The influence of learner characteristics on degree and type of participation in a CSCL environment

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Abstract

Computer-Supported Collaborative Learning (CSCL) is often presented as a promising learning method. However, it is also facing some new challenges. Apart from answering the question of whether or not working with CSCL generates satisfying learning outcomes, it is important to determine whether or not all participants profit from collaboration, with the computer as a means of communication. This paper describes the implementation and effects of an experimental program in 5 classes with a total of 120 students in elementary education who, in groups of four, engaged in Knowledge Forum discussion tasks on the subject of healthy eating. The study explores whether or not differences occur in the participation of students who differ in gender, sociocultural background and ability, and whether or not computer skills, computer attitudes, comprehensive reading scores and popularity with classmates are related to student participation. Students' participation in this CSCL environment appears to be dependent on a number of learner characteristics. Girls contribute more words to the discussions than boys do and are more dependent on their computer skills in this production. Students who are good at comprehensive reading also contribute more words. Popularity among classmates appears to influence the degree of participation further. We also found indications that students with immigrant parents write fewer contributions than those whose parents are not immigrants.

Introduction

Computer-Supported Collaborative Learning (CSCL) is often presented as a promising learning method. It offers the opportunity to collaborate with peers, which can enhance students' learning processes, as several studies have shown (Scardamalia & Bereiter, 1994; Slavin, 1990; Webb & Palincsar, 1996). Such studies reveal that the collaborative

learning process should be supported by a teacher, who clarifies the learning goals, creates an open and meaningful learning task, and suggests resources for use in the completion of this task. In CSCL, support from the computer application provides further opportunities for learning. The way in which the learner grasps and uses the affordances and resources of the environment is decisive for the learning that can take place.

In this paper, we investigate whether or not all participants profit equally from working with CSCL. Studies in cooperative learning have shown differences in participation and learning outcomes that can be traced to predictors such as ability, preknowledge, social-cultural background and gender (Terwel, Gillies, Van den Eeden & Hoek, 2001; Webb, 1984). Several studies in Computer Mediated Communication (CMC) and CSCL have shown differences in the amount and type of participation related to learner characteristics (eg, Barrett & Lally, 1999; Lipponen, 1999; Robertson, Hewitt & Scardamalia, 2003). The differences found often concern gender differences (Prinsen, Volman & Terwel, 2006).

In this study, we explore whether or not differences occur in the participation of students who differ in gender, sociocultural background, ability and popularity with classmates. We also investigate differential participation according to differences in computer skills, computer attitudes and comprehensive reading skills. The investigation is based on the following research questions:

1. How do the student characteristics (gender, social-cultural background, ability and popularity) affect participation in CSCL?
2. How do the preknowledge and attitude variables (computer skills, attitude towards working with computers and comprehensive reading scores) affect participation in CSCL?
3. Do interaction effects occur between student characteristics and prior knowledge and attitude variables?

These questions involve looking at the degree of student participation in CSCL discussions. However, merely looking at the *degree* of participation by students is only superficially informative about their opportunities for learning. The *types* of interaction in which students engage, more specifically the quality of their participation, come closer to being determinants of the actual learning gain. That is why we first report on the *degree* of participation in CSCL discussions, followed by the *type* of participation in this learning environment.

Theoretical and empirical background
CSCL is based on a combination of theoretical notions developed in the field of cooperative learning and a socioconstructivist perspective. Cooperative learning research emphasises the importance of inducing sociocognitive conflicts, resource sharing and verbalising thoughts as the primary mechanisms for learning and development. A socioconstructivist perspective emphasises collaborative knowledge building in a community of inquiry. In CSCL, one of the basic mechanisms of cognitive growth is considered to be communicative in nature (Shunk, 2000; Vygotsky, 1978).

It is assumed that participation in collaborative knowledge-building interactions in a CSCL learning environment can enhance participants' learning. The participation of *all* students in a collaborative discussion in the classroom is therefore considered important. Participation in communicative computer environments, however, does not appear to be balanced. A review of the literature on this issue mainly yielded findings on gender differences (Prinsen *et al*, 2006). Studies by Barrett and Lally (1999) and by Carr, Cox, Eden and Hanslo (2004) report that male students take more turns and send more messages than female students do. Lipponen (1999) and Robertson *et al* (2003) report similar results in CSCL studies with girls writing a relatively lower proportion of notes. Some studies, however, find that the length of female students' messages is greater than those of male students (Li, 2002; Robertson *et al*, 2003). Others also find a tendency for boys to enter more words than girls do (McConnell, 1997).

Some studies report that group composition plays a role in the participation of males and females in CMC (eg, Savicki, Kelley & Lingenfelter, 1996a). Another factor found to be relevant in relation to participation is the degree of popularity that students enjoy with their classmates (Cho, Stefanone & Gay, 2002; Lipponen, Rahikainen, Hakkarainen & Palonen, 2003). The position in the social network of the class appears to be a more prominent determinant of participation than is often assumed; a student's status or popularity affects both the degree of his or her participation and the extent to which information is actually shared regardless of the content of the contributions.

Surprisingly, little is known about differences in participation in CSCL, depending on students' ability level or ethnic or social background. Differences between minority and majority groups and differences according to social background may be expected. Previous studies have shown that differences in computer experience and comprehensive reading ability related to social and ethnic background influence students' participation in educational activities involving computer-mediated communication (Volman, Van Eck, Heemskerk & Kuiper, 2005).

Research into differences between students in type of participation also shows mainly gender differences. Participation indicators such as levels of agreement and disagreement in groups, the amount of argumentation and personal opinion offered, and the number of questions asked have been studied. In the study by Selfe and Meyer (1991), males were found to disagree with others twice as often as females, although no differences were found in the number of agreements. Savicki *et al* (1996b) measured the level of conflict in differently gender-composed groups. Male-only groups showed the largest percentage of messages containing tension (attacking an opposing argument), followed by mixed groups, with female-only groups showing no tension. In a study by Savicki, Kelley and Oesterreich (1999), boys' groups communicated more by means of arguments, attacks and responses to attacks. Underwood, Underwood and Wood (2001) noticed that in CSCL, as in CMC, males tend to post more authoritative statements while female students seem more willing to share their own intuitive conceptions and personal opinions. Li (2002) found that female students' messages contain signifi-

cantly more 'information requesting' than those of male students. Females' initial messages included significantly fewer 'explanation-providing' messages than males' initial messages.

As to differences in ability level, differences in the guidance students need in order to participate adequately have been noticed. Rahikainen, Lallimo and Hakkarainen (2001) showed that the teacher's guidance in a Computer Supported Intentional Learning Environment (CSILE) learning environment varied a great deal according to students' level of advancement. The less advanced students were still being guided by the teacher in searching for new information and externalising their thoughts at the end of the course, whereas for other students, this kind of guidance was only necessary at the beginning of the course.

Again, the literature does not reveal much about differences in the types of participation of students from different ethnic and social backgrounds.

In the literature, computer skills and computer attitudes appear to be related to participation in computer use in education. Such variables often explain the relationship found between gender and participation in educational computer activities (Volman & Van Eck, 2001). Little research has focused on these variables in CSCL, although Bernard, Mills and Friend (2000) draw attention to differences between males and females in computer anxiety. The females in their CSCL study demonstrated higher levels of computer anxiety. This may have influenced their enjoyment of working in these environments. Males' and females' attitudes towards CSCL have, as far as we know, not been studied directly, however. Such a study could be interesting as it has been argued that CSCL may have a number of features that are attractive to girls, in particular interaction, collaboration, writing and problem solving.

Finally, in our search, we did not find any studies addressing the relationship between student characteristics like gender, social and ethnic background, ability level and popularity, or preknowledge and attitude variables like computer skills and computer attitude on the one hand, and cognitive and affective learning outcomes of students in CSCL environments on the other (Prinsen *et al*, 2006).

CSCL researchers are starting to take an interest in the participation of different categories of students in CSCL. Until now there have not been enough findings to answer general questions about the impact of student characteristics. A number of factors add to the difficulty of executing careful reviews of the findings. CSCL applications vary. They vary in their affordances, such as the amount of support they provide for collaboration. Also, the methods of study vary, and questions that seem similar on the surface are answered by means of quite different research designs. A systematic reporting on the (learning environment) factors that could influence the variables under examination is often lacking. The task is not always explained clearly; nor is the application used always thoroughly described, while grouping decisions are not explained in advance (Crook, 1998) and instructions issued to students in advance of their use of CSCL are

hardly ever elaborated. The role of the teacher in structuring the learning process might be supported in better informed ways if research could arrive at conclusions as to how these factors in the learning environment affect the participation and learning outcomes of students working with CSCL.

On the basis of the literature, we decided to investigate whether or not patterns of participation in CSCL are related to gender, sociocultural background, ability level and popularity. We will also look at differences in computer skills and computer attitudes. Because we are investigating the participation of students in a computer-supported learning environment that strongly relies on students' language skills, comprehensive reading skills of students will also be taken into account.

Research methodology

Design

The research design is characterised as a quantitative descriptive, exploratory study. A lesson series on the subject of healthy eating was developed, in which groups of four students engaged in Knowledge Forum[1] discussion tasks. The amount and type of participation of students were measured and related to student characteristics and prior knowledge and attitude variables.

Participants

Five primary-school classes (Grade 5, average age of students 10 years) and their teachers participated in the study. The schools were all in the city of Amsterdam, the Netherlands and were selected from a network of schools related to a local organisation facilitating the schools' computer networks. They were selected to represent schools with a diverse student population and from different socio-economic areas in the city. The teachers agreed to free up about 70 minutes a week over 6 weeks in their regular lesson plan. A total of 120 children (57 boys, 63 girls) participated in the CSCL discussions and completed questionnaires. Nearly a quarter of the children had immigrant parents. Almost a quarter were from low-income backgrounds.

Instruments

The control and independent variables were measured as follows. The Standard Progressive Matrices test was administered to determine general ability (Intelligent Quotient (IQ) percentile scores). The cultural background of the children was further measured by asking the children in which country their parents were born. If both parents were born abroad, the children were considered to belong to a minority sociocultural background. Finally, the students' popularity was established in a questionnaire item in which the children were asked to mention the person in their class with whom they most liked to do collaborative work behind the computer. The times that the same student was mentioned were then counted.

[1]Developed at the Ontario Institute for Studies in Education.

Before the lessons started, a questionnaire was administered to determine relevant skills and attitudes. A list of general computer skills was taken from a Dutch monitor instrument (van Gennip, Braam & Poulisse, 2002). General computer skills were determined by providing the children with a list on which they could indicate the computer skills they thought they possessed (25 items). The instrument proved sufficiently reliable, with a Cronbach's alpha of 0.87. Furthermore, the general attitude towards working with computers was assessed by asking agreement scores on 34 assertions about working with computers (on a 5-point scale from *totally agree* to *totally disagree*). The assertions were adapted from an instrument originally designed by Martinot, Kuhlemeyer and Feenstra (1988). The instrument proved sufficiently reliable, with a Cronbach's alpha of 0.84. The questionnaire consists of four subscales: the Pleasure scale (alpha 0.77), the Fear and difficulty scale (alpha 0.71), the Interest scale (alpha 0.72), and the Usefulness and relevance scale (alpha 0.67). During the research period, the children took a test on comprehensive reading (Dutch Central Institute of Test Development (CITO) Standardised test) to determine their achievement level in reading.

The dependent variables are the degree and quality (type) of students' participation in the discussion task. Participation was measured both by counting the mean number of contributions and by counting the mean number of words contributed per minute over the four lessons in the Knowledge Forum. The type of participation was established by using a coding scheme similar to an instrument first developed by Veldhuis-Diermanse (2002). We adapted the original scheme slightly in order to make it more suitable for our discussion task and for the age of the students in our study. The coding scheme distinguishes between cognitive, affective and regulative contributions to the discussion. In this study, we focus and report only the cognitive contributions, although we do acknowledge the importance of the affective and regulative contributions. Cognitive contributions include asking questions (questions about facts and questions for an explanation or an illustration), formulating answers (with and without elaboration) and agreeing or not agreeing (with and without elaboration). Affective contributions concern affective/emotional remarks or responses. Regulative contributions are contributions aimed at monitoring progress in the discussion, evaluating the group process or instructing fellow students. Finally, a rest category included off-topic contributions, chat and social talk. We took a sample of 1,938 from a total of 5,500 contributions made to Knowledge Forum by 122 students. We coded each contribution, and in the end, we counted and calculated the means (percentages) for each general category in the coding scheme (like 'question asking', 'providing explanations'). All students were represented in the sample with their contributions in one of the lessons, and all lessons were equally represented in the sample. A content analysis was carried out, achieving an interrater agreement of 75%.

Procedures
Prior to the study, a workshop was organised during which the use of the Knowledge Forum programme was explained to the five primary-school teachers who participated in the study. First, all teachers joined three 2-hour sessions in which they became familiar with the Knowledge Forum application and the theory behind CSCL in

hands-on discussion tasks. The conditions for CSCL were discussed. Then the lesson plan was introduced by the teacher to the children in their classes. The students of each class were divided by the teacher into heterogeneous groups of four (according to gender, ability and socio-ethnic background). They tried to make combinations with two by two divisions in the groups, placing, as much as possible, two boys with two girls, two lower achievers with two higher achievers and finally, two pairs with different socio-ethnic backgrounds. Students' achievement levels were judged on the basis of their scores on national comprehensive reading, math and spelling tests. The popularity that the students enjoyed with classmates was not taken into account by the teacher in constituting the groups because this is a value that can only be attributed by the fellow students.

The lesson plan consisted of six lessons concerning the topic of 'nutrition and health', a domain within the integrated subject 'World orientation and Science' (see Table 1 for an overview of the lesson plan). The first lesson was a practice lesson in which students received instructions in the use of the programme and were required to discuss a sample question in the Knowledge Forum with their group. They were also made familiar with the scaffolds provided in the Knowledge Forum programme. These scaffolds were simplified for an improved matching of the task and the level at which the students collaborate (eg, 'Opinion' was changed to 'I think'). After this lesson, the students received some feedback on the group process. Three lessons followed in which students carried out discussion tasks. Each lesson started with the reading of a chapter on healthy eating (about 1,500 words at a time), followed by the introduction of two discussion questions, after which the children were given some time to prepare the discussion questions individually. The children were told to prepare the answers well as they would have to discuss their answers with their group afterwards. Subsequently, each group of four students spent 30 minutes discussing the answers to two questions on the chapter in Knowledge Forum. The questions were designed for nonfixed answers. The children were instructed to collectively find as many alternative (right) answers as possible, and were told that they would be evaluated on their individual participation and learning gains as well as their group process. Each group member sat at his or her own computer and was told only to communicate through the computer. In total, the children dis-

Table 1: Overview of the lesson plan

Lesson 1	Practice lesson (one question)
	Topic: sugar
Lesson 2	CSCL discussion lesson (two questions)
	Topic: energy and nutritious substances
Lesson 3	Evaluation lesson
Lesson 4	CSCL discussion lesson (two questions)
	Topic: reading labels
Lesson 5	Evaluation lesson
Lesson 6	CSCL discussion lesson (two questions)
	Topic: hygiene

CSCL, Computer-Supported Collaborative Learning.

cussed answers to seven complex questions during the course of the lessons (including one practice lesson).

After the first and second discussion lessons, the children received feedback regarding the way they had executed the first discussion task during an evaluation lesson. They were told how many of the possible alternative answers their group had found and received feedback on the number of notes contributed that were actually on-subject in order to point out how often they had been off-task. They both received feedback on their group discussion and on the individual students' contribution to the discussion. They also received some feedback on the group process.

At least one researcher was always present at the time that the groups were behind their computers to assist in case of problems with the use of the programme. As some children were out of the classroom during this time and as the regular lessons were to continue, it also seemed wise to keep an eye on the groups to make sure they only communicated by means of the computer programme.

Analysis
The data were analysed using analyses of variance (ANOVAs) and regression analysis.

Results
The results section consists of two subsections in which the data are described and analysed in relation to the two dependent research variables (I) Degree of participation (measured as number of words contributed and number of contributions), and (II) Type of participation in the CSCL discussion tasks.

I Degree of participation
First, the descriptive statistics concerning student characteristics, questionnaires and tests are reported. Second, the relations between the variables involved are explored. Finally, we show the results of a regression analysis in which the dependent variable 'number of words contributed' was regressed on a selected set of predictor variables.

Table 2 shows the descriptive statistics for the student characteristics, questionnaires and tests. Concerning the attitude variables, we only report on 'Fear and difficulty' because the other computer-attitude scales and the attitude towards collaboration and Knowledge Forum scales appeared not to be related to any of the dependant variables.

Table 3 shows the significant correlations between the research variables. The following conclusions may be drawn from this. Boys report that they are more skilled in working with computers (mean = 22) than girls (mean = 20) (ANOVA, *df* 1,2 = 1, 116; *F* = 3.89; sign = 0.05). There is also a difference between boys and girls in the fear and difficulty they experience in working with computers. Boys experience less 'Fear and difficulty' (mean = 4.27) than girls (mean = 3.85) (A high score on 'Fear and difficulty' is an indication of a student experiencing little fear and difficulty) (ANOVA, *df* 1,2 = 1, 115; *F* = 11.45; sign = 0.001). The ANOVA further shows a

	M	SD	Min	Max
Gender (dummy)	0.53	0.50	0	1
Sociocultural background	0.24	0.43	0	1
IQ (score on Standard Progressive Matrices Test (SPM))	46.40	5.23	34	57
Popularity	0.89	0.99	0	4
Computer skills	21.00	4.29	7	25
Comprehensive reading	54.37	16.02	26	100
Fear and difficulty	4.05	0.70	1	5
Amount of words per minute	6.16	2.84	1.89	15.27
Number of contributions per lesson	15.04	6.66	4.75	38.75

N students = 120.

significant relation between sociocultural background and comprehensive reading. Students with immigrant parents score significantly lower on comprehensive reading (mean = 49) than those whose parents were not immigrants (mean = 56) (ANOVA, *df* 1,2 = 1, 116; *F* = 4.09; sign = 0.045). In addition, significant correlations were found between IQ and comprehensive reading: the higher the IQ, the better the score on comprehensive reading (ANOVA, *df* 1,2 = 1, 110; *F* = 3.74; sign = 0.007).

Correlations between gender, popularity, computer skills and comprehensive reading scores on the one hand and Number of words contributed on the other were found. Sociocultural background, IQ and computer skills appeared to be correlated with Number of contributions. Only the correlation between gender and the number of words and the correlation between sociocultural background and the number of contributions were shown to be significant in an ANOVA. These analyses show an effect of gender on the number of words contributed in the CSCL lessons (ANOVA, *df* 1,2 = 1, 118; *F* = 27.28; sign = 0.00). Girls contribute an average of 7.33 words, boys an average of 4.87 words. Another analysis shows a difference in the number of contributions of students with immigrant parents (mean = 12.34) and those whose parents are not immigrants (mean = 15.83). (ANOVA, *df* 1,2 = 1, 116; *F* = 6.09; sign = 0.015). The other correlations (IQ—number of contributions, popularity—number of words) do not remain significant in an ANOVA.

We explored several possible regression models. In our regression analysis we used Z-scores for all variables and a dummy variable for Gender. It appeared that participation measured by the number of words could be explained best by the variables included in our study. We therefore present a model with number of words as a dependent variable here. Fitting all the independent variables in a regression model with participation (Amount of words) as the dependent variable, we found significant effects for Comprehensive reading and Popularity. In addition, an interaction effect for gender and computer skills was found. The final regression model is presented in Figure 1. The results of the regression analysis are presented in Table 4.

Table 3: Correlations between the variables

	Sociocultural background	IQ (percentile scores)	Popularity	Computer skills	Comprehensive reading	Fear and difficulty	Number of words	Number of contributions
Gender	−0.09	0.05	0.05	−0.18*	0.11	−0.30**	0.433**	0.15
Sociocultural background		−0.12	−0.08	0.06	−0.19*	0.08	−0.157	−0.22**
IQ (percentile scores)			0.16	−0.01	0.30**	0.02	0.133	0.19*
Popularity				0.06	0.15	0.02	0.242**	0.14
Computer skills					0.11	0.52**	0.309**	0.205*
Comprehsive reading						0.12	0.275**	0.149
Fear and difficulty							0.08	0.06
Number of words								0.67**

*Correlation is significant on the 0.05 level (two-tailed).
**Correlation is significant on the 0.01 level (two-tailed).
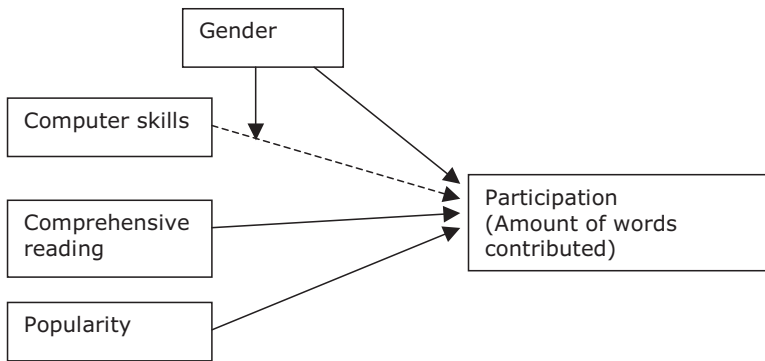N students = 120; Pearson Correlation.

Figure 1: Regression model for the combined effects

Table 4: Regression of the predictors on the dependent variable 'number of words contributed'

Model	R^2	Standard error of the estimate	R^2 change	F change	Sign. F change
1	0.187	2.60	0.187	25.58	0.000
2	0.346	2.34	0.159	26.66	0.000
3	0.369	2.31	0.023	3.99	0.048
4	0.399	2.27	0.030	5.35	0.023
5	0.437	2.20	0.038	7.20	0.008

1, Predictors: (Constant), Gender (dummy); 2 Predictors: (Constant), Gender (dummy), Z-score: Computer skills; 3 Predictors: (Constant), Gender (dummy), Z-score: Computer skills, Z-score: Comprehensive reading; 4 Predictors: (Constant), Gender (dummy), Z-score: Computer skills, Z-score: Comprehensive reading, Z-score: Popularity; 5, Predictors: (Constant), Gender (dummy), Z-score: Computer skills, Z-score: Comprehensive reading, Z-score: Popularity, Interaction variable: Computer skills and Gender.

The following conclusions may be drawn from Table 4. Forty-four percent of the degree of difference in participation between students (Number of words contributed) can be explained by five factors that are included in the study. Gender and computer skills explain the largest part of the variance: 19% and 16% respectively. Apart from these two factors, the predictors 'Comprehensive reading', 'Popularity' and the interaction variable 'Gender*Computer skills' significantly contribute to an explanation of the variance in the dependent variable. Table 5 shows the coefficients.

In the full model (Model 5 in Table 5), all betas are significant except for computer skills. There is consequently no computer-skill effect. However, there is a significant interaction effect in relation to Gender*Computer skills. Differences in male students' computer skills do not lead to differences in degree of participation, but for females, computer skills are important. In other words, female students depend on their computer skills

Table 5: Coefficients of the regression of predictors on the dependent variable 'Amount of words contributed'

Model 5	Unstandardised coefficients		Standardised coefficients		
	B	Standard error	Beta	t	Sign.
(Constant)	−0.455	0.110		−4.135	0.000
Gender (dummy)	0.924	0.151	0.459	6.134	0.000
Z-score: Computer skills	0.127	0.119	0.126	1.063	0.290
Z-score: Comprehensive reading	0.164	0.078	0.158	2.096	0.038
Z-score: Popularity	0.169	0.074	0.168	2.281	0.025
Interaction variable: Gender*Computer skill	0.410	0.153	0.313	2.683	0.008

while male students do not. The implication for CSCL might be that training computer skills seems especially beneficial for girls: the more computer skills, the greater the degree of participation.

The main results regarding degree of participation may be summed up as follows. Participation in this particular CSCL environment (as measured by number of words contributed) appears to depend on several learner characteristics and preknowledge variables: gender, popularity and comprehensive reading. Girls contribute more words to the discussions than boys and appear to be more dependent on their computer skills in this production. Popular students are more active in the discussion in terms of number of words contributed than their less popular classmates. It is not clear from this study, however, whether or not popular students receive more comments and are therefore called upon to react more, or whether or not they take more initiatives to communicate themselves. A high comprehensive reading score also contributes to active participation in the discussion task. Since CSCL involves a great deal of on-screen reading, it is not surprising that, in order to participate, a student should possess a degree of competence in comprehensive reading in terms of number of words contributed. In the production of (the number of) contributions, students' sociocultural backgrounds play a role. This may be explained by the lower competence in comprehensive reading in this group.

II Type of participation
An exploratory content analysis of the contributions of 115 students (30 groups divided over the 3 lessons) was conducted. In total, 1,938 codes could be classified. As already mentioned in the methodology section, students' types of participation were established by means of a coding scheme that classified the contributions to the discussion in terms of cognitive contributions (asking questions for facts and for an explanation; formulating answers and agreeing, with and without elaboration), and affective and regulative contributions to the discussion. In the succeeding discussions, we will first characterise the CSCL discussion in general and subsequently report in greater

detail on the type of participation according to the coding scheme. The only student variable that appeared to correlate with type of participation was gender. We will finally report on the gender differences found.

Overview of students' discussions

Many studies show that the average depth of discussions in CMC and CSCL leaves much to be desired. The length of the discussion threads is often short and the students do not always build on each others' contributions. The average length of the threads in this study was seven contributions. This is not a particularly bad result compared to other research (Guzdial, 1997, mean length 2.8; Guzdial & Turns, 2000, mean length 2.8; Hewitt & Tevlops, 1999, mean length 2.69; Lipponen, Rahikainen, Hakkarainen & Palonen, 2003), mean length 3.8). The length of the threads does not say much about the quality of the content, however. Some groups write short threads, but the answers given are complete and the quality of the content is good. In such cases, there is no need to build too much on the results. When we look more closely at the content of some very long discussions, they appear to include a great deal of talk about things other than the lesson content.

Table 6 shows the means, standard deviations, minima and maxima of the coding categories. We have added up the scores on similar codes into bigger categories so that general patterns of differences in contribution types can be examined. To report all the scores of the separate codes would get us into too much detail for the scope of this paper. The rest category included about 5% of the contributions.

We will first give a more general characterisation of the discussion. We will then go on to explore the differences in types of participation.

In this sample, the majority of the contributions were supportive in nature (Accepting = 29%). The students agreed with each other most of the time. Almost half of these supportive comments were elaborated with an argument or with a further and more complete answer. The other half were contributions of the type 'I agree' and 'I think so

Table 6: Descriptive statistics for type of participation, percentages of coded categories

	M	SD	Min.	Max.
Providing answers/ explaining	27.61	11.91	6.25	66.67
Accepting	29	15.95	0.00	68.42
Nonaccepting	11.10	9.75	0.00	44.44
Questions	13.13	12.62	0.00	62.5
Regulative contributions	6.03	8.13	0.00	38.1
Affective contributions	7.71	9.19	0.00	50

N contributions = 1,938 (students = 115).

too'. More than a quarter of the contributions consisted of providing explanations or answers (Providing answers/explaining). Half of these answers were not elaborated with arguments or other additions. There was a reasonable amount of questioning (13%) even though the majority of these questions fit into the category of simple questions, asking for facts or specific answers. A great number of questions remain unanswered. If an explanation is given, it is not always adequate. When examining the passages in which explanations are provided, we see that giving explanations poses problems for many students in that it demands a great degree of skill. About 11% of the contributions may be characterised as evoking discussion (Nonaccepting); that is, the writer disagrees with the previous contribution. In most cases of disagreement (about two-thirds), there is an additional explanation or elaboration. We consider elaboration as an indication of knowledge being constructed. Therefore, the way that students respond to each other cannot always be labelled as knowledge construction. Nevertheless, the finding that many supportive comments and most disagreements in the groups were backed up with elaborations or arguments is promising. A number of times during the lessons, the students thought they had finished the task when they found an agreement to an answer. However, the task was not merely to reach an agreement but to arrive at an answer that was both complete and detailed. Because the task was fairly well structured, not much time was spent on regulation (6%). About 8% of the contributions were of an affective nature.

Gender differences in type of participation
Do girls and boys write different types of contributions in the CSCL discussion? Table 7 shows how the variables in Table 6 correlate with gender.

All significant correlations, as reported in Table 7, were also significant in the ANOVA. The following conclusions may be drawn from Table 7: boys provide more contributions with answers and explanations (mean = 30% of their contributions) than girls (mean = 25% of their contributions) (ANOVA, *df* 1,2 = 1, 115; $F = 4.14$; sign = 0.044). Girls show more acceptance of contributions made by others (mean = 32%) than boys (mean = 26%) (ANOVA, *df* 1,2 = 1, 115; $F = 4.51$; sign = 0.036). Boys contribute a larger percentage of messages expressing disagreement (mean = 13%) than girls (mean = 9%) (ANOVA, *df* 1,2 = 1, 115; $F = 6.25$; sign = 0.014), and girls pose more questions to others (mean = 15%) than boys (mean = 11%) (ANOVA, *df* 1,2 = 1, 115; $F = 4.23$; sign = 0.042).

Table 7: Correlation matrix type of participation by Gender (Pearson Correlation)

	Gender	Providing answers/ explaining	Accepting	Nonaccepting	Questions	Regulative contributions	Elaborated contributions	Affective contributions
Gender	1	−0.19*	0.19*	−0.23*	0.19*	0.03	0.07	−0.12

*Correlation is significant at the 0.05 level (two-tailed).

It is possible that girls have more covert ways of showing disagreement. We examined the frequency of using specific sentence openers that are available in the Knowledge Forum message writing windows. It showed that girls use the sentence opener "Yes, but …" significantly more often (mean = 11 times in a lesson) than boys (mean = 7 times in a lesson) (ANOVA, *df* 1,2 = 1,92; *F* = 5.46; sign = 0.022). In this type of contributions, students first agree by saying yes, but then include another viewpoint that may be of a disagreeing nature.

Conclusions and discussion

This study reveals significant differences in students' *degree of participation* in a CSCL learning environment, both in terms of the number of messages contributed by students and the number of words contributed to the discussion. Some students write an average of 5 contributions per lesson, others up to 38. Some students contribute an average of 2 words per minute, while others contribute up to 15 words per minute. The participation in this CSCL environment appears to be dependent on a number of learner characteristics. Girls contribute more words to the discussions than boys and are more dependent on their computer skills in this production. Popularity among classmates also appears to influence the degree of participation. Students with immigrant parents write fewer contributions than those whose parents are not immigrants. Students who are good at comprehensive reading contribute more words. This is not surprising because CSCL involves a great deal of on-screen reading, and the students had to read in preparation for the discussion.

Comparing our findings with the literature on participation in CMC and CSCL, we see some similarities and some differences. The boys in our study did not contribute more messages than the girls, which disconfirms the findings of some CMC (Barrett & Lally, 1999; Carr *et al*, 2004) and CSCL studies (Lipponen, 1999; Robertson *et al*, 2003). In fact, the girls contributed more words to the Knowledge Forum discussion. This is in accordance with Li (2002), who examined communication and interaction by boys and girls in a sixth-grade primary class using Knowledge Forum. Our findings, however, contrast with those of McConnell (1997), who discerned a trend with males entering more words than females in a group of postgraduate students working in a computer conference environment. It is uncertain as to whether or not this finding can be explained by the age group of the participants, by the characteristics of the particular application used or by the content of the lessons.

Similar to Bernard *et al* (2000), we found that females experience more fear and difficulty in working with computers, although this did not seem to influence their participation in working in this particular CSCL environment. We did not study the effect of group composition on participation, given that all our groups were heterogeneous in nature. It follows that the differences found here should only be generalised to heterogeneous groups.

We also found that individual popularity affects a student's participation (see also Cho *et al*, 2002; Lipponen *et al*, 2003). It is not clear from this study, however, whether or

not popular students are more active in the discussion because they receive more comments and are therefore called upon to react more, or whether or not they take more initiatives to communicate themselves. It might also be that they are considered popular because of their capabilities. In contrast to Rahikainen *et al* (2001), we did not find any effects of ability level (IQ) on participation.

Carr *et al* (2004) argue that differences between students in participation in computer-mediated discussions do not necessarily constitute a problem. They interpret the rather limited participation of some students in online chats in their study as a 'peripheral participation', in Wenger's (1998) sense. Instead of participants being marginalised, they see limited participation as a stage on the road to full participation. The question of marginalisation or peripheral participation can only be answered by monitoring individual participation patterns so as to establish whether or not a student's way of participating is, in fact, subject to development. However, differences in participation levels that can be attributed to a specific social group (gender, sociocultural background) cannot be interpreted in this way and should be a reason for interventions.

Collaboration necessitates a mutual engagement of participants in an effort to solve a problem together. The quantity of a student's participation is an indicator of this engagement. One can argue that more interactions make more learning possible, so we would like all students to participate actively in CSCL work to ensure that they can all profit from it. Teachers should therefore monitor how actively students engage in CSCL work and should gain information from the low-participating students to find out why they are inactive. They can then decide on the proper intervention. From our results, we conclude that interventions could be aimed at training specific computer skills relevant for participation in CSCL or at providing support for students with less competence in comprehensive reading.

Although we did not study the relation between student participation and learning gain, we assume that learning gain will be more related to *quality of participation* than to quantity of participation. Interactions that induce a sociocognitive conflict and stimulate resource sharing and the verbalising of thoughts may be assumed to have a positive impact on learning.

Comparing our findings on types of participation with findings from other studies, we again observe some similarities and differences. Like Selfe and Meyer (1991), we found that boys disagreed with others more often than girls. In contrast to their findings, however, we also find differences in the number of agreements, with girls agreeing more often with what was said. Like Li (2002), we found that girls' messages contained significantly more 'information requesting' than messages from boys. Girls' messages also included significantly fewer 'explanation-providing' messages than those sent by boys.

Robertson *et al* (2003) argue that gender differences should not be seen as a problem because both male and female styles are necessary in the process of knowledge con-

struction. Although we acknowledge that different roles in collaborative learning may contribute to the learning process or reflect different stages in the development of student participation, we do not believe that students benefit from taking one and the same role in the group for longer periods of time.

Teachers could encourage their students to take on different roles. They could raise awareness with boys that, although conflict and disagreement can be constructive, it could put off some participants who prefer a different style of communication. Girls are more likely to agree with what is said by others. This creates a friendly atmosphere in the group, which is certainly beneficial. The teacher can show, however, that disagreement is not necessarily offensive if it is used for the purpose of learning something from each other. Although our study reveals some interesting relations between student characteristics and degree and type of student participation in CSCL, further research is needed to determine the extent to which these differences in participation found are related to learning outcomes. In addition, a greater insight is required into how specific types of participation that contribute to learning can be stimulated in all students.

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