, F. J., & Kirschner, P. A. (2010). Awareness of group performance in a CSCL environment: Effects of peer feedback and reflection. *Computers in Human Behavior*, *26*, 151–161.

Prinsen, F. R., Terwel, J., Volman, M., & Fakkert, M. (2008). Feedback and reflection to promote student participation in computer supported collaborative learning: A multiple case study. In R. Gillies, A. Ashman, & J. Terwel (Eds.), *Computer Supported Collaborative Learning Series. Vol. 8. The teacher's role in implementing cooperative learning in the classroom* (pp. 132–162). New York, NY: Springer.

Prinsen, F. R., Volman, M. L. L., Terwel, J., & Van den Eeden, P. (2009). Effects on participation of an experimental CSCL-programme to support elaboration: Do all students benefit? *Computers & Education*, *52*, 113–125.

Saab, N. (2005). *Chat and explore. The role of support and motivation in collaborative scientific discovery learning* (Doctoral thesis). Amsterdam, The Netherlands: University of Amsterdam.

Scardamalia, M., & Bereiter, C. (1996). Computer support for knowledge-building communities. In T. Koschmann (Ed.), *CSCL: Theory and practice of an emerging paradigm* (pp. 249–268). Mahwah, NJ: Erlbaum.

Schellens, T., & Valcke, M. (2006). Fostering knowledge construction in university students through asynchronous discussion groups. *Computers & Education*, *46*, 349–370.

Schellens, T., Van Keer, H., Valcke, M., & De Wever, B. (2007). Learning in asynchronous discussion groups: A multilevel approach to study the influence of student, group and task characteristics. *Behaviour & Information Technology*, *26*, 55–71.

Snel, M. J., Terwel, J., Aarnoutse, C. A. J., & Van Leeuwe, J. F. J. (2012). Effectiveness of guided co-construction versus direct instruction for beginning reading instruction. *Educational Research and Evaluation*, *18*, 353–374.

Soller, A., & Lesgold, A. (2007). The role of technology in CSCL. *Computer-Supported Collaborative Learning*, *9*, 63–86.

Stahl, G. (2000). Collaborative information environments to support knowledge construction by communities. *AI & Society*, *14*, 1–27.

Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–426). Cambridge, UK: Cambridge University Press.

Strijbos, J. W., Martens, R. L., & Jochems, W. M. G. (2004). Designing for interaction: Six steps to designing computer-supported group-based learning. *Computers & Education*, *42*, 403–424.

Suthers, D. D., & Hundhausen, C. D. (2001). Learning by constructing collaborative representations: An empirical comparison of three alternatives. In P. Dillenbourg, A. Eurelings, & K. Hakkarainen (Eds.), *European perspectives on computer-supported collaborative learning* (pp. 577–584). Maastricht, The Netherlands: Universiteit Masstricht.

Suthers, D. D., & Hundhausen, C. D. (2003). An empirical study of the effects of representational guidance on collaborative learning. *Journal of the Learning Sciences*, *12*, 183–219.

Terwel, J. (2003). Cooperative learning in secondary education: A curriculum perspective. In R. M. Gillies, & A. F. Ashman (Eds.), *Cooperative learning: The social and intellectual outcomes of learning in groups* (pp. 54–68). London, UK: RoutledgeFalmer.

Terwel, J., Gillies, R. M., Van den Eeden, P., & Hoek, D. (2001). Co-operative learning processes of students: A longitudinal multilevel perspective. *British Journal of Educational Psychology*, *71*, 619–645.

Ulicsak, M. H. (2004). ''How did it know we weren't talking?'': An investigation into the impact of self-assessments and feedback in a group activity. *Journal of Computer Assisted Learning*, *20*, 205–211.

Van der Linden, J. L., Erkens, G., Schmidt, H., & Renshaw, P. (2000). Collaborative learning. In P. R. J. Simons, J. L. Van der Linden, & T. Duffy (Eds.), *New learning* (pp. 1–19). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Van der Meijden, H. (2005). *Knowledge construction through CSCL: Student elaborations in synchronous, asynchronous, and three-dimensional learning environments* (Unpublished doctoral dissertation). Radboud University, Nijmegen, The Netherlands.

Veldhuis-Diermanse, A. E. (2002). *CSCLearning? Participation, learning activities and knowledge construction in computer-supported collaborative learning in higher education* (Unpublished doctoral dissertation). Wageningen University, Wageningen, The Netherlands.

Volman, M., Van Eck, E., Heemskerk, I., & Kuiper, E. (2005). New technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. *Computers & Education*, *45*, 35–55.

Webb, N. M. (2008). Teacher practices and small-group dynamics in cooperative learning classrooms. In R. Gillies, A. Ashman, & J. Terwel (Eds.), *Computer Supported Collaborative Learning Series. Vol. 8. The teacher's role in implementing cooperative learning in the classroom* (pp. 205–225). New York, NY: Springer.

Webb, N. M., & Farivar, S. (1994). Promoting helping behavior in cooperative small groups in middle school mathematics. *American Educational Research Journal*, *31*, 369–395.

Webb, N. M., & Farivar, S. (1999). Developing productive group interaction in middle school. In A. M. O'Donnell, & A. King (Eds.), *Cognitive perspectives on peer learning* (pp. 117–149). Mahwah, NJ: Erlbaum.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer supported collaborative learning. *Computers & Education*, *46*, 71–95.

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2003). Facilitating collaborative knowledge construction in computer-mediated learning with structuring tools. In R. Bromme, F. Hesse, & H. Spada (Eds.), *Barriers and biases in network-based knowledge communication in groups* (pp. 15 – 17). Dordrecht, The Netherlands: Kluwer Academic.