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Functional versus Spontaneous Roles during CSCL

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Abstract. In this paper, two studies are reported on the effect of functional roles on computer-supported collaborative learning (CSCL) in higher education – the second is a replication of the first. Prescribed functional roles were implemented in half of all groups during a project-based course in higher education. All communication was via e-mail. Analysis of Likert-scale evaluation questionnaires gathered in both studies revealed a latent variable 'perceived group efficiency' (PGE) which – depending on the level of constraints set by preconditions – appears to increase the awareness (Study 1) or the level of efficiency (Study 2). However, Likert-scales provide a surface level analysis of actual behaviour and no insight in the collaborative process. Hence, the e-mail communication was investigated with two content analysis procedures: content analysis of the type of communicative statements and analysis of the role behaviours performed in role and nonrole groups. Results from both studies reveal that significantly more statements are focused on coordination in role groups. In addition, analysis of role behaviour reveals that students in role groups perform significantly more according to the functional roles than their counterparts in nonrole groups, although spontaneous role behaviour emerged in nonrole groups as well.

Keywords: roles, coordination, collaboration, computer-mediated communication, triangulation

INTRODUCTION

Computer-Supported Collaborative Learning (CSCL) is a relatively new discipline in the field of educational technology. At present, there are no clear guidelines to determine how a CSCL environment should be designed (Strijbos, Kirschner, & Martens, 2004a). To a considerable extent this is caused by differences in group size, the technology used, the length of the study, the research methodology and the unit of analysis (Lipponen, 2001). The design of CSCL environments often seems based on subjective decisions regarding tasks, pedagogy and technology, or general views regarding pedagogical support such as cooperative learning or collaborative learning. At present, it is increasingly acknowledged that 'learning' and 'collaboration' rely on interaction (Baker, 2002; Stahl, 2004; Strijbos, Martens, & Jochems, 2004b) and thus that *group interaction* is the primary process to be studied to assess performance and learning benefits in CSCL environments.

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). Conflicts regarding coordination are likely to occur in asynchronous CSCL settings (Benbunan-Fich & Hiltz, 1999). Group cohesion and a sense of responsibility can affect coordination. Responsibility is proportionally related to group performance (i.e., a greater sense of responsibility can increase group performance). Group cohesion has been shown to increase stability, satisfaction and efficient communication (Forsyth, 1999). Group cohesion and responsibility correspond with two key concepts in collaborative learning: 'positive interdependence' and 'individual accountability'. Roles can be used to foster these key concepts, and subsequently promote group cohesion and responsibility (Mudrack & Farrell, 1995). Roles are defined as more or less stated functions/duties or responsibilities that guide individual behaviour and regulate intra-group interaction (Hare, 1994). In addition, roles can stimulate awareness of the overall group performance and each members' contribution (Mudrack & Farrell, 1995). 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.

Several pedagogical approaches that have been developed for cooperative learning use roles to support coordination and intra-group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-oriented or process-oriented. Content-oriented roles focus on the facilitation of knowledge acquisition, using for example 'scripted cooperation' (O'Donnell & Dansereau, 1992; Weinberger, 2003). Process-oriented or management roles focus on individual responsibilities regarding the coordination

(e.g., Kynigos, 1999). These role descriptions share, however, that they comprise one single job, task or duty. Collaboration assignments in higher education are more complex and take place over an extended period of time (i.e., not restricted to classroom time), thus requiring more explicit coordination. Consequently, the previous mentioned uni-dimensional roles for face-to-face collaboration appear inadequate to support collaboration in higher education, let alone asynchronous CSCL settings.

INVESTIGATING THE EFFECT OF FUNCTIONAL ROLES

Both studies reported in this paper investigate the impact functional roles, which are based on role descriptions by Johnson et al. (1992), Kagan (1994), and Mudrack and Farrell (1995). The roles were designed to give each student an individual responsibility, but at the same time all roles were essential to the collaboration and thus interdependent (project planner, communicator, editor and data collector; for a detailed description see Strijbos, Martens, Jochems, & Broers, 2004c). The research question in both studies was: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?'.

In one previous study (Strijbos, et al., 2004c) principal axis factoring of several 5-point Likert-scales (i.e., team development, group process satisfaction, task strategy and the level of intra-group conflict) and a single question rated on a 10-point scale (the quality of collaboration) from the evaluation questionnaire revealed a latent variable (explaining 79% of all common variance) that was interpreted as 'perceived group efficiency' (PGE). Multilevel modelling (MLM) of PGE yielded a positive marginal effect revealing that functional roles appear to increase students' *awareness* of perceived group efficiency. This study is hereafter referred to as Study 1. The second study is a replication of the first (Strijbos, Martens, Jochems, & Broers, in press-a), as examination of the course design in the first study identified several preconditions that – if controlled – could ensure a more evenly matched comparison of the research conditions (i.e., 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). Analysis of the Likert-scales revealed again the latent variable PGE (explaining 71% of all common variance) and MLM showed that the functional roles appeared to increase the *level* of perceived group efficiency. This study is hereafter referred to as Study 2.

Most questionnaires – especially Likert-scales – provide a surface level analysis of actual behaviour. The perception of collaboration gives no insight in the actual collaborative process. It is possible for instance that role groups and nonrole groups in Study 1 were equally active in organising and coordinating their activities, hence no difference regarding PGE level could be found. Similarly, the difference between role groups with a high and low PGE level might have been caused by more 'rigid' role behaviour (i.e., strictly performing the task belonging to the assigned role). In addition, research shows that role behaviour emerges spontaneously to some extent (De Laat & Lally, 2003). Hence, it is imperative that the communication is subjected to analysis to determine *why* a group perceives themselves as more efficient and to explore *how* students coordinate and organise their collaboration.

A quantitative content analysis approach was taken. Since the communication is coded, summarised and frequencies or percentages are used for comparisons and statistical testing, such an approach requires more rigour to warrant the apparent robustness of conclusions. Lack of reliability increases the probability of Type II errors (wrongly accepting the null-hypothesis) and to a smaller degree, Type I errors (wrongly rejecting) can occur. Moreover, examples of statistical comparison without intercoder reliability appear in CSCL reports (Pata & Sarapuu, 2003). To conduct the research that is reported in this paper, two content analyses procedures were constructed. Although the research context was similar, the unit of analysis was different. One procedure investigated the type of communicative statements and a segmentation procedure was developed (see Strijbos, Martens, Prins, & Jochems, in press-b). The other procedure was designed to investigate role behaviour and a message was used as the unit of analysis. Data on the reliability of the procedures will be provided in the results section of Study 1.

STUDY 1

At the Open University of the Netherlands (OUNL), 57 students enrolled in a course on 'policy development' (PD) and 23 in a course on 'local government' (LG). In total 80 students enrolled. Five students enrolled in both courses making a total of 75 participants (45 male and 30 female; age 23-67 years, Mean = 34.4, SD = 9.03) and 43 completed the course successfully (53.8 %). The design was a quasi-experimental random independent groups design. Four functional roles were introduced in half of the groups (distributed by the members amongst themselves), aimed at promoting coordination and organisation of activities essential for the group project: project planner, communicator, editor and data collector (see Strijbos et al., 2004c). The other half of the groups received a non-directive instruction (e.g., obvious, unspecific and general information regarding planning and task division) and the students were told to rely on their intuition and/or collaboration experiences (see Strijbos

et al., 2004c). Each group consisted of four students and during the course they communicated electronically via e-mail. Their task was to collaboratively write a policy report regarding reorganisation of local administration.

Prior to collaboration a face-to-face meeting was organised (separate for each condition). All groups were required to inform the supervisor whether they started with the practice assignment or immediately with the final assignment that would be graded. Role groups were required to inform their supervisor about the assignment of the roles in their group within two weeks and hand-in a progress report every two weeks. Supervisors were instructed to focus on the content of the assignment. If a request for process 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. It is by no means possible or feasible to exclude customary communication channels (e.g., telephone or face-to-face). If used, students were requested to send transcripts to their group members to retain transparency of communication. In spite of geographical distance three groups organised a face-to-face meeting. Five students participated in both courses and were placed in the same research condition (none of these students finished both courses). If only two members remained, that group was excluded from the analyses.

Content analysis of communication

To analyse the communicative statements a 'sentence or part of a compound sentence that can be regarded as a meaningful sentence in itself, regardless of coding categories' was used as the unit of analysis (Strijbos et al., in press-b). Intercoder reliability of two trials was .82 and .89 (proportion agreement). This was corroborated by a cross-validation check on an English language set of discussion forum messages during project-based learning (high similarity to the research context) where proportion agreement was .87. In addition, a coding scheme was constructed with five main categories, and reliability (Cohen's kappa) proved to be on average .70 (substantial, cf. Landis & Koch, 1977):

- Task coordination (TC): any statement that concerns the alignment of intra-group collaboration through references with respect to time, references with respect to an activity (that is to be or has been) performed by a group member or the group, or a reference to time and an activity (e.g., "Who makes an inventory of pressure groups that are involved?");
- Task content (TN): any statement that is aimed at the content of the task or assignment in general, statements focusing on the problem solving or discussion of task content, and/or focusing on the content or editing of the report (e.g., "We should delete section two.");
- Task social (TS): any statement that contains a qualitative judgment, an evaluation or attitude towards collaboration in general, towards the whole group or specifically towards (the effort by) an individual group member (e.g., "Maarten, my compliments for your analysis.");
- Non task (NT): any statement regarding previous experiences, face-to-face meetings, acquaintance, technical problems, and social affairs not directed towards the task, or that expresses to contact the moderator (e.g., "How was your holiday?");
- Non-codable (NOC): any statement that cannot be assigned any of the other codes previously described (e.g., "Attached a new schedule with the latest deadlines and tasks.").

Content analysis was performed on all e-mail messages contributed by forty students equally distributed across both research conditions (role and nonrole; n = 5 and N = 20). 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, a Mann-Whitney U-test was performed to compare research conditions (five groups in each condition). All communication on the first assignment that a group performed (practice or final) was analysed. It was expected that roles would decrease the amount of coordinative statements in favour of content focused statements. Results are depicted in Table 1.

	Role (n = *5*)			*Nonrole* (n = *5*)		
Item	M	SD	*Rank*	M	SD	*Rank*
Number of messages	78.20	22.30	7.2	52.40	17.47	3.8
Number of segments	759.60	173.04	7.8	401.20	156.12	3.2
Task coordination	63.95	16.99	7.2	37.35	20.45	3.8
Task content	37.65	17.22	7.4	16.35	16.48	3.6
Task social	4.40	2.73	7.5	1.95	0.48	3.5
Non task	21.40	7.76	7.1	12.55	4.83	3.9
Non-codable	62.55	13.73	8.0	32.10	10.33	3.0

Table 1. Mean, standard deviations and Mann-Whitney rank scores for the number of messages, number of segments and the five main categories.

No main effect was observed for the amount of messages send, but a significant difference was observed for the amount of segments (U = 1.000, df = 4, p < .05). Regarding the content of the communication several main effects were observed in favour of the role condition: significant more 'task coordination' (U = 4.000, df = 4, p < .10), 'task content' (U = 3.000, df = 4, p < .05), 'task social' (U = 2.500, df = 4, p < .05), and 'non-codable' statements (U = 0.000, df = 4, p < .05) were made in the role condition.

Content analysis of role behaviour

A procedure was developed to investigate the communication to what extent students acted according to their functional roles, as well as whether spontaneous roles emerged in the nonrole groups. A 'message' was the best suited unit of analysis given our research objectives (Strijbos et al., in press-b). Each task belonging to one of the four functional roles was re-worked into a coding category. These were aggregated in five main categories: one for each role and a 'no code' category. Role behaviour is less frequent than communicative statements and it was decided to summarise the behaviour at the level of the message, i.e. the number of times that role behaviour was performed in a single e-mail was not taken into account. Each e-mail was assigned one of five codes:

- Project planner (P): statements about data, activities and deadlines and statements that remind other group members of their activities, as well as delegating an activity to a fellow group member, setting-up a discussion agenda and stimulating discussion around the information sources (e.g., "When all have responded, Lisette can setup a planning.");
- Communicator (C): statements that concern communication with the supervisor, as well as informing the supervisor about the groups' progress and asking questions on behalf of group members and communicating the answers (e.g., "I will send a message to our supervisor about our progress.");
- Editor (E): statements that concern writing a first draft of the group report and any subsequent versions, each of them followed by a request for comments and suggestions by all other group members (e.g., "I have written a first draft of the report; please send you comments as soon as possible.");
- Data collector (D): statements regarding the pre-selection of relevant information (data) sources provided on a Cd-rom, as well as statements concerning the collection of alternative information sources, and distributing them amongst other team members (e.g., "I have found some relevant sources on the Cd-rom.");
- Non-code (NC): no code assigned to an e-mail message.

The proportion of agreement was 81% and Cohen's kappa was .67, which is substantial (cf. Landis & Koch, 1977). Case summaries were made for each group (Table 3). Role behaviour is indicated by the capitals P, C, E and D. Members of the role groups are represented according to their role (Pp, Co, Ed and Dc). Nonrole group members are represented by their initials. It should be noted, that students in nonrole groups were less likely to exert C-behaviour as they were not required to hand in a progress report. However, the role descriptions were guiding and not coercive, so it is likely that even students in role groups performed other behaviours than those specified by their role. Since group members in nonrole groups *could* have performed a role, but were *by no means expected* to do so, an analysis of concordance is unsuited as it neglects the possibility of role behaviour by chance. To correct for chance Cohen's Kappa was computed (Table 2). Since any member of a nonrole group could have performed a role, nonrole kappa's are based on the distribution with the most possible scores on the diagonal. In addition, the total amount of role behaviour was computed for each group.

Role		
Group	Total behaviour	Kappa
PD 1	49	.41
PD 2	62	.40
PD 3	63	.22
PD 4	116	.31
LG 1	65	.02
Nonrole		
Group	Total behaviour	Kappa
PD 5	75	.00
PD 6	23	.09
PD 7	53	.03
LG 2	32	.14
LG 3	54	.11

Table 2. Total amount of role behaviour and consistent role behaviour (Cohen's kappa) per group.

No main effect was observed for the total amount of role behaviours aggregated at the group level (Mean $Rank_{role}$ = 6.80; Mean $Rank_{nonrole}$ = 4.20; U = 6.000, df = 4). A directional Mann-Whitney U-test revealed a significant difference between the research conditions with respect to the extent that – functional or spontaneous – roles were performed (U = 4.000, df = 4, p < .05; one-sided). These results indicate that group members in role groups predominantly perform the tasks (role behaviour) that are expected. Table 2 reveals that the role groups with the highest (PD 2) and lowest (PD 1) level of perceived group efficiency (PGE) (Strijbos et al., 2004c) did not differ in their kappa value, illustrating that role groups with a low PGE level did not act more rigidly according to the functional roles than those with a high PGE level. The kappa values for nonrole groups are consistently low or very low and the slightly higher values for LG 2 and LG 3 indicate that roles may have emerged spontaneously. Table 3 illustrates that students in role groups performed predominantly according the functional roles (bold scores on the diagonal) and also that 'role behaviour' emerged spontaneously to some extent in nonrole groups, i.e. a project planner in LG 2 (Gr) and an editor in LG 3 (Ve).

Role						*Nonrole*					
PD 1						PD 5					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**19**	1	0	1	21	Re	**20**	1	**14**	1	36
Co	12	**3**	0	1	16	Ve	**9**	0	**4**	0	13
Ed	4	0	**7**	0	11	Ni	**9**	0	**5**	1	15
Dc	4	1	0	**6**	11	Vd	**8**	0	**3**	0	11
PD 2						PD 6					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**19**	0	1	4	24	Wi	**5**	0	**4**	0	9
Co	3	**8**	3	3	17	Jo	**4**	0	**2**	0	6
Ed	7	0	**9**	3	19	Bo	**4**	1	**5**	0	10
Dc	2	0	0	0	2	St	**1**	0	**2**	1	4
PD 3						PD 7					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**17**	0	6	3	26	Mo	**20**	1	**4**	1	26
Co	12	**3**	3	0	18	Kn	**4**	0	**0**	0	4
Ed	4	0	**7**	0	11	Ro	**10**	0	**4**	1	15
Dc	2	0	4	**2**	8	Ka	**7**	0	**1**	0	8
PD 4						LG 2					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**8**	0	6	1	15	Gr	**8**	1	**2**	0	11
Co	31	**19**	8	2	60	Va	**7**	1	**2**	0	10
Ed	7	0	**16**	3	26	Ap	**3**	0	**4**	0	7
Dc	2	0	2	**11**	15	Te	**4**	0	**0**	0	4
LG 1						LG 3					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**8**	0	5	1	14	Ho	**7**	0	**4**	1	12
Co	4	**0**	1	0	5	Jh	**4**	0	**3**	0	7
Ed	8	2	**8**	2	20	Ve	**10**	1	**13**	2	26
Dc	11	1	12	**2**	26	Bk	**3**	0	**4**	2	9

Table 3. Case summaries of role behaviour per individual, group and condition.

It is also apparent, however, that whether a student in a nonrole group assumed a specific role s/he still performed other role behaviours, predominantly P and E behaviours. Moreover, the E-behaviour in the nonrole groups is mostly spread across all members (bold scores), whereas in role groups this behaviour is more bound to a single member exerting the specific functional role. This same pattern can also be identified to some extent with the P-behaviour (bold scores).

STUDY 2

At the Open University of the Netherlands (OUNL), 39 students enrolled in a course on 'policy development' (PD) and 25 in a course on 'local government' (LG). In total 64 students enrolled. Five students enrolled in both

courses making a total of 59 participants (32 male and 27 female; Age 22-55 years, Mean = 38, SD = 8.42, 1 missing) and 49 completed the course successfully (76.5 %). The design was similar to Study 1: functional roles were introduced in half of the groups and their task was to construct a shared policy report regarding reorganisation of local administration. All communication was through e-mail. Based on the evaluation of the first study students were asked to indicate, prior to the course, whether they wanted to start with a practice assignment or proceed immediately with the final assignment that would be graded. They were also asked whether they preferred a slow (ten months) or fast (six months) study pace. Most students could be grouped according to their preference; however, given the number of registering students it was not always possible to maintain groups of four students. In contrast to the first study, however, nonrole groups had to hand in a progress report every four weeks as well: on the one hand to increase a 'sense' of supervision but on the other hand to retain a difference with the role groups (progress report every two weeks). Overall, three groups in the role condition were composed 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 editor. It was assumed that this did not increase the students' workload as the instruction explicitly stated that studying the data could be distributed. The other four groups started with four members. In the nonrole condition, two groups started with five members and the other four groups with four members. Five students participated in both courses and they were placed in the same research condition (three students in the role condition and two in the nonrole condition). Two students that participate in both courses at the same time had to be grouped in the same condition and group (one of them dropped out in both groups due to a conflict with the other group member). Four students already participated in either course in the previous year and were placed in the same condition (three students in the role condition and one in the nonrole condition). None of these students were grouped in the same group. Although some students participated in both courses and/or for a consecutive time, they were included in the analyses because efficiency and collaboration relies on the intra-group interaction with all other group members and they collaborated with three other students with whom they had not worked before. If only two members remained, that group was excluded from the analyses.

Content analysis of communication

The analysis methodology was similar to Study 1. Content analysis was performed on all e-mail messages contributed by fifty-one students equally distributed across both research conditions (role n = 7, N = 25; nonrole n = 6 and N = 26). All communication on the first assignment that the group performed (practice or final) was analysed. One nonrole group started with the practice assignment, but half way this group switched to the final assignment, yet 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 over represented as this is typically conducted in the first half of the collaboration. Initially it was expected that roles would decrease the amount of coordinative statements, however based on the Strijbos et al. (2004c) results, the expectation for the second study was adjusted to an increase of coordination. A Mann-Whitney U-test was performed to compare both conditions. Results are depicted in Table 4. 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. No main effect was found for the other main categories.

	Role (n = *7*)			*Nonrole* (n = *6*)		
Item	M	SD	*Rank*	M	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	114.96	46.06	8.7	75.73	32.98	5.0
Task content	61.90	41.90	6.6	65.82	52.97	7.5
Task social	9.63	5.25	8.6	5.20	4.82	5.2
Non task	26.68	14.52	7.4	21.99	8.09	6.6
Non-codable	92.60	48.36	7.4	81.92	53.16	6.5

Table 4. Mean, standard deviations and Mann-Whitney rank scores for the number of messages, number of segments and the five main categories.

Content analysis of role behaviour

Case summaries were made for each group (Table 6). Role behaviour is indicated by the capitals P, C, E and D, the members of the role groups are represented according to their role (Pp, Co, Ed and Dc) and nonrole group

members by their initials. Similar to Study 1, the role behaviour distribution was investigated by computing a Cohen's kappa for each matrix – using the scores on the diagonal as the indicator for functional role behaviour. In contrast to Study 1, the students in nonrole groups now handed in a progress report every four weeks: still retaining a difference with students in role groups who handed in a report every two weeks. Nevertheless, compared to Study 1 students in nonrole groups are more likely to exert C-behaviour (and the role descriptions were still guiding and not very coercive).

Whereas all groups in Study 1 formed a perfect four by four matrix, the analyses in Study 2 were more complicated. Three role groups performed according to three roles and thus the behaviours in the E-column represents the combined total of E and D behaviour. This does not favour the role groups because D-behaviours are generally distributed across all members and thus this aggregation leads to more deviations from the diagonal than scores on the diagonal. In addition, two nonrole groups consisted of five group members. Similar to Study 1 the kappa in nonrole groups is based on the distribution with the most possible scores on the diagonal because any member could have performed a role consistently. In addition, the group member that in any combination caused the highest number of deviations from the diagonal was eliminated. In other words, similar to Study 1 the most optimal four by four matrices – in terms of functional roles – were created for the nonrole groups. Table 5 present the total amount of role behaviour for each group and the obtained kappa values.

Role		
Group	Total behaviour	Kappa
PD 1	72	.35
PD 2	64	.32
PD 3	131	.09
PD 4	95	.20
PD 5	103	.10
LG 2	95	.41
LG 4	115	.17
Nonrole		
Group	Total behaviour	Kappa
PD 6	67	.09
PD 7	66	.14
PD 8	45	.07
PD 9	108	.09
LG 1	42	.23
LG 3	77	.10

Table 5. Total amount of role behaviour and consistent role behaviour (Cohen's kappa) per group.

In contrast to Study 1, a significant main effect was observed for the amount of role behaviour aggregated at the group level ($U = 9.000$, $df = 5$, $p < .05$; one-sided). Students in role groups performed more role behaviours than students in nonrole groups. A directional Mann-Whitney U-test showed a significant difference between the research conditions with respect to the extent that – functional or spontaneous – roles were performed ($U = 7.500$, $df = 5$, $p < .05$; one-sided). Similar to Study 1 the results indicate that – in general – group members in role groups perform functional role behaviour that is expected. Table 5 reveals that the role groups with the highest (PD 4) and lowest (PD 2) level of perceived group efficiency (PGE) do differ slightly in their kappa value. However, PD 2 is the only role group in the second study with a low PGE level and compared to the other groups with a high PGE level (see Strijbos et al., in press-a) the kappa obtained for PD 2 does not indicate that this group acted more rigidly according to the functional roles. In Table 5 also a high kappa value can be observed for PD 3, but a low PGE level was observed, signalling that role behaviour does not automatically lead to a higher PGE level. The kappa values for nonrole groups are low or very low, but compared to Study 1 a little higher, apparently because the nonrole groups were required to hand in progress reports as well. The slightly higher values for PD 7 and LG 1 indicate that roles may have emerged spontaneously.

Table 6 illustrates that students in role groups acted predominantly according to the functional roles (bold scores on the diagonal) and that role behaviour emerged spontaneously to some extent in nonrole groups, i.e. a project planner emerged in LG 1 (Vo) and PD 9 (Sc), an editor emerged in PD 7 (Wa), and in PD 6 (Ev), LG 1 (Mo) and LG 3 (We) a communicator emerged. It is apparent that students with an emergent role in a nonrole group still perform various other role behaviours. Finally, similar to Study 1, E-behaviour – and to some extent also P-behaviour (bold scores) – is spread predominantly across all nonrole members (bold scores), whereas in role groups this behaviour is on average bound to the member exerting the specific functional role.

Role						*Nonrole*					
PD 1						PD 6					
	P	C	E		Σ		P	C	E	D	Σ
Pp	**13**	0	7		20	Mc	**18**	2	**7**	1	28
Co	11	**7**	5		23	Ev	**6**	4	**3**	0	13
Ed	8	0	**21**		29	Ne	**13**	2	**6**	0	21
						Db	**5**	0	**0**	0	5
PD 2						PD 7					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**18**	1	3	0	22	Re	**13**	3	**1**	0	17
Co	6	**4**	1	1	12	Vk	**13**	2	**2**	1	18
Ed	8	1	**9**	1	19	Wa	**14**	2	**8**	2	26
Dc	7	0	1	**3**	11	Sw	**3**	0	**1**	1	5
PD 3						PD 8					
	P	C	E		Σ		P	C	E	D	Σ
Pp	**28**	0	12		40	Ra	**14**	0	***0***	0	14
Co	28	**11**	11		50	Th	**10**	1	***0***	0	11
Ed	30	0	**11**		41	Le	**5**	0	***0***	0	5
						Vg	**13**	1	***0***	1	15
PD 4						PD 9					
	P	C	E		Σ		P	C	E	D	Σ
Pp	**36**	0	8		44	Sc	**29**	6	**4**	2	41
Co	15	**7**	3		25	Vb	**10**	0	**7**	0	17
Ed	18	1	**7**		26	Me	**7**	3	**10**	3	23
						Vl	**19**	1	**6**	1	27
PD 5						LG 1					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**15**	5	8	1	29	Vo	**8**	1	**1**	0	10
Co	4	**1**	2	0	9	Mo	**5**	4	**2**	0	11
Ed	21	2	**21**	2	46	Va	**5**	2	**4**	1	12
Dc	9	0	7	**3**	19	Ev	**5**	1	**2**	1	9
LG 2						LG 3					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**27**	0	4	3	34	Gr	**17**	0	**4**	0	21
Co	7	**7**	0	4	18	We	**15**	4	**2**	0	21
Ed	11	0	**16**	1	28	Ma	**16**	2	**6**	0	24
Dc	9	0	0	**6**	15	We	**8**	0	**3**	0	11
LG 4											
	P	C	E	D	Σ						
Pp	**18**	0	8	0	26						
Co	5	**5**	0	0	10						
Ed	28	4	**21**	1	54						
Dc	15	1	6	**3**	25						

Table 6. Case summaries of role behaviour per individual, group and condition.

DISCUSSION

In this paper the impact of functional roles, adapted for a computer-mediated context in a higher and distance education setting, was investigated with two content analysis procedures. Previous reported results from two studies focused on grades and Likert-scale questionnaires, which tend to provide a surface level analysis of actual behaviour. Hence, all e-mail communication was subjected to two content analysis procedures.

In Study 1 content analysis of the communication shows – as hypothesised – more 'task content' statements in the role condition. However, this was not due to a decrease in the amount of coordinative statements. In fact, the amount of coordinative statements increased, which disproves the alternative interpretation for the lack of significant difference between research conditions regarding PGE, i.e. that the groups in both conditions were equally active in coordinating their collaboration. Apparently, the roles stimulated coordination and as a result 'task content' statements increased as well. Content analyses with respect to 'role behaviour', functional or

spontaneous, revealed qualitative differences between role and nonrole groups regarding the collaboration process. No difference was observed in the total amount of role behaviour, but group members of role groups performed role behaviours, associated with their functional role, more frequently than members with a different functional role. The kappa values for nonrole groups are consistently low or very low and the slightly higher values for LG 2 and LG 3 indicate that roles emerged spontaneously to some extent. In other words, the functional roles affected the organisation and coordination of the collaboration, and thus the impact of the instruction is validated. In addition, a plausible alternative interpretation for the observed PGE difference in the first study (Strijbos et al., 2004c) was disproved: the role groups with the highest (PD 2) and lowest (PD 1) PGE did not differ in their kappa value, illustrating that group members in the role group with a low level of PGE did not act more rigidly according to the functional roles. However, the variability in adherence to the functional roles (as expressed by the kappa values) shows that the roles acted as a guiding principle rather than as a set of coercive rules – which underlines the need for the computation of kappa instead of other statistical techniques. Two role behaviours (i.e., P and E) were frequently exerted by students in the nonrole groups, but these were not bound to a single group member, but distributed across all group members. Spontaneous roles emerged in two nonrole groups, but these group members still performed other role behaviours. Overall, the results indicate an overall involvement of each student in nonrole groups with the group task, especially where it concerns P-behaviour. The spread of E-behaviours in nonrole groups across members indicates that these groups organised their collaboration by splitting the content of the shared report into (sub)topics which were individually studied, written and subsequently assembled (A+B+C+D) in a 'collaborative' report. To some extent this behaviour seems to have occurred in some of the role groups as well, but appears to have been less consistent across these groups. Although it can be argued that this distribution enhances involvement in the task, it impedes the collaboration if the outcomes of individual study phases are not shared with other group members. The task-split approach could explain why less D-behaviours are observed as they were likely combined with E-behaviours.

In Study 2, the content analysis of communicative statements illustrates that the roles affected coordination. Similar to Study 1 the number of 'task coordination' statements was increased. A main effect was observed for the number of messages – but not for the segments – indicating that students in the role groups interacted more frequently than students in nonrole groups. More important, this difference in 'task coordination' replicates the earlier outcomes of the first study, however, the number of 'task content' statements did not increase in Study 2. Thus, changing the preconditions appears to have levelled out some of the disadvantages of the nonrole groups. The groups in both conditions were required to hand in progress reports and this may have stimulated content-focused contributions. Content analysis with respect to 'role behaviour', functional or spontaneous, revealed the same qualitative differences with respect to the collaboration process between role and nonrole groups. In contrast to Study 1, a significant difference was observed in the total amount of role behaviour. Compared to Study 1 the impact of the preconditions is reflected in the total amount of messages send and the role behaviours scored. A more even comparison regarding C-behaviour was possible as nonrole groups were required to hand in a progress every four weeks. Similar to Study 1, students in role groups predominantly performed their functional role behaviour more frequently than group members with a different role – again validating the impact of the functional roles. The kappa values for nonrole groups in Study 2 were again consistently low or very low and the slightly higher values for PD 7 and LG 1 indicate that roles emerged spontaneously to some extent. Three types of role behaviour were observed in the nonrole groups, but again distributed across all group members showing overall involvement. Finally, the spread of E-behaviours in nonrole groups – similar to Study 1 – was observed, indicating that these groups tend to split the task into individual topics. Spitting the task is very similar to a professional context where task allocation is often based on expertise. In fact, several role groups in both studies pursued this strategy to some extent. Although expertise roles can have a positive impact on the amount of information shared (see Stasser, Stewart, & Wittenbaum, 1995), it should be noted that students are not experts in a professional sense.

The results reported in this paper clearly underline that investigating functional roles during CSCL requires triangulation of data sources, analysis methods and 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 efficiency, communication, social interaction, etc.) and the instruments used to measure these processes vary with respect to their quality, e.g. reliability. The outcomes of both studies reveal that functional roles stimulate coordination and overall group efficiency in a project-based CSCL course in higher education. Comparison of both studies reveals the possibility of a different added value of functional roles in educational environments with a varying degree of teacher-student control, such as small groups of students in an educational setting controlled by the teacher (Study 2) versus students in a community of learners who construct their own groups and learning opportunities (Study 1). It is clear that more research is needed to investigate the use of functional roles and the diversity of spontaneous roles – in controlled and uncontrolled CSCL environments – to support this interpretation.

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