THE EFFECT OF FUNCTIONAL ROLES ON PERCEIVED GROUP EFFICIENCY DURING COMPUTER-SUPPORTED COLLABORATIVE LEARNING: A MATTER OF TRIANGULATION.

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The effect of functional roles on perceived group efficiency during computer-supported collaborative learning: A matter of triangulation.

Jan-Willem Strijbos[1]

Open University of the Netherlands, P.O. Box 2960, 6401 DL, Heerlen, The Netherlands

Rob L. Martens

Leiden University, P.O. Box 9555, 2300 RB, Leiden, The Netherlands

Wim M. G. Jochems

Open University of the Netherlands, P.O. Box 2960, 6401 DL, Heerlen, The Netherlands

Nick J. Broers

University of Maastricht, P.O. Box 616, 6200 MD, Maastricht, The Netherlands

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[1] Correspondence should be sent to Jan-Willem Strijbos, Open University of the Netherlands, Educational Technology Expertise Center, P.O. Box 2960, 6401 DL, Heerlen, The Netherlands. E-mail: jan-willem.strijbos@ou.nl

Abstract

In this article, the effect of functional roles on group performance and collaboration during computer-supported collaborative learning (CSCL) is investigated. Especially the need for triangulating multiple methods is emphasised: Likert-scale evaluation questions, quantitative content analysis of e-mail communication and qualitative analysis of open-ended questions were used. A comparison of fourty-one questionnaire observations, distributed over thirteen groups in two research conditions – groups with prescribed functional roles (n = 7, N = 18) and nonrole groups (n = 6, N = 23) – revealed no main effect for performance (grade). Principal axis factoring of the Likert-scales revealed a latent variable that was interpreted as perceived group efficiency (PGE). Multilevel modelling (MLM) yielded a positive marginal effect of PGE. Most groups in the role condition report a higher degree of PGE than nonrole groups. Content analysis of e-mail communication of all groups in both conditions (role n = 7, N = 25; nonrole n = 6, N = 26) revealed that students in role groups contribute more 'coordination' focussed statements. Finally, results from cross case matrices of student responses to open-ended questions support the observed marginal effect that most role groups report a higher degree of perceived group efficiency than nonrole groups.

Keywords: Computer-supported collaborative learning, roles, coordination, collaboration, computer-mediated communication

The effect of functional roles on perceived group efficiency during computer-supported collaborative learning: A matter of triangulation.

Small group dynamics have been studied in educational contexts since the 1970s. Whereas cooperative learning research initially focused on face-to-face cooperation at the elementary school level, it was gradually extended to higher education. The technology push in the 1980s, resulting from rapid developments in Computer-Mediated Communication (CMC), stimulated the rise of a new discipline in the 1990s called Computer-Supported Collaborative Learning (CSCL). CSCL draws its inspiration from various research disciplines suchs as sociolology, computer science, educational psychology, social psychology and communication science. Nevertheless, CSCL has become a popular pedagogical approach at most educational levels and increasingly so in higher education (Strijbos, Kirschner, & Martens, 2004a).

At present, however, there are no clear guidelines to determine how a CSCL environment should be designed (Gros, 2001). Developers question what tasks or work methods should be used (Enkenberg, 2001) and they have indicated considerable variations in the quality of interaction and learning outcomes (Häkkinen, Järvelä, & Byman, 2001). To a large extent this is caused by differences in group size, technology used, length of the study, research methodology and unit of analysis (Lipponen, 2001). The design of CSCL seems often based on subjective decisions regarding tasks, pedagogy and technology, or views such as ‘cooperative learning’ or ‘collaborative learning’. Although cooperative learning is associated with division of labour and collaborative learning with the equality of group member contributions to a shared problem solution (Dillenbourg, 1999; Brandon & Hollingshead, 1999; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999), there are far more similarities than differences between both views. Most CSCL approaches rely on two common principles – adopted from cooperative

learning – called ‘positive interdependence’ (Johnson, 1981) and ‘individual accountability’ (Slavin, 1980). Positive interdependence promotes ‘group cohesion’ and a heightened sense of ‘belonging’ to a group; and can be achieved through the task, resources, goals, rewards, roles or the environment (Brush, 1998). Individual accountability refers to the extent to which students are individually accountable for jobs, tasks or duties, and it was introduced to counter the ‘free-rider effect’: some students would deliberately not invest any (or little) effort. Both principles, however, relate to group dynamics phenomena ‘group cohesion’ and ‘social loafing’ (Forsyth, 1999), and thus they apply to any form of small group learning.

Furthermore, it is gradually more acknowledged that ‘learning’ and ‘collaboration’ both reside on interaction (Baker, 2002; Stahl, 2004; Strijbos, Martens, & Jochems, 2004b) and thus that *interaction* is the primary process to be studied to assess performance and learning benefits in CSCL environments. Strijbos, Martens and Jochems (2004b) propose a process-oriented design method for (computer-supported) group-based learning that focuses on fostering the envisioned group interaction that is thought to enhance learning instead of focussing on the final product of such interaction (which tends to be the dominant view in most institutes providing higher education). This method centers on five elements that directly shape group interaction: learning objectives, task-type, level of pre-structuring, group size and the technological tool used.

The need for systematic design of CSCL is amplified by some observations that conflicts regarding coordination during group interaction are more likely to occur in asynchronous CMC settings compared to face-to-face settings, since group members are not physically present at the same time and/or place (Benbunan-Fich & Hiltz, 1999). Finally, asynchronous communication is also ‘non-natural’ as immediacy of feedback, prone to face-to-face settings, is not present.

Clearly, some support should be designed to help students overcome difficulties in group coordination during asynchronous collaboration. One approach is to provide students with pedagogical support or a specific type of pre-structuring – which is often also referred to as 'scripting' (Dillenbourg 2002; Weinberger, 2003) – such as the use of roles.

The use of roles to support coordination during asynchronous CSCL

Group performance effectiveness depends on the one hand on the groups' use of their alternate opinions and on the other hand on the handling of increased coordination (Shaw, 1981). Roles can promote group cohesion and responsibility (Mudrack & Farrell, 1995) and thus they can be useful in fostering 'positive interdependence' and 'individual accountability' (Brush, 1998). Roles can be defined as more or less stated functions/duties or responsibilities that guide individual behaviour and regulate group interaction (Hare, 1994). In addition, roles can stimulate a group members' awareness of the overall group performance and each members' contribution. As stated by Mudrack and Farrel (1995): "The opinions that others form about one's contribution to the group effort will likely be influenced, in part, by which roles the focal group members play." (p. 559). Finally, roles appear to be most relevant when a group pursues a shared goal requiring a certain level of task division, coordination and integration of individual activities.

Three main categories of roles can be distinguished: individual roles, task roles and maintenance roles, each of which is comprised of several different roles (Mudrack & Farrell, 1995). However, these are based on a self-report inventory and pertain to roles that participants can perform during collaboration and each participant performs several roles simultaneously, thus making it difficult to implement such roles in educational contexts. Several pedagogical approaches, developed for cooperative learning, use roles to support coordination and group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either

content-focussed – facilitating knowledge acquisition through individual knowledge differences using 'jigsaw' (e.g., Bielaczyc, 2001), 'scripted cooperation' (O'Donnell & Dansereau, 1992), or 'prompting scripts' (Weinberger, 2003), or process-focussed roles on individual responsibilities regarding the coordination (e.g., Kynigos, 1999). Most roles developed for cooperative learning settings, however, comprise one single job, task or duty; mainly because they were developed for face-to-face collaboration in primary education. Although the use of roles is widely regarded as an effective instructional strategy in cooperative learning and CSCL, their effect has not been investigated systematically in both higher/distance and primary education.

If cooperative learning and more specifically roles were used in higher education, they were not adapted to higher education, although students in these settings vary considerably in (prior) knowledge, experience and collaboration skills, as compared to students in secondary/ primary education. Moreover, collaboration assignments in higher education are more complex and they take place over an extended period of time (i.e., not restricted to classroom time), thus requiring more explicit coordination than in primary or secondary education. Consequently, the previously mentioned uni-dimensional roles for face-to-face collaboration appear inadequate to support collaboration in higher education, let alone asynchronous CSCL settings. Thus, explicit and detailed roles descriptions should be provided.

Investigating the effect of functional roles in CSCL

The study reported in this article investigates the impact of roles that counter 'process losses' because of coordination demands. These roles are referred to as 'functional roles' based on role descriptions in reports by Johnson et al. (1992), Kagan (1994), and Mudrack and Farrell (1995); and adapted for an asynchronous CSCL setting in higher education. Strijbos, Martens, Jochems and Broers (2004c) found that functional roles appear to increase awareness of group

efficiency, whether the group performs well or poor. The outcomes also indicated that groups in the role condition appeared to be more susceptible to conflict and/or dropout. Examining dropout ('during' and 'not finishing the course timely' combined) revealed a significantly higher rate in nonrole groups (Kirschner, Strijbos, Kreijns, & Beers, 2004) and students' responses to open-ended evaluation questions revealed that the role groups experienced no negative consequences – in terms of progress – as a result of dropout (Strijbos, Martens, & Jochems, submitted). Clearly, dropout is not a preferable outcome from an educational point of view. Examination of the course design identified several preconditions that – if controlled – could decrease or prevent dropout, such as their preference for a practice assignment, slow or fast study pace, setting up of a time schedule, establishing a communication discipline and externalising expectations regarding effort prior to collaboration. Controlling for these preconditions can ensure a more evenly matched comparison of both research conditions.

The present study is a replication of the study by Strijbos et al. (2004c), however, explicit attention is paid to the aforementioned preconditions and to control their possible confounding influence. The main research question is: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?'. Based on the outcomes of the study by Strijbos et al. (2004c) it is expected that functional roles will have no effect on group performance (in terms of grade) because of lack of variance, however, it is expected that the roles will have a positive effect on collaboration in terms of perceived group efficiency. When the present study was conducted, roles were expected to decrease the amount of coordinative statements similar to Strijbos et al. (2004c). Based on their results, however, the expectation for role groups in the present study was adjusted to an increase of coordination. Multiple methods were used to investigate the effect of these roles: self-report Likert-scales,

quantitative content analysis of e-mail communication and cross case matrices of open-ended questions. It will be illustrated that triangulation of outcomes (and methods) is essential to investigate the effect of functional roles in particular and CSCL in general.

Triangulating multiple methods to investigate CSCL

Before the method and analyses of the self-report questionnaire data and e-mail communication are discussed it is important to point out that CSCL research requires triangulation of multiple methods to analyse data from multiple sources. In this study both quantitative and qualitative questionnaire data – as well as – quantitative analysis of a qualitative source (e-mail) are used. Analysis of each of these data sources requires a separate method.

Multilevel modelling. With respect to the analysis of self-report Likert-scale data, it is important to note the implications of non-independent observations with respect to the analysis of group collaboration. This issue was only recently raised in research on CSCL and small group collaboration. Cooperative learning research has frequently applied the ANOVA procedure to investigate the impact of an instructional strategy using individual level observations (see Slavin, 1995). This is no exception in some recent CSCL studies (Hübscher-Younger & Narayanan, 2003; Van Oostendorp & Juvina, 2003). However, individual scores are influenced by the group a student belongs to, thus their scores are not independent. Non-independent observations have strong implications for the analysis of group processes. Stevens (1996) points out that ANOVA is not suited: the assumption of independence is violated, because students' perception of efficiency depends on all members' contributions. Violation of independence increases as a function of the interdependence in a group, thus yielding a major increase of a Type I error. As an alternative Stevens (1996) suggest either to test with a stricter level of significance ($p < .01$ or even $p < .001$) or to use the group average. Multilevel modelling (MLM) is a technique that pays

explicit attention to nested structures of data (individuals in groups) and the subsequent interdependence between individual scores, without loosing variance as is the case when the group mean is used. MLM appears to be the best suited technique to investigate self-report perception questionnaire data (cf. Bonito, 2002). Since most CSCL research designs do not exceed 20 participants (Stahl, 2002) and MLM-analyses with a small sample size (less than 50) are rarely performed, we will discuss the methodological and analytical considerations in more detail in the method and results section that covers the MLM-analyses.

Content analysis. Analysis of written electronic communication transcripts has gained increased attention in CSCL in the past decade (Hara, Bonk, & Angeli, 2000; De Laat & Lally, 2003). In general two approaches exist: the 'quantitative' and the 'qualitative' approach. In the first approach communication is coded and obtained frequencies and percentages are used in statistical comparisons. The latter approach deploys techniques such as phenomenography, ethnography and participant observation techniques to reveal descriptive trends (Miles & Huberman, 1994). Large variations with respect to the unit of analysis exist; it can be a message, paragraph, theme, unit of meaning, illocution, utterance, statement, sentence or proposition. Common to all is that the unit is ill-defined and arguments for choosing a specific unit lack (Strijbos, Martens, Prins, & Jochems, 2006). Furthermore, although it is acknowledged that reliability for a quantitative content analysis procedure is essential – and studies often report an intercoder reliability statistic – reliability is seldom addressed with respect to the unit of analysis (Rourke, Anderson, Garrison, & Archer, 2001). Although Neuendorf (2002) states, "Without the establishment of reliability, content analyses measures are useless." (p. 141), some examples of statistical comparison without any intercoder reliability being provided can be found in CSCL research (Pata & Sarapuu, 2003). More rigour regarding the reliability of 'segmentation in units

of analysis' and 'coding' are essential to warrant the accuracy of observations. Irrespective of the segmentation reliability, the units should still be meaningful with respect to coding; in other words enable a researcher to answer the research question. In the current study 'a sentence or part of a compound sentence' is used as the unit of analysis. A procedure to segment transcripts in the units was developed, as well as a procedure for coding. Data with respect to the reliability of both procedures and the outcome of the analyses will be provided in the results section.

Cross case matrices. Open-ended questions were included in the evaluation questionnaire to provide opportunities for extended feedback. The questions were divided in five categories: 'general issues', 'functional roles and task division', 'collaboration progress', 'coordination impact' and 'assessment and supervision'. Groups in the role condition answered twenty open-ended questions and students in the nonrole groups answered seventeen questions (a slight difference due to specific evaluation of the roles). Cross case matrices were used to analyse students' responses to the open-ended questions (see Miles & Huberman, 1994). The matrices were constructed by aggregating individual responses per group and per category. Next, individual responses were summarised at the level of the group to create a cross case matrix at the group level for each category. Finally, group level summaries were aggregated to construct cross case matrices at the level of the condition for four categories.

Method

Participants

At the Open University of the Netherlands (OUNL) 39 students enrolled in a course on 'policy development' (PD) and 25 students in a course on 'local government' (LG). In total 64 students enrolled (36 male and 28 female). Their age ranged from 22 to 55 years (Mean = 38, SD = 8.42, 1 missing). Five students enrolled in both courses. Also, four students enrolled who had

already participated in either course in the previous year. Participants varied in their educational and professional background (common to distance education). The course was completed by 49 students, of whom 41 returned the evaluation questionnaire.

Design of study

The study has a quasi experimental random independent groups design. The experimental manipulation involved the introduction of a prescribed role-instruction in half of the groups (R-groups). The instruction aimed at promoting the coordination and organisation of activities that were essential for the group project. The other half of the groups was left completely self-reliant regarding organisation and coordination of their activities (NR-groups). Each group consisted of three to five students – depending on the number of students that chose to start with a practice assignment and whether they elected a slow of fast study pace – and the groups communicated electronically by e-mail throughout the course. Their task was to collaboratively write a policy report providing an advice regarding reorganisation of local administration, a topical subject in the Netherlands.

To assess the effect of roles on performance, group-level grades are compared. In order to investigate their effect on the perceived collaboration each students' perception of their teams' development, group process satisfaction, their task strategy, the level of intra-group conflict and the quality of collaboration have been measured. All e-mail communication was analysed to investigate whether the roles increased coordination and content focused statements. Finally, students' responses to open-ended questions were analysed to complete and strengthen the interpretation of results obtained.

Materials

Instructions. Half of the groups were instructed to use functional roles: 'Project planner' (PP), 'Communicator' (CO), 'Editor' (E) and 'Data collector' (DC). The other half received a non-directive instruction (e.g., obvious, unspecific and general information regarding planning and task division) and they were instructed to rely on their intuition or previous collaboration experiences (for instructions see Strijbos et al., 2004c). Students in the R-groups had to distribute the roles themselves and exerted their role for the full duration of the course (roles did not rotate). Instructions in both conditions were delivered as a short electronic text at the beginning of the course. They were also presented to students present during a face-to-face meeting at the start of the course.

Intake questionnaire. The intake questionnaire consisted of two sections. One section combined several scales addressing individual characteristics such as attitudes, need for closure and achievement motivation. All items were rated on a five-point Likert-scale. These scales were all already previously tested and their reliability ranged from .78 to .86. Reliabilities that will be reported further, only apply to this study.

Both attitude scales (Clarebout, Elen, & Lowyck, 1999) were reliable and measured at intake and evaluation: attitude towards computer-mediated communication (intake: $\alpha = .67$; 8 items) and attitude towards collaborative problem solving (intake: $\alpha = .81$; 7 items). A scale to assess active or passive orientation to group work ($\alpha = .62$; 6 items) was constructed and tested prior to this study (Strijbos, 2000). The need for closure questionnaire is developed by Kruglanski (cf. De Grada & Kruglanski, 1999) and translated into a Dutch version by Cratylus (1994); the latter version was used in this study. Need for closure consist of five subscales: need for structure, need for predictability, decisiveness, intolerance for ambiguity and closed-mindedness. The scales need for structure ($\alpha = .79$; 8 items), need for pedictablitity ($\alpha = .67$; 7

items) and need for decisiveness (α = .71; 6 items) were sufficiently reliable to be used in further analyses. Achievement motivation (Hermans, 1976) was measured using the P-scale of this questionnaire (α = .86; 44 items). ICT-experience was measured through several non-scaled questions adapted from Valcke (1999). Finally background characteristics (such as received education/training, occupational group and branch of industry) were collected using a standard Open University of the Netherlands (OUNL) questionnaire. Out of the 64 students that enrolled in the course – controlling for the five students that registered for both courses – 56 out of a possible 59 students (95%) returned the intake questionnaire. The course was successfully completed by 49 students (76.5 %), of whom 41 returned the evaluation questionnaire (83.7 %).

Evaluation questionnaire. The evaluation questionnaire consisted of forty-six items, belonging to six scales, that are rated on a five-point Likert-scale and several questions that were rated on a ten-point scale. Results that will be reported in this article are restricted to the six scales, which were already previously tested and showed reliabilities ranging from .76 to .92, and one question rated on a ten-point scale: perceived quality of collaboration. Reliabilities that are reported further, only apply to this study.

Attitude towards computer-mediated communication (α = .85; 8 items) and attitude towards collaborative problem solving (α = .85; (7 items) are self-evident. Team development (α = .90; 10 items) provides information on the perceived level of group cohesion, whereas group process satisfaction (α = .71; 6 items) provides the perceived satisfaction with general group functioning (both cf. Savicki, Kelley, & Lingenfelter, 1996; translated into Dutch). Intra-group conflict (α = .80; 7 items) provides the perceived level of conflict between group members and task strategy (α = .86; 8 items) indicates whether students perceive that their group deployed an appropriate strategy for the given task (both cf. Saavedra, Early, & Van Dyne, 1993; translated

into Dutch). In addition students were requested to answer about twenty open-ended questions (opportunities for extended feedback).

Procedure

After course registration students were informed that the research investigated the group processes of students collaborating through e-mail and to determine the suitability of this format for distance education. Two weeks prior to the start of course students had to indicate whether they wanted to start with the group assignment in October 2001 or March 2002. Based on the evaluation of the study by Strijbos et al. (2004c) students were asked to indicate whether they wanted to start with a practice assignment or to proceed right away with the final assignment that would be graded. They were also asked whether they preferred a slow (ten months) or fast (six months) pace to complete the group assignment. In contrast to the study by Strijbos et al. (2004c), geographical distance was not increased, as their study had revealed that students would organise a face-to-face meeting regardless of distance. Most students could be grouped according to their preference regarding the assignment and the study pace, however, given the number of registering students it was not always possible to maintain groups of four students. Overall, three groups in the role condition constituted of three members from the start. A separate role instruction was provided for these groups in which the tasks of the data collector were added to the reporter. It was assumed that it did not increase this students' workload too much as the role instruction explicitly stated that studying the data could be distributed. The other four role groups started with four group members. In the nonrole condition, two groups started out with five members and the other four groups with four group members.

Prior to collaboration a separate face-to-face meeting was organised for each research condition. General information and the instructions in both conditions were provided during this

meeting and electronically afterwards. Students were introduced to a communication discipline (visible prior to registration) and a project planning form. The communication discipline (see appendix A) was introduced to ensure that students would start with the assignment within two weeks after the meeting. In the study by Strijbos et al. (2004c) some groups had to be excluded because students did not respond until four weeks after the start of the assignment, destabilising and ultimately wrecking the group. In addition, a project planning form was introduced to focus students' attention on the need to coordinate their resources, but they were also asked to indicate how many hours they could contribute to the group assignment on a weekly basis; as the Strijbos et al. (2004c) study had revealed that students greatly varied in the amount of hours they could spent on their study.

After the meeting all remaining contact between students was virtual. Role groups were required to inform their supervisor about the distribution of the roles in their group within two weeks. Contact with the supervisor was restricted to a single group member in the role groups and s/he (communicator) was required to hand in a progress report every two weeks, whereas all students in nonrole groups were allowed to contact the supervisor. In contrast to the Strijbos et al. (2004c) study, however, nonrole groups had to hand in a progress report every four weeks: on the one hand to increase a 'sense' of supervision but on the other hand to retain a difference with the role groups. Supervisors were instructed to answer questions that focused on the content of the assignment. Supervisors were not allowed to provide support regarding coordination and group management. If a request for support was received, students in the role condition were told to rely on the roles, whereas students in the nonrole condition were told to rely on their intuition or experiences with collaboration. Although students were instructed to use e-mail, it is by no means possible nor feasible to exclude customary communication channels, such as telephone

and face-to-face contact. If used, students were requested to send transcripts to their group to retain transparency of communication. Occasionally students used the telephone during their collaboration, but most contact was by e-mail. Three groups organised a face-to-face meeting; two of them organised a meeting twice. Five students participated in both courses and were placed in the same research condition (three students in the role condition and two in the nonrole condition). Since students had two opportunities to start with the group assignment and given their preference regarding the assignment and study pace, two students that participated in both courses at the same time had to be grouped in the same condition in the same group (one of them dropped out in both groups due to a conflict with the other member that also participated in both groups). Four students already participated in either course in the previous year and were placed in the same research condition (three students in the role condition and one in the nonrole condition; they had not participated in particularly well performing groups in the Strijbos et al. (2004c) study. None of the students that had previously participated were grouped together in the same group. Although some of the students participated in both courses and/or for a consecutive time, they were included in the analyses because, firstly, group efficiency and collaboration relies on the interaction with other group members and secondly they collaborated with three other members with whom they had not worked before. One student that was placed in a role group never contacted the group, as only two members remained that group was excluded from all of the analyses. All remaining groups managed to finish the course timely.

Results

Investigation of correlations between individual characteristics and dependent variables

Pearson correlations were computed to investigate whether the variables measured at the intake could be used as co-variates. A correlation matrix was computed. No correlations were

found between any of the variables measured on intake. Neither at the individual level between these constructs and any dependent variables measured at the evaluation, nor at the group level between these constructs and grade were any correlations found. It was concluded that none of the intake variables, signifying individual characteristics, could be used as co-variates.

Effect of condition on grade

Grades were administered on a group level. A Mann-Whitney U-test was performed to investigate the difference between the role (Mean 7.4, SD = .70) and nonrole (Mean 7.8, SD = .34) condition. A non-directional test was performed. No main effect was observed for grade Mean $Rank_{role}$ = 5.71; Mean $Rank_{nonrole}$ = 8.50; U = 12.000, df = 5).

Descriptives and correlations between dependent variables

Descriptives were computed for both conditions. A considerable spread of scores is indicated by standard deviations, occurring in both conditions, shown in Table 1.

Insert Table 1 about here

Pearson correlations between these six variables were computed for the entire sample (N = 41). Medium to high correlations (.49 to .78, $p < .01$) were found between all of the variables, except for 'Attitude towards CMC' and 'Attitude towards CL'.

To avoid the problem of multiple testing principal axis factoring was performed to investigate whether a possible latent variable existed. Table 2 shows the factor loading scores. The extraction explains 71% of all common variance between the dependent variables and factor scores were computed.

Insert Table 2 about here

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The resulting factor was interpreted as 'perceived group efficiency' (PGE). Standardised factor scores were computed for all variables used in the Extraction. In the subsequent analysis we will refer to this variable as PGE.

Multilevel modelling

Our sample consists of 13 groups and the number of observations in each group varies between two and five. This design is skewed, i.e. the number of observations on levels 1 (group) and 2 (individual) are not balanced. Although our model is less efficient in the so-called random component on both levels, ML-analyses can be applied (Mok, 1995). Secondly, our sample size is rather small (N = 41). This has some implications for performing ML-analyses, especially with respect to statistical power. Although the technique will be discussed to some extent, see Strijbos et al. (2004c) for more detail.

Investigating the influence of roles on perceived level of group efficiency (PGE) suggests the use of a t-test or its equivalent reformulation into an ordinary least squared regression model (Ordinary Least Squares – OLS). However, OLS-regression assumes that the residuals are independent and this assumption is obviously violated, because the scores of students in the same group will be more similar than the scores of students from different groups. MLM is more appropriate and thus the intra-class correlation coefficient, a measure of the dependency between scores within the same group, was computed (.45). Failure to incorporate this interdependency among scores in a statistical model will lead to an underestimation of the standard errors of model parameters, resulting in a much larger than nominal probability of a Type I error (Snijders & Bosker, 1999). Instead a multilevel model (model one) was constructed using CONDITION as

a predictor of the dependent variable PGE yielding a so-called random intercept model (Snijders & Bosker, 1999):

$$PGE_{ij} = \gamma_{00} + \beta_1 \times CONDITION_j + U_{0j} + e_{ij} \quad (1)$$

The PGE score of person *i* in group *j* is the result of equation (1), where γ_{00} is a fixed intercept, β_1 is the regression coefficient of group level variable condition, CONDITION is a 0–1 indicator variable with 1 corresponding to nonrole groups, U_{0j} is group level variance and e_{ij} is individual level variance. Estimation of this model with ML-wiN (Version 1.10, Centre for Multilevel Modelling, 2003) yielded the following fixed parameter values (with corresponding standard errors within parentheses): PGE_{ij} = .403 (.256) - .745 (.362) × CONDITION. An overview of the random parameters is provided in Table 3.

Insert Table 3 about here

The deviance reported in this table is equal to minus twice the log-likelihood and can be used for a formal test of the goodness-of-fit of the model. By comparing this deviance value with the deviance of the model without CONDITION as predictor (so-called null or empty model), a significance test for CONDITION is provided. In spite of the small number of observations the effect of providing roles to group members is shown to be marginally significant ($\chi^2 = 3.525$, *df* = 1, $.05 < p < .10$).

However, the study by Strijbos et al. (2004c) also tested the hypothesis that roles, in theory, are likely to increase individual awareness of group efficiency. Indeed, evidence for such 'heteroscedasticity' (unequal error variances), instead of the homoscedasticity underlying a

random intercept model, was found. Groups in the role condition were divided in two distinct clusters whereas groups in the nonrole condition were more homogenous, thus it is reasonable to assume that this might be the case for our present data. Heteroscedasticity can be included in a ML-model by allowing a *random slope*: the regression coefficient of CONDITION is allowed to vary in both levels (see Snijders & Bosker, 1999, p. 119):

$$PGE_{ij} = \gamma_{00} + \gamma_{10}CONDITION_j + U_{0j} + U_{1j}CONDITION_j + e_{ij} \quad (2)$$

In Eq. (2) $\gamma_{00} + \gamma_{10}CONDITION_j$ represents the fixed part and $U_{0j} + U_{1j}CONDITION_j + e_{ij}$ the random part. Analysis of the fixed part of the model yielded the following results: PGE = .396 (.302) - .737 (.369) × CONDITION. Estimations of the random part of the model are provided in Table 4.

Insert Table 4 about here

The residual variance on the group level has been translated in a variance of the intercept (0.434), a variance of the regression slope (zero) and a co-variance between values of U_{0j} and U_{1j} values (- 0.149). Comparing the deviance of the random slope model (2) with the deviance of the fixed slope model (1), shows that the model fit does not improve after including a random slope parameter ($\chi^2 = 0.696$, $df = 2$, $p > .05$). In addition, the estimation of the regression slope variance was estimated as zero.

However, in the case of a limited number of observations the statistical power of the test is comparatively small and a closer look at the marginal effect for the random intercept model is warranted. We looked at predictions of PGE for each group (R = role group, NR = nonrole

group), based on the random intercept model. The results are shown in Table 5 and graphically depicted in Figure 1.

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Insert Table 5 about here

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Insert Figure 1 about here

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Figure 1 shows that the level of PGE for most role groups is consistently higher than the level for nonrole groups. In addition, the variances in the role and nonrole condition are for the most part equal. The lack of statistical significance seems to be affected by an apparent outlier in the role condition. However, given the results by Strijbos et al. (2004c), this outlier in fact signals a meaningful difference, i.e. roles appear to increase awareness of group efficicency and more extreme scores in the role condition are thus to be expected.

Content analysis

Before discussing the outcomes, it must be noted that all contributions by group members of the groups used in the MLM analyses, regardless whether they finished the course or returned the evaluation questionnaire, were included. Content analysis was performed on all e-mail messages contributed by fifty-one subjects equally distributed across research conditions (role $n = 7$, $N = 25$; nonrole $n = 6$ and $N = 26$). All communication on the first assignment the group performed (practice or final) was analysed. Although one nonrole group started with the practice

assignment but switched halfway to the final assignment, it was decided to include only the communication on the practice assignment in the analysis. Including all communication would not only result in an increase of statements coded, but specifically coordination would be affected as this is typically conducted in the first half of the collaboration (which is corroborated by an overall examination of communication in all groups).

A segmentation procedure that would be systematic and independent of the coding categories was developed (Strijbos, Martens, Prins, & Jochems, 2006). Although the sentence as a unit of analysis is not uncommon (e.g., Fahy, Crawford, & Ally, 2001; Hillman, 1999), segmentation of compound sentences was added. The unit was defined as 'a sentence or part of a compound sentence that can be regarded as a meaningful sentence in itself, regardless of coding categories'. Punctuation and the word '*and*' mark potential segmentation, but this is only performed if both parts before and after the marker are a 'meaningful sentence' in itself. Intercoder reliability of two segmentation trials was. 82 and .89 (proportion agreement, for more detail see Strijbos, Martens, Prins & Jochems, 2006) and corroborated by a cross-validation check on an English language set of message contributed to a discussion forum during project-based learning (high similarity to our research context): proportion agreement turned out to be .87. In addition, a coding scheme was constructed with five main categories 'task coordination (TC)', 'task content (TN)', 'task social (TS)', 'non task (NT)' and 'non-codable (NOC)'. Reliability (Cohen's kappa) proved to be on average .70 (substantial) (cf. Landis & Koch, 1977).

Statistical comparisons were restricted. For the questionnaire data it was possible to reduce the number of dependent variables to a single factor to avoid the problem of multiple testing. Principal axis factoring of the five main categories, however, does not result in a factor that can be meaningful interpreted, therefore statistical comparisons were restricted to the

number of messages, segments and the frequency for each main category on the level of the group. Because of the small number of observations, the Mann-Whitney U-test was performed to compare the research conditions. Results are depicted in Table 6.

Insert Table 6 about here

A main effect was observed for the number of messages sent ($U = 7.000$, $df = 5$, $p < .05$), however, no difference was observed for the number of segments coded. Significant more 'task coordination' ($U = 9.000$, $df = 5$, $p < .05$; one-sided) was observed in favour of the role groups. A one-sided test was performed, as it was expected that roles would increase 'task coordination' statements. No main effect was found for any of the other main categories.

Cross case matrices

Student responses to the open-ended questions were aggregated at the condition level (role, $N = 18$; nonrole, $N = 23$) for the categories 'general issues', 'collaboration progress', 'coordination impact' and 'assessment and supervision'. Responses to the category 'functional roles and task division' were aggregated at the group level because the questions differed for both conditions and students' responses turned out to be very diverse.

General issues concerned two questions: 'Did your group use other information and communication tools (ICT) than e-mail or organise a face-to-face meeting?' and 'Did your group use the revise tool in Microsoft Word©?'. Differences between the conditions were only observed for the first question and student responses are shown in Table 7.

Insert Table 7 about here

Students in the nonrole condition – compared to students in role groups – report using other communication tools (telephone, chat and/or a face-to-face meeting) more frequently. Interestingly students of the role group with a high level of PGE collectively keep silent about the fact that they met twice for a face-to-face meeting (revealed by the e-mail communication transcripts).

Functional roles and task division comprises different questions for each condition. Students in the role condition were asked three questions: 'How did you experience your role?', 'Do you think that the functional were adequate and equal in workload?' and 'Do you believe that your role increase your involvement with the collaboration?'. Given the diversity of the responses these are summarised at the group level and shown in Table 8.

Insert Table 8 about here

Students in the nonrole groups were asked to 'Describe how your group divided the tasks: did you group split-up the content of the product and divide it amongst their members or did your group use functional tasks or roles?'. Given the diversity of questions in both conditions the student responses are only summarised at the group level. The results are shown in Table 9.

Insert Table 9 about here

Students in the role condition express that the functional roles were not equal with respect to the associated task. Although the students performing the roles of 'Project planner' (PP) and

'Communicator' (CO) can limit their contribution to occasional check-ups on group progress, students in the role condition were informed that all students were required to provide input and effort for the group product (policy report). In the nonrole groups students' responses indicate a pattern that can be referred to as 'splitting up the task'. In most groups the content of the task was divided between the group members (or subgroup dyads) and each studied the associated literature and individually wrote that part of the shared policy report. In four groups a leader or an editor role emerged spontaneously during the collaboration, mostly because of experienced necessity with respect to maintaining the groups' progress rather than an individual preference.

Collaboration progress consists of four questions: 'How was the progress of collaboration in your group?', 'Do you believe that group members contributed equally to the collaboration?', 'Did you often experience that you had to wait for other group members during collaboration?' and 'Did group members dropout during collaboration, and if so were there any consequences?'. Differences between the conditions were only observed for the first and third question. Student responses to these questions are shown in Table 10.

Insert Table 10 about here

In comparison more students in the role condition report that the progress of the collaboration was fine, whereas more students in the nonrole condition report that progress was difficult or slow. With respect to student perception of the equality of participation there is no difference between both conditions. In the nonrole condition this was attributed to a lack of participation of a group member(s), whereas students in the role condition ascribe the perceived inequality to the functional roles. Analysis of the extent to which students report that they experienced waiting for

other group members is closely connected with the first question in this category. Students in the nonrole condition already reported that collaboration progress was difficult or slow, but they also report frequently that they waited for group members – however not more often than students in the role groups. Interestingly, students in both conditions consider a lack of planning or not meeting agreed tasks or deadlines (agreements) as the prime cause for waiting. Finally, with respect to the dropout there is no difference between the conditions and students report that this had no serious consequences. In general, however, the role or task(s) of the member that dropped out was taken over by one of the remaining members and not evenly distributed.

Coordination impact addresses two questions: 'Did your group make many agreements about activities or deadlines?', 'Did these agreements stimulate the groups' progress?'. There were no differences in the extent to which agreements were made with respect to activities or deadlines. Similarly, there was no difference between the conditions whether these agreements focussed on organisational issues or the content of the task. Although there was no difference with respect to making agreements, students in nonrole groups indicate more frequently that the agreements did not stimulate progress. Table 11 presents students' responses to this question.

Insert Table 11 about here

In most cases, the perceived lack of progress from making agreements is attributed to group members not keeping them or not responding at all. Three students explicitly state that this was frustrating and resulted in irritation.

Assessment and supervision is comprised of three questions: 'Do you think it is justified that all group members get the same grade?', 'Did your group contact the supervisor and how do

you rate the response?' and 'What is your opinion about the supervision throughout this assignment?'. Students in both conditions do not differ in their opinion towards the use of group grades. In fact, most students consider this appropriate because it concerns a 'shared'report'. With respect to the contact with a supervisor also no differences were observed, however, rating the supervision did reveal differences between conditions which are shown in Table 12.

Insert Table 12 about here

Students in the nonrole condition report more often that the supervisor feedback was late and/or insufficient and some report that the supervisor did not seem to be involved and/or stayed in the background.

Discussion

In this study the impact of functional roles, adapted for a computer-mediated context in a distance education setting, was investigated. The main research question was: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?'. Roles did not affect group performance in terms of a group grade. However, this is largely due to a lack of variation (grades varied between 6 and 8.5 on a ten point scale).

The data used in this study was gathered from multiple sources: self-report Likert-scale questions, open-ended questions and content analysis of electronic communication. Investigating functional roles during CSCL requires triangulation of data sources, analysis methods and their outcomes. In fact, it can be argued that CSCL research in general requires triangulation because a variety of processes are studied simultaneously (e.g., learning, group efficieny, communication,

social interaction, etc.) and the instruments used to measure these processes vary with respect to their quality, for example their reliability.

Multilevel modelling (MLM) revealed that roles are likely to affect the perceived level of group efficiency (PGE). A positive marginal effect was found in favour of the role groups: PGE in most role groups is consistently higher than in nonrole groups. This study was conducted in an ecological valid setting, but it is imperative to investigate natural collaborating groups in an educational setting – hence, the sample size is very likely to be small as it depends on the number of students that register for a course. Given the small sample size and small degree of statistical power, it can be argued that a significance level of $.05 < p < .10$ is justified. Moreover, the statistical significance is also hampered by an apparent outlier in the role condition, which appears to result from an increase in awareness of group efficiency by the roles. Students' responses with respect to the open-ended questions on the progress of collaboration and whether agreements stimulated progress, shows that two students from the same group in the role condition report that progress was difficult and the agreements did not stimulate progress. Both of them participated in the 'outlier' group. More importantly, however, the MLM results indicate that using functional roles elevates students' perceived group efficiency (PGE).

Results from the content analysis show that functional roles increased 'task coordination' statements. Although a main effect was observed for the number of messages, the significant difference in coordinative statements is not invalidated because no difference was observed for the number of segments coded. More importantly, this finding replicates the earlier outcomes of the Strijbos et al. (2004c) study. The increase of 'task coordination' statements, however, did not increase the number of 'task content' statements – as was the case in the study by Strijbos et al. (2004c). Apparently the changes in the preconditions appear to have levelled out some of the

disadvantages of the nonrole groups. Also, the fact that groups in both conditions were required to hand in progress reports may have kept nonrole groups 'on task' and stimulated task focused statements.

Cross case matrices of the open-ended questions revealed that nonrole groups reported more frequently the use of additional communication channels. With respect to the 'functional roles' and 'task division' category, students in role groups considered the roles unequal in terms of effort. However, the role instruction was more guiding than coercive and thus it left students room for an individual interpretation on how they actually performed their role. Perhaps students in role groups with a high PGE level acted more closely according to the prescribed instruction than students in the role group with low PGE. Moreover, a strong allegiance to prescribed roles could be in line with teamwork and collaboration in a professional context. Similarly, nonrole groups tended to organise collaboration by splitting the task (policy report) into several smaller components that were handled individually (or in dyads) which is also similar to a professional context where task allocation is often based on expertise. With respect to 'collaboration progress' role groups report more frequently that the progress was fine, compared to students in nonrole groups who report it was difficult or slow. Moreover, progress appears to be inversely related to the extent that students experienced that they had to wait for other group members. Finally, the role groups report more frequently that the agreements that they made about tasks and deadlines stimulated progress than their counterparts in nonrole groups.

Nevertheless, the outcomes obtained with these three different methods of analysis for three different data sources, illustrates the need for triangulation of multiple data sources and methods. Self-report Likert-scales can be a fast and relatively easy approach to investigate the impact of any instructional intervention, but this would not have revealed *why* role groups

perceive themselves as more efficient. Results from the open-ended questions reveal that they experienced a lower degree of waiting for responses, which ties in with the observation that students in role groups contributed more 'task coordination' statements than students in nonrole groups. Apparently roles increase coordination, decrease the extent of experienced 'waiting', which in turn increased students' perception that agreements stimulated progress and is ultimately expressed in a higher level of perceived group efficiency for most of the role groups. Finally, the observation that most nonrole groups have a lower level of PGE is in line with them reporting that agreements did not affect progress much, they experienced waiting and also their opinion about supervision; which clearly reveals that nonrole students experienced a higher need for supervisor feedback and express that it was either not there or insufficient. The latter may also be related to the fact that role groups handed in a progress report twice as frequently as the nonrole groups and thus they may have had a heightened sense of supervision awareness compared to students in the nonrole groups.

In sum, this study reveals that functional roles stimulate coordination and overall group efficiency in a project-based CSCL course in distance education. Changes in the preconditions – compared to the Strijbos et al. (2004c) study – not only decreased dropout, but appear to have controlled for some external sources that may have interfered with the functional roles in the study by Strijbos et al. (2004c). In the near future it is planned to investigate other aspects of functional roles, such as role conflict and role ambiguity, but it is clear that more systematic research regarding the use of functional roles in small groups and CSCL is needed.

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Appendix A: Commmunication discipline

1) Depending on your study pace, you will check at least once every two days (6 months) or once every four days (10 months) for new messages. This is just a minimun, it is advised to check more often.
2) If you receive a message that requires a response or an answer, you will respond as soon as possible. This prevents unnescessary waiting on the part of your group members for your answer or response.
3) If you send a message, you will always send it to the shared e-mailaddress (list address) so that all members will be informed of the developments within your group.
4) If you wish to change your e-mailadress on the list – to which messages send to the shared e-mailadress are redirected – you will send a request to the list owner who will change it.
5) If you wish to add a second e-mailadress to the list (for instance your home or work) – to which messages send to the shared e-mailadress are redirected – you will send a request to list owner who will add your second address.
6) If you receive a message from the list owner, you will repond promptly.
7) If personal circumstances (work, family or holiday) cause that you will not be able to read and respond to messages for a certain amount of time, you will notify your group in advance.
8) If you are unable to continue with the group assignment, you will inform your group members. In case you started in October 2001 and you are confident that you will be able to start in a new group in March 2002, send a request to your supervisor and s/he will contact you.
9) When you have been placed in a group you are obliged to establish contact with your fellow group members within the first two weeks and make work arrangements.
10) When you have been placed in group, but you fail to establish contact with your fellow group members in the first two weeks, you will be eliminated from that group. In case you started in October 2001 you can send a request to your supervisor to start in a new group in March 2002, however, given your failure to establish contact in your first group no consideration will be given to your preferences regarding the assignment (practice yes/no) or study pace.

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Figure Captions

Figure 1. Model estimates of PGE for the random intercept model.

Table 1

Mean and standard deviations of dependent variables by experimental condition.

	Role (N = 18)		Nonrole (N = 23)		
	Mean	SD	Mean	SD	Min - max
Quality of collaboration	7.22	2.01	6.57	1.38	1 - 10
Team development	3.75	0.64	3.39	0.62	1 - 5
Group process satisfaction	3.91	0.60	3.61	0.57	1 - 5
Intra-group conflict	1.94	0.64	2.56	0.53	1 - 5
Task strategy	3.88	0.56	3.47	0.55	1 - 5
Attitude towards CMC	3.79	0.43	3.52	0.64	1 - 5
Attitude towards CL	3.82	0.62	3.54	0.58	1 - 5

Note. CMC, Computer-Mediated Communication; CL, Collaborative Learning

Table 2

Factor extraction for dependent variables.

	Factor loading
	Extraction
Quality of collaboration	.736
Team development	.734
Group process satisfaction	.791
Intra-group conflict	-.878
Task strategy	.859

Table 3

Random variance estimates of the random intercept model.

Parameter	Estimate	Standard error
Group level variance	.254	.171
Individual level variance	.521	.139
Deviance = 101.517		

Table 4

Random variance estimates of the random slope model.

Group level		
Parameter	Estimate	Standard error
Variance intercept	.434	.343
Variance slope	.000	.000
Covariance slope and intercept	-.149	.187
Individual level		
Parameter	Estimate	Standard Error
Variance	.507	.135
Deviance = 100.821		

Table 5

PGE prediction estimates by group for the random intercept model.

Role	
Group	PGE estimate
PD 1	.52
PD 2	-.54
PD 3	.35
PD 4	.92
PD 5	.51
LG 1	.68
LG 2	.35
Nonrole	
Group	PGE estimate
PD 6	-.69
PD 7	-.89
PD 8	.00
PD 9	.01
LG 3	-.26
LG 4	-.23

Table 6

Mean, standard deviations and Mann-Whitney rank scores for number of messages, number of segments and the five main categories – at the group level – by condition.

	Role (n = 7)			Nonrole (n = 6)		
	Mean	SD	Rank	Mean	SD	Rank
Number of messages*	128.57	29.27	9.0	80.29	41.14	4.7
Number of segments	1053.71	348.62	7.1	1059.17	526.13	6.8
Task coordination (TC)[1]	114.96	46.06	8.7	75.73	32.98	5.0
Task content (TN)	61.90	41.90	6.6	65.82	52.97	7.5
Task social (TS)	9.63	5.25	8.6	5.20	4.82	5.2
Non task (NT)	26.68	14.52	7.4	21.99	8.09	6.6
Non-codable (NOC)	92.60	48.36	7.4	81.29	53.16	6.5

[1] $p < .05$, one-sided; * $p < .05$, two sided

Table 7. Matrix for the use of other ICT tools by condition.

Role	Nonrole
Four students in two different groups used the phone. One adds they used it twice and one once. Two students in another group add they used the phone several times.	Three students in three different groups used the phone. One adds it was used once. One adds using it twice and one adds using it on a regular basis with another student. Two students in two different groups report that a face-to-face meeting was organised. One student adds it was held twice. Four students in the same group report that they used chat (‘Netmeeting’) twice.

Table 8. Matrix by group for students' experience, perception of equality and increased involvement in role groups.

	Functional roles						
	PD 1 (*N* = 3)	PD 2 (*N* = 2)	PD 3 (*N* = 2)	PD 4 (*N* = 2)	PD 5 (*N* = 3)	LG 1 (*N* = 3)	LG 2 (*N* = 3)
How was role experienced?	Three experienced the role as positive. One adds that the progress reports are important. One adds that s/he did not have to remind the others. One adds s/he liked his/her role as s/he likes to write, but adds it's the most dependent role and s/he doesn't prefer it.	One student reports performing the role as was expected but others had a lack of discipline. One states that his/her role felt important but s/he only got comments from one member.	One student reports that s/he did not have to remind others of their task, so the execution of the role went fine. One states that the his/her role was not intensive.	One studens report the prescribed roles were good, although it left little room for interpretation. One of the students reports s/he experienced the role as constructive and adds thinking outside his/her role but in the interest of the team.	One experienced the role as pleasant. One describes the role. One student reports that his/her role was not executed as s/he had intended.	Two experienced the role as good. Two add that the group applied flexibility in execution. One adds s/he worked with roles in his/her work environments and it influences the final result.	Two experienced the role as pleasant. One adds all (but one) did keep to their role and one adds his/her role was not difficult as s/he had prepared a part of it in advance. One of the students describes the role.
Role division equal?	Three students report that roles were not equal. One adds that CO is easier and one adds the E role requires more effort.	Two students report that roles were not equal. One adds that E takes more effort. One adds that CO takes the least effort.	One student reports that roles were equal, but adds the writing must be distributed, but revising by one. One adds the E role was not important in their group.	One student reports that roles were equal, but adds that CO was lighter. One reports roles were not equal and adds that PP is quite intensive at the start and CO vague.	Two students report that roles were not equal. Two add that E takes more effort, one also adds CO is lighter. One reports the roles were equal, but s/he put in more effort voluntarily.	Two students report that roles were not equal. Two add CO takes the least effort and one also adds DC is lighter. One reports the roles were equal, given that they were handled flexible.	One student reports that roles were not equal and adds that E and DC require more effort. Two report the roles were equal and one adds investing more effort voluntarily.
Role increased involvement?	Two students report the roles increased involvement. One of them also adds that the progress reports did increase activity. One adds that of the roles, the E role is the most demanding.	Two students report the roles increased involvement. One of them adds s/he now knows a lot about the topic. One adds that helping with editing increased the value.	One student reports that roles increase involvement equally. One reports his/her role was not very important in their group.	Two students report their role did not raise involvement. One of them adds that you simply have to go for it at all times.	Two students report their role did not raise involvement. Both of them add all group members were very involved. One also adds that they did not stick to the roles. One adds that his/her role was pivotal in the team.	Two students report the role raised their involvement. One of them adds integrating comments by others. One adds that the coordination requires decisions to keep the group on track. One student reports roles made no difference for involvement.	Two students report the role raised their involvement. One of them adds selecting information felt as being important. One adds performing a pivotal role and s/he motivated the others. One reports roles did not raise involvement ('a role is a role').

NOTE: PP = Project planner; CO = Communicator; E = Editor; DC = Data collector

Table 9. Matrix by group for students' perception of the organisation and task division in nonrole groups.

	Task division					
	PD 6 (*N* = 3)	PD 7 (*N* = 4)	PD 8 (*N* = 3)	PD 9 (*N* = 4)	LG 3 (*N* = 5)	LG 4 (*N* = 4)
Describe how your group divided tasks? Splitting up content or use of roles?	Three students report the work was done in two sub groups: one group would do everything for the practice assignment, the other group would do the most work for the final assignment. One adds that two members in the end finished the report. One adds there were no roles used. One adds the progress reports were made in rotation.	Four students report that in the end a student was assigned as a 'director'. One adds this member became also a 'process' guard. Two add that the individual contributions were combined in the report by this member. One adds s/he proposed to have a 'coordinator', which s/he became.	Three students report the use of roles. Two add it was a 'coordinator' and a 'writer' role. One adds that each group member was assigned a part of the content. One adds the roles were established only after a face-to-face meeting.	Four students report the content was split up and divided between group members. Two add that there were no roles, but an editor was assigned. One adds that functional tasks were performed in a natural way. One adds that the progress reports were made in rotation.	Four students report the content was spilt up and divided between group members. Three add that there were no roles, but an 'editor' and the task of progress reports were assigned. One adds that a 'chair' could prevent some of the coordination difficulties. One adds s/he took the lead in the beginning and suggested that members choose a part of the content to their personal interest. One reports a list of the tasks that were assigned.	Three students report the content was spilt up and divided between group members. All add that one member voluntarily took the task of adding individual contributions into a shared report and one voluntarily took up the task to write progress reports. Two add there was no conscious use of functional roles or task division.

Table 10. Matrix for perceived collaboration progress and waiting by condition.

	Collaboration progress	
	How was the progress of collaboration?	Experienced waiting for group members?
Role	Thirteen students in six different groups report that the progress was fine. Three students in the same group adds it was rough in the beginning, but after a member that did not contribute dropped out it was fast, good and pleasant. Two students in another group add that it refers to three of the four members, but one student in the same group adds that it refers to all. Four students in three groups add that there was a good division of labour and signal there was mutual understanding. One adds that although the collaboration was pleasing it required some time to get a grip on the assignment. Two students in the same group report collaboration did not progress smoothly, One of them adds that activities were taken up slowly and agreements not kept. One adds that only two of the four members were active.	Three students in two different groups experienced having to wait for other group members. One student adds this involved often an extra e-mail for clarification. One adds s/he had to wait often and describes it as de-motivating; one student in the same group adds that sometimes no response was received. One student reports having to wait occasionally and adds this involved holidays but also adds that the members informed each other regularly enabling them to anticipate. Fourteen students in five different groups report that they did not have to wait. Five students add that they kept to the planning (tasks/deadlines). One student in two different groups adds s/he is pleased that the other members adjusted to his/her faster study pace. One student adds that the members might have waited for him/her. One student in another group adds that the collaboration was fast and relaxed.
Nonrole	Ten students in five different groups report that progress was fine. Two students in the same group add that it was fine with one of the members and that both other member did not contribute. One student in another group adds that this refers only to three of the four members. One student in another group adds it was better during the final assignment than during the practice and one student in the same group adds that the face-to-face meetings improved progress. Six students in three different groups report that progress was difficult or not smooth. Two students in the same group add that the collaboration was better during the final assignment than the practice assignment. In another group one student adds that a group member acted negatively towards another and one adds forced collaboration is always difficult. Three students in three different groups add that there were differences of opinion. One student reports that the other two members wanted to proceed faster, but s/he elected the OUNL to determine his/her individual study pace.	Nine students in six different groups experienced having to wait. Three students in the same group add that this refers to the practice assignment and not to the final assignment. Two students from the same group add that they had to wait for the social loafer. Five students in four different groups indicate this involved waiting for a response. One also add that it seemed at times that group members were attending to other (non study related) matters; and one adds that another group member only spend one night per week on the group assignment. Three students in two different groups report that they waited occasionally. Eleven students in four different groups report that they did not have to wait. Two students in the same group indicate that s/he also not responded fast. Two students in two different groups indicate that waiting involved holidays and that this was not annoying. One adds not having to wait but is not pleased that the group finished ahead of schedule. One student reports that waiting was no problem as s/he focused on other courses in the mean time.

Table 11. Matrix for whether agreements stimulated progress by condition.

Role	Nonrole
Fourteen students in six different groups report the agreements stimulated progress. One of them reports that agreements did not stimulate progress, however, s/he adds that other group members were sufficiently professional to keep them. Four students in four different groups add that agreements provided clarity and members knew what they were expected to do. One students adds a planning forces members to respond timely. One student adds agreements are essential. One student reports that agreements sometimes stimulated progress, but also lead to delay while waiting for an answer. Two students in the same group report that agreements did not stimulate progress. Both add that they were often not kept.	Twelve students in four different groups report the agreements stimulated progress. One student adds that members kept to the agreements and another student in the same group adds any changes in the agreements were timely communicated. One adds that sometimes members had to be reminded. One adds the agreements stimulated progress but that it only refers to three of the four group members. Two students in the same group report that the agreements stimulated progress mostly. Eight students in four different groups report that the agreements did not stimulate progress. Six students in four different groups report that it was mostly caused by one group member not responding or keeping the agreements. Three of them explicitly add it resulted in frustration and irritation. One student adds that the others wanted to move faster which also happened.

Table 12. Matrix for students' opinion about the supervision by condition.

Role	Nonrole
One student reports they asked supervision once and that it was good. One student in a different group reports the supervision focused on the process and not the content. One student in yet another group reports that s/he expected an answer to the issue of a non-participating group member. Three students in two groups report they asked for little supervision and one adds they did not really need it. Eight students report that their group did not ask for it or need supervision. Two students in different groups report that a group member(s) had done a similar course before. One of the students add it seemed that the supervisor paid attention as revealed by their requests for late progress reports. Two students report supervision does not apply.	One student reports that the supervision put them on the right track. One student reports it was available if needed. Five students in three different groups report the supervisor did not seem to be involved and/or stayed in the background. One student reports s/he did not experience any sense of supervision. Five students in three groups report that the response was late and/or the feedback was insufficient or lacked. One student adds it amplified his/her insecurity about a novel study format. Six students in two different groups report that they did not contact the supervisor and/or that it was not needed.