T. Koschmann, D. Suthers, & T.W. Chan (Eds.), *Computer Supported Collaborative Learning 2005: The Next 10 Years!*
Mahwah, NJ: Lawrence Erlbaum Associates.

The Impact of Role Assignment as Scripting Tool on Knowledge Construction in Asynchronous Discussion Groups

Tammy Schellens
tammy.schellens@ugent.be

Hilde Van Keer
hilde.vankeer@ugent.be

Martin Valcke
martin.valcke@ugent.be

Bram De Wever
bram.dewever@ugent.be

Department of Education
Ghent University

Abstract. The present paper describes the impact of learning in asynchronous discussion groups on students' levels of knowledge construction. Multilevel analyses were applied to uncover the influence of student, group, and task variables and the specific impact of the assignment of roles. Results indicate that students' attitude towards the learning environment and their engagement in the discussion group are significant predictors. No significant overall differences in students' mean levels of knowledge construction between the role and no role condition were observed. However, additional analyses revealed (1) that students in the role condition more often reached the highest level; and (2) that assigning students the role of summarizer resulted in significantly higher levels of knowledge construction.

Keywords: CSCL, collaborative learning, asynchronous discussion groups, roles, scripting

INTRODUCTION

Computer-supported collaborative learning (CSCL) environments have been argued to foster collaborative knowledge construction (Clark, Weinberger, Jucks, Spitulnik, & Wallace, 2003). Collaboration as such, however, does not systematically produce learning (Dillenbourg, 2002). Research evidence shows that the efficacy of collaborative learning depends on various conditions such as group composition (e.g., size, gender), task features (e.g., task complexity), and individual student characteristics (e.g., learning styles, attitude towards the learning environment) (Schellens & Valcke, in press; Schellens, Van Keer, & Valcke, 2004). These conditions interact with one another in a complex way. Moreover – despite their impact – it must be taken into account that not all these variables can be manipulated directly while designing CSCL environments. Instead of changing the conditions that indirectly determine the group interactions (e.g., group size, heterogeneity of group members), in the present study we especially focus on variables that can be manipulated to influence students' interactions in a direct way. More specifically, we try to **script** students' discourse in CSCL environments. This aim corresponds to the suggestion of Dillenbourg (2002) who claims that the application of scripts for collaborative learning can be a technique to affect collaborative learning directly. Collaboration scripts can specify, sequence and assign collaborative learning activities in on-line learning environments (Kollar, Fischer, & Hess, 2003; Weinberger, Reiserer, Ertl, Fischer, Mandl, 2003). The concept of 'script' however encompasses a very broad range of methods, techniques and approaches. In this respect, it is difficult to speak about the overall efficacy of CSCL scripts. The aim of the present study is to analyze the impact of a specific type of collaboration script, namely the assignment of **roles** to group members in asynchronous discussion groups.

CONTEXT OF THE PRESENT STUDY

The present study was conducted in a naturalistic research setting. The asynchronous discussion groups were a formal component of a 7-credit, first year university course 'Instructional sciences', which is part of the academic bachelor's curriculum 'Pedagogical Sciences' at Ghent University. This freshman course introduces students to a large variety of complex theories and conceptual frameworks related to learning and instruction.

All students taking the course (N = 286) participated in the study. The discussion groups were set up in parallel to 12 weekly face-to-face sessions. Participation to the discussion groups was obligatory and evaluated.

Twenty-five percent of the final score for the course was based on the quality of individual student participation to the electronic discussion groups.

THEORETICAL EXPLORATION OF THE VARIABLES INVOLVED

In order to understand the entire story of learning in a CSCL environment we need to consider variables at different levels.

Regarding the importance of **characteristics of individual students**, there is little research evidence about their specific impact in the CSCL field. Variables such as gender, age, and appreciation towards the learning environment are rather considered as background variables. Hakkarainen and Palonen (2003) for example report about the impact of gender on students' interest in CSCL and how this influences learning outcomes. Other research indicates that learners who are motivated and engaged, tend to learn more than those who are not (Reio & Wiswell, 2000). Engagement and contributing to the discussion appear to be mutually interrelated: motivated students are likely to participate more in CSCL environments, which leads to higher levels of knowledge construction (Schellens et al., 2004). Learners generally are more engaged and motivated when the learning mode is compatible with the ways in which they cognitively process information (Sternberg, 1997). Workman (2004) more specifically suggests that design researchers should consider the learning styles of the students and provide fitting learning environments when possible. Schellens and Valcke (2000) also observed that consistency between the requirements of the on-line learning environment and learning styles is important. In the same study they also pointed at the importance of student satisfaction, which interacts with the impact on knowledge construction.

Taken into account the empirical grounds of the aforementioned student characteristics, the following variables will be considered in the theoretical base of the present study: gender, learning styles, attitudes towards the CSCL environment, and engagement in the discussion, which will be operationalized as the individual amount of messages contributed to the discussion group.

In relation to **group characteristics**, prior research has stressed the importance of fostering intensive group interaction (Dillenbourg, Baker, Blaye, & O'Malley, 1995; Schellens & Valcke, in press; Schellens et al., 2004). Studies more specifically report that an increase of the amount of discourse promotes learning (e.g., Jeong & Chi, 1997; Mäkitalo, Weinberger, Häkkinen, & Fischer, 2004). Some of these authors also point at the relationship between interaction levels and group size. Group size should not be too large, since larger groups do not provide the opportunity for all members to participate in full. On the other hand when groups are too small, there is not enough interaction to provide a critical amount of exchange of ideas or information in order to come to higher levels of knowledge construction (Johnson, Johnson, & Holubec, 1998; Slavin, 1995). In this respect it is also logical to assume that the number of students depends on the requirements of the collaborative learning task (Kumar, 1996). In addition to level of interaction and group size, the literature also goes into the issue of group composition as a critical characteristic. Research results, however, are less conclusive and come to contradicting results. Some studies emphasize heterogeneous groups (Johnson et al., 1998; Nurrenbern, 1995; Slavin, 1995), while other studies contradict these research results (Felder, Felder, Mauney, Hamrin, & Dietz, 1995).

In the context of the present study, group size will be kept constant (10 to 12 students per discussion group) and group composition will be randomized, to obtain heterogeneous groups. Intensity of the group interaction will be measured and used as an interaction variable.

With regard to **task characteristics**, recent CSCL research suggests that a clear task structure is needed to foster cognitive processing and academic performance (Dillenbourg, 2002; Weinberger, 2003). Other research points at the need to state directions, guidelines, and specific types of expected cognitive processing (Cifuentes, Murphy, Segur, & Kodali, 1997; Harasim, Hiltz, Teles, Turoff, 1998; Schellens & Valcke, in press). Hakkarainen, Lipponen, and Järvelä (2002) also indicate the need to prompt students to articulate their conceptual understanding to promote learning and knowledge building. These prompts are also called collaboration scripts.

As stated above, there is a broad range of approaches that fit the description of collaboration scripts. One of the potential ways of imposing structure on learners' collaboration is the use of roles. Roles can be defined as more or less stated functions, duties, or responsibilities that guide individual behavior and regulate intra-group interaction (Hare, 1994). Roles appear to stimulate group members' awareness of the overall group performance and each member's contribution (Strijbos, Martens, Jochems, & Broers, 2004). In addition, according to Aviv (2000), certain roles are required to bridge over periods of silence or too silent participants. Advocates of a more structured learning approach generally assert that assigning roles to group members results in more rapidly and more consistent levels of interaction, while others contend that less structure stimulates more elaborate and critical dialogue. According to Rose (2002), assigning roles and providing close monitoring of group interaction creates learning advantages in the short term. However, small groups may approach similar levels of productive interaction in the long term without the added instructional expense.

In addition to scripting students' interaction by assigning roles, another important task characteristic brought up in the literature is the extent to which the assignments link up with students' Zone of Proximal Development. Illera (2001) states that motivation to work collaboratively on a task and the zone of proximal development are intertwined. He observed that when the task exceeded the abilities of the students, their interest and involvement reduced. This brings us to a second task characteristic: task complexity. This issue has hardly been studied in the context of CSCL. Harper, Squires, and Mc Dougall (2000) indicate that task complexity is necessary to provide authentic learning environments. But they also stress that too much complexity can make learners feel insecure and lose track of learning objectives. Research has stressed the need to present tasks or assignments that are within a 'zone' that matches the learner's abilities (Schellens et al., 2004; Quinn, 1997). In the case of too complex task, students did not engage in the discussion, while in the case of rather simple tasks, students were not interested to discuss the matter.

More research is, however, needed to get a better understanding of the impact of these task characteristics. Therefore, the use of roles and task complexity will be considered as key research variables in the present study.

THEORETICAL FRAMEWORK OF THE PRESENT STUDY

Figure 1 presents a graphical representation of the theoretical base for the present study. This is an extension of the approach adopted in previous research (Schellens & Valcke, 2002). It integrates social constructivist principles and concepts derived from the information processing approach to learning.

The key dependent variable in the theoretical base is students' 'levels of knowledge construction' as reflected in the group discussion contributions. Independent variables are described in the following paragraphs.

The figure depicts three key substructures: (1) the individual learning process of a student, (2) the task put forward in the CSCL environment, and (3) the collaborative dimension in the CSCL setting. The learning process of an individual student (*student a*) is presented at the center of the figure. 'Learning' is considered as an information processing activity, building on the assumption that learners engage actively in cognitive processing in order to construct mental models. In this way, new information is integrated into existing cognitive structures.. Because of the importance of individual experiences and existing cognitive structures, characteristics of the individual learner, such as attitude towards the CSCL learning environment, gender, and learning styles are considered of importance. Moreover, it can be hypothesized that the more students express their line of thought, the more the construction of mental models is facilitated. Therefore, student engagement in the discussion (i.e. the amount of individual contributions) is regarded as relevant.

A second substructure points at the impact of the task put forward in the learning environment and discussed in the CSCL setting. The student assignments in the discussion groups are assumed to trigger the cognitive processes of the individual students. The amount of imposed structure in the discussion, that is discussing with or without roles assigned to the students, and the complexity of the task are considered to influence the nature of the cognitive activities. This results in varying levels of knowledge construction.

Finally, a third substructure refers to the importance of the group in the CSCL setting. An important characteristic in this respect is the intensity of the group interaction. The task is put forward in a collaboration environment. This invokes *collaborative learning* that builds on the necessity of the learner to organize output that is relevant input for the other learners (*student a to n*). The exchange at input and output level is considered to reflect a richer base for the further cognitive processing at individual level. This assumption is central in the cognitive flexibility theory of Spiro, Feltovich, Jacobsen, and Coulson (1988). The more exchange at input and output level, the more knowledge construction that can be realized. The output is a central element in the theoretical base of the present study. The asynchronous nature of the discussion environment forces the learner to communicate the output in an explicit way. All the written communication in the CSCL environment is therefore considered relevant. The student output mirrors their cognitive processing activities. Individual processing is slowed down by the complex nature of the tasks since learners have to cope with selection, organization, and integration processes. As a consequence, learners experience the *limited capacity* of their working memory, also referred to as *cognitive load* (Sweller, 1994). However, learners in a collaborative setting can profit from the processing effort of other group members. Since the output of other learners is organized, students are expected to experience lower levels of cognitive load when using this output as input for their own individual cognitive processing. This subsequent output is expected to be of better quality, thus reflecting a higher level of knowledge construction. In the present study, we build on the work of Gunawardena, Lowe, and Anderson (1997) to identify students' levels of knowledge construction. This analysis and coding system will be used to analyze the transcripts of the written communication and to determine students' individual levels of knowledge construction. At a more basic level, the coding will also identify whether the discussion input is task-oriented or not task-oriented. This distinction is derived from the work of Veerman and Veldhuis-Diermanse

(2001). Task-oriented communication input can be coded further following the levels of knowledge construction as distinguished by Gunawardena and her colleagues (1997).

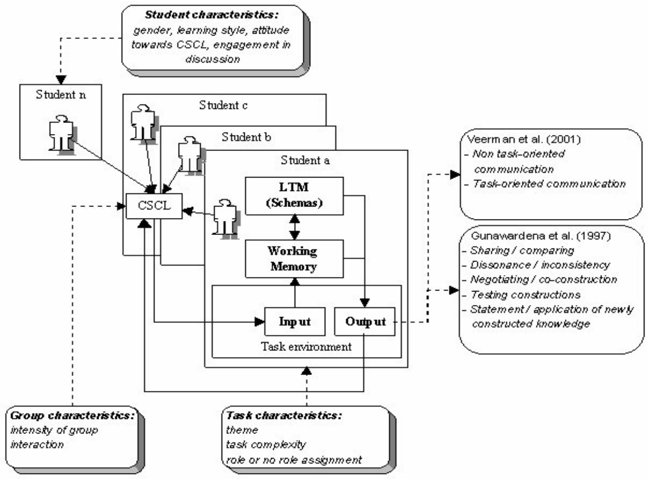

Figure 1. Graphical representation of the theoretical framework

According to the theoretical framework, learners construct knowledge by active participation in discussing and sharing knowledge with their peers when working in small groups. Students actively engage in learning processes when working jointly on a learning task by mutually explaining the learning contents, giving feedback to other group members, asking and answering questions, etc. (Weinberger, 2003). However some groups encounter difficulties when engaging in activities of collaborative knowledge construction. Numerous studies indicate that the desired effects often fail to emerge. Research for instance indicates that not all group members are actively engaged in the discussions (Salomon & Globerson, 1989) or that the content of the group discussions remains superficial (Coleman, 1995). Reasons for these deficits can result from characteristics of the individual students or from characteristics of the group, but can also be due to the unique character of the task. The focus in the present research will be especially on the task characteristics and more specifically on the impact of task complexity and the use of roles. Considering the theoretical framework, student and group characteristics will also be taken into account in the analyses, since we suppose they interact with one another and influence the dependent variable 'level of knowledge construction'.

PROCEDURE

All students (N = 286) enrolled for the course 'instructional sciences' were randomly assigned to a discussion group (N = 23). Each group consisted of about 12 students.

An experimental design was adopted with the entire first-year student population being randomly assigned to the discussion groups. More specifically, two research conditions can be distinguished: students in the discussion groups did or did not receive role assignments. Informed consent was obtained of all students.

After a trial discussion session of three weeks, students participated in four consecutive discussion themes. The entire treatment lasted 4 months. Within the three-week time frame students were flexible as to time and place to work on the discussion assignments. After three weeks, student no longer had access to the particular theme and a new discussion theme was presented.

During the first face-to-face session of the semester, the objectives of participation in the discussion were communicated to the students, at the same time, a demonstration was given of the CSCL environment. A number of strict rules, were stated. At the start and at the end of the course, a number of instruments were presented to the students. In this way, data was gathered with regard to the student characteristics age, gender, and educational level. During the first administration, a special section was added to measure students' attitude towards the task-based learning environment and their attitude towards participation in the discussion groups. Furthermore, the Approaches and Study Skills Inventory for students (ASSIST) was presented to gather information about students' 'learning styles' (Entwistle, Tait, & McCune, 2000). Reported reliability for the ASSIST is high, with Cronbach's α between .80 and .87.

The information about the group characteristic 'intensity of interaction' was derived from the analysis of the contributions to the discussion groups (see infra). The task characteristic 'task complexity' will be explained when describing the discussion themes.

Students worked together in the discussion groups by applying the theoretical concepts of the course to solve problems, which were presented in the on-line environment. These problems were, in line with the constructivist principles, based on real-life authentic situations. For a more detailed description of the kind of discussion assignments see the research of Schellens and colleagues (2004).

Task complexity was determined for each task in the discussion groups. The degree of complexity of the tasks showed a strong upward trend in the second and third assignment, while the fourth assignment was again less complex.

The nature of the discussion assignments was the same for all 23 discussion groups in the research, regardless of the research condition the groups were in: the same learning goal, context, inquiry expectations, time requirements, and deliverables were put forward. The experimental treatment was based on whether roles had been assigned or not. Students in 15 out of 23 discussion groups were assigned specific roles. Four different roles were distinguished: 'moderator', 'theoretician', 'summarizer', and 'source searcher'. These roles were assigned randomly to 4 students in each group. At the start of every new discussion assignment, the roles were assigned to 4 other students within the same group. This is in line with a collaboration script proposed and tested by O'Donnell and Dansereau (1992).

The 'moderator' closely monitored the discussions in the on-line environment (every 2 or 3 days) and interjected praise, offered advice, answered questions, and posed critical questions. This student stimulated active group participation. The 'theoretician' had to make sure that all appropriate theories were considered when tackling the task and had to indicate which aspects, relevant theoretical knowledge, or information was lacking. The 'summarizer' summarized the contributions and initial solutions of the students in the discussion groups. This student had to indicate the different points of view and had to try to make some provisional conclusions. The 'source searcher' looked for additional sources and further information, so that students were prompted to look further than the content of the available course reader.

HYPOTHESES

The present research aims to observe the differential impact of assigning discussion roles to students on their level of knowledge construction. In addition, the impact is studied of variables at the level of the student, the group, and the task. The following hypotheses present step-by-step sub-questions in relation to this general research questions.

Impact of student characteristics:

- More intensive and active participation in the discussion groups is positively related to students' level of knowledge construction.
- Students with a positive attitude towards the on-line learning environment will reach significantly higher levels of knowledge construction.
- Students with a deep or strategic learning style will obtain significantly higher levels of knowledge construction.

Impact of group characteristics:

- Being part of a group with intensive discussion activity will lead to significantly higher individual levels of knowledge construction.

Impact of task characteristics:

- The complexity of the task has a significant impact on the level of knowledge construction.
- Working in the role condition will have a significantly positive impact on students' levels of knowledge construction.

ANALYSIS OF THE TRANSCRIPTS OF THE DISCUSSION GROUPS

The transcripts of eight groups were randomly selected from the larger data set. For each of the eight groups, the complete communication submitted in relation to the four discussion themes was used for analysis purposes using the scheme of Gunawardena and colleagues (1997). This content analysis scheme has been developed following a grounded theory approach. It proposes a typology to evaluate knowledge construction through social negotiation. The authors developed an interaction analysis model that discriminates between five phases in the negotiation process during a learning process. Every phase corresponds to a typical level of knowledge construction. In the long run, every learner is expected to reach the highest phases in the negotiation process, thus reaching the highest level of knowledge construction.

In the present research the complete message was used as the unit of analysis. According to Rourke and colleagues (2001) this choice presents some advantages. Firstly, it is objectively identifiable: multiple coders can agree consistently on the total number of units. Secondly, it produces a manageable, controllable set of cases. In the case of the present study for example, we recorded a total of 1933 messages. The third advantage is the fact that we are dealing with a unit which parameters were determined by the author of the message.

To establish inter-rater reliability we used the following method: three independent researchers carried out the coding task. After the coding of each complete transcript of a discussion by the individual coders, the quality of the coding was assessed by determining percent agreement measures. A value of .70 was put forward as a criterion for inter-rater reliability. The initial value was .85. After negotiations percent agreement was .91. To check whether it was not always the same researcher changing the coding category, percent agreement was also calculated for each individual researcher. The latter represents the agreement between the first and second coding of a unit of analysis. Intra-rater reliability always exceeded .70.

RESULTS

Because in the present study the students are divided in a number of groups, the problem under investigation has a clear hierarchical structure. Because of the joint modeling of individual and group variables, we took a multilevel modeling perspective on analyzing the data, for these models are specifically geared to the statistical analysis of data with a clustered structure. To analyze the data, MlwiN for multilevel analysis was used (Rasbash et al.,1999).

To test the hypotheses regarding the impact on students' levels of knowledge construction students' 'mean level of knowledge construction' per discussion theme was used as a dependent variable.

The first step in the analysis was to examine the results of a fully unconditional three-level null model (Model 0). The intercept of 1.95 in this model simply represents the overall mean of the level of knowledge construction according to the 5-level coding scheme of Gunawardena and colleagues (1997). As can be inferred from Model 0, the overall variability in the mean level of knowledge construction per discussion theme can be attributed for the most part (96.20%) to discussion theme-level factors (differences between the four assignments), for 3.26% to differences between students within the groups, and only for a small part (0.54%) to group-level factors (differences between the groups). This is already an important result implying that the differences between the diverse groups and students are much smaller than the differences in individual students' levels of knowledge construction between the different assignments. This entails that the features of the assignment will be of central importance in the further analysis.

To gain a clear insight into the development in students' levels of knowledge construction from discussion theme 1 to theme 4, the measurement occasions were added to the fixed part of the model (Model 1). As can be seen in Table 1 a significant change in levels of knowledge construction could be determined for the second ($\chi^2 = 11.06$, $df = 1$, $p = .000$), the third ($\chi^2 = 13.26$, $df = 1$, $p = .000$), as well as for the fourth theme ($\chi^2 = 8.78$, $df = 1$, $p = .003$). For these discussion assignments a significant decrease in students' mean levels of knowledge construction is observed as compared to the first assignment.

Table 1
Summary of the model estimates for the three-level analyses of students' levels of knowledge construction

	Model				
Parameter	Model 0	Model 1	Model 2	Model 3	Model 4
Fixed					
Intercept	1.95 (0.05)	2.21 (0.08)	2.18 (0.07)	2.17 (0.01)	2.19 (0.08)
Theme 2		-0.34 (0.10)	-0.36 (0.09)	-0.36 (0.09)	-0.41 (0.08)
Theme 3		-0.38 (0.10)	-0.41 (0.09)	-0.41 (0.09)	-0.40 (0.08)
Theme 4		-0.31 (0.10)	-0.21 (0.09)	-0.21 (0.09)	-0.25 (0.08)
Amount of messages			0.06 (0.02)	0.06 (0.02)	0.05 (0.01)
Attitude towards learning environment			0.03 (0.01)	0.03 (0.01)	0.02 (0.01)
Role condition				0.02 (0.08)	
No role assignment in role condition					-0.02 (0.07)
Moderator					-0.25 (0.12)
Theoreticus					-0.16 (0.13)
Source searcher					-0.67 (0.14)
Summarizer					1.08 (0.13)
Random					
Level 3					
σ^2_{v0}	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.01 (0.01)
Level 2					
$\sigma^2_{\mu 0}$	0.02 (0.03)	0.02 (0.03)	0.04 (0.02)	0.04 (0.02)	0.02 (0.02)
Level 1					
σ^2_{e0}	0.53 (0.05)	0.50 (0.04)	0.35 (0.04)	0.35 (0.04)	0.25 (0.03)
$\sigma_{e0eappr.}$			0.04 (0.01)	0.04 (0.01)	0.02 (0.00)
$\sigma^2_{eappr.}$			0.01 (0.00)	0.01 (0.00)	0.00 (0.00)
Deviance	838.52	821.98	591.25	591.21	487.08

Note. Values in parentheses are standard errors.

As a next step in the analyses, explanatory variables were included in the model. In Model 2, it can be seen that both student and task characteristics significantly influence students' mean level of knowledge construction. At student level, higher individual number of postings and a positive attitude towards the learning environment result in higher mean levels of knowledge construction. At task level, especially the complexity of the assignments affects students' mean level of knowledge construction per theme. In particular, it appears that the reported significant decrease in mean levels of knowledge construction from the first to the subsequent themes disappears when correcting for task complexity. Structuring the task by assigning roles to students does not have an overall significant impact on the mean level of knowledge construction. Students who were asked to take up the role of 'theoretician' or 'moderator' did not score differently as compared to students who worked in groups without role structuring. Students who were assigned the role of 'source searcher' or 'moderator' scored significantly lower. However, students who had to summarize the discussion at various moments obtained significantly higher mean levels of knowledge construction. Finally, as to the effect of group level variables, the research findings revealed no significant impact of the intensity of the group's interaction on students' mean levels of knowledge construction.

In order to unravel the discourse taking place in the different research conditions, additional analyses were carried out to take a closer look at the differences in the discourse between the discussion groups with and without roles assigned. More specifically, we focused on the following questions:

- Is there a difference in the proportion of task-oriented versus non-task-oriented communication under the two research conditions?
- Is there a difference in the distribution of the different levels of knowledge construction under the two conditions?
- Are there differences with regard to the changes in students' levels of knowledge construction over time for the different conditions?

Chi square analyses were used to explore potential differences in the distributions within the research conditions. Mann-Whitney U-tests were used to test for differences between the role and no role condition.

Is there a difference in the proportion of task-oriented versus non-task-oriented communication under the two conditions?

The amount of task-oriented messages far outweigh the amount of not task-oriented messages in both the role (X^2 = 992.88, df = 1, p =.000) and no role condition (X^2 = 341.88, df = 1, p =.000). By comparing both conditions, using Mann-Whitney U, no significant difference can be noticed (Z = -1.45, df = 1, p = .148).

Is there a difference in the distribution of the different levels of knowledge construction under the two conditions?

To explore the differences between the two research conditions, we first analyzed whether the amount of messages in the five levels of communication are equally distributed in both conditions. No equal distributions are observed for both conditions. This is confirmed by the Chi-Square analysis for both the role (X^2 = 1397.24, df = 4, p = .000) and no role condition (X^2 = 470.29, df = 4, p = .000). More specifically, in both conditions level 1 and level 3 communication types were observed to a significantly higher extent, whereas level 4 and 5 have hardly been observed.

If we compare both research conditions using the Mann-Whitney U-test, no significant differences can be noticed for the mean levels of knowledge construction reached under both conditions (Z = -0.23, df = 4, p = .82) although it appears that the distribution of proportions over the five levels is not quite similar (X^2 = 572.64, df = 4, p = .000). Correspondence analysis revealed that the differences are mainly found in the three higher levels and more especially in the highest level of knowledge construction. In the role condition students more often reached the highest level of knowledge construction, which was however at the expense of messages in level 3 and 4. No significant differences were found with regard to the percentage of messages situated in level 1 and 2. In summary, the findings indicate that, regardless the research condition, numerous contributions were situated at the lower levels of knowledge construction.

Are there differences in the changes over time for both conditions?

Findings reflect a certain decrease in communication reflecting higher levels of knowledge construction for both conditions.

In the role condition, there is an increase of level 1 knowledge construction, which was at the expense of a decrease in messages situated at level 2 to 4. However, there is an increase in level 5 knowledge construction. This change in proportions is significant (X^2 = 51.18, df = 4, p = .000). Correspondence analysis indicated that the changes in proportions of level 3 and 5 were not significant. However, there are significant proportion changes for level 1, 2, and 4.

In the no role condition a different picture arose. There were shifts in the distribution of proportions, but these were not similar to the changes in the role condition. Level 1 communication increased over the discussion themes, while there was a decrease in the amount of messages situated at level 2. Clearly different as compared to the role condition was that the communication situated at level 3 increased, while there was a complete drop of messages in level 4 and level 5. This overall change in proportions is significant (X^2 = 36.52, df = 4, p = .000). Correspondence analysis showed that the most significant distribution changes were situated at level 2 to 4.

In conclusion, it can be argued that there is a change in students' levels of knowledge construction over time. However, the changes are different in both research conditions.

DISCUSSION AND CONCLUSION

The results indicate that a large part of the overall variability in levels of knowledge construction can be attributed to task characteristics.

As to the impact of student characteristics, the amount of individual contributions is a significant predictor for the level of knowledge construction. The level of knowledge construction is also significantly influenced by the attitude towards task-based learning and the attitude towards the group discussions. Accordingly, it can be concluded that the first two hypotheses about the impact of student characteristics can be accepted. More intensive and active individual participation in the discussion groups is positively related to students' achieved level of knowledge construction, as well as adopting a positive attitude towards the learning environment and towards participating in group discussions. The third hypothesis, however, has to be rejected. No significant differences in levels of knowledge construction were found for students with different learning styles. Students with a deep or strategic learning style did not obtain a significantly higher level of knowledge construction compared to students with a surface approach.

Contrary to the results with regard to student characteristics, the hypothesis regarding the impact of group characteristics were not corroborated. These findings can be explained by the fact that there was very little difference in interaction activity between the discussion groups. This relates to the fact that, based on the previous research results, we changed the 'rules' concerning the minimum participation requirements in the discussion groups. Students were expected to contribute more messages to the discussion groups in order to receive a high evaluation score. As a consequence, hardly significant differences between the groups could be detected as to their level of interaction. Combining of the findings about the impact of both student and group characteristics, makes us aware of the fact that promoting effective group discussion activity is not to be reduced to 'stimulating to contribute a large number of messages'. The fact that also a positive attitude towards the learning environment has a significant and positive impact on student outcomes, stresses the importance of promoting learning as an enjoyable activity (Westrom 2001).

As to the impact of task characteristics, significant differences between the consecutive discussion themes were found. However, the findings were not in line with the expected results. It was hypothesized that students would reach higher levels of knowledge construction when they deal with the consecutive discussion theme assignments. The results showed rather a significant decrease in levels of knowledge construction. Further analysis however illustrated that this significant decrease in level of knowledge construction disappeared when correcting for task complexity. This finding points at the critical importance of the task design and task solution support provisions. Task complexity appeared to be an important task characteristic. When the tasks were too complex, the levels of knowledge construction were significantly lower. On the other hand, when the tasks are too straightforward, students experience no challenge and the number and quality of the contributions also drop.

As to the additional impact of assigning roles, contrary to our expectations, structuring the task by assigning roles to students did not have an additional impact on students' obtained main levels of knowledge construction. These results were not in line with the positive results of role scripting found in other research (Weinberger, 2002; Mäkitalo, Weinberger, Häkkinen, and Fischer, 2004; Jeong & Chi, 1997; Strijbos 2003). But, in comparing our research results, we should take into account that these types of scripting are not completely comparable to the role structuring that was applied in the present study. Moreover, also the dependent variable differs in these studies, which makes it difficult to compare the research results.

Despite the fact that in the present research students' mean level of knowledge construction in the role and no role conditions did not differ, additional analyses revealed some potentially interesting results. As to the differences in the proportion of task versus non-task-oriented messages, no significant differences were observed between the role and no role condition. This is not in line with other research (Strijbos et al., 2004) where students in the role condition contributed more 'task content' focused statements. However we have to put the present findings in perspective by mentioning that an important part of these messages were inherent to the specific role description (e.g., encouraging, planning …).

As stated above, regarding the levels of knowledge construction, the overall picture did not show significant differences. At the end of the semester, the mean levels reached did not differ in both conditions. We noticed however, that the distribution pattern of the levels was no longer similar. In the role condition students more often reached the highest level of knowledge construction, although this was at the expense of messages at level 3 and level 4. There were no significant differences for the proportion of lower level messages. Based on these findings, it can be concluded that even though students' mean level of knowledge construction in both conditions did not differ, the assignment of roles did have an effect on the interaction in the discussion groups. The findings reveal that students in the role condition more often reach the highest levels, but apparently still need a certain amount of low level postings at the start of the discussion activity to ground the rest of the discussion.

Apart from the fact that being part of a role-based group did not have an impact on students' mean levels of knowledge construction, we investigated whether having a specific role assignment had an impact on the levels of knowledge construction for individual students. We found that students who had to perform the role of 'theoretician' did not reach significantly different levels of knowledge construction as compared to students who worked in groups without role structuring. Students who were assigned the role of 'source searcher' and 'moderator', however, scored significantly lower than the reference students in the no roles condition. Only students who had to 'summarize' the discussion obtained significantly higher levels of knowledge construction.

REFERENCES

Aviv, R. (2000). Educational Performance of ALN via Content Analysis. *Journal of Asynchronous Learning Networks, 4 (2),* 53-72.

Cifuentes, L., Murphy, K., Segur, R., & Kodali, S. (1997). Design Considerations for Computer Conferences. *Journal of Research on Computing in Education, 30(2),* 177-201.

Clark, D., Weinberger, A., Jucks, I., Spitulnik, M., & Wallace, R. (2003). Designing Effective Science Inquiry in Text-Based Computer Supported Collaborative Learning Environments. *International Journal of Educational Policy, Research & Practice, 4 (1),* 55-82.

Coleman, E. B. (1995). Learning by explaining: Fostering collaborative progressive discourse in science. In R. J. Beun, M. Baker, & M. Reiner (Eds.), *Dialogue and instruction: Modeling interaction in intelligent tutoring systems* (pp. 123-135). Berlin: Springer

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL?* (pp. 61-91). Heerlen: Open Universiteit Nederland.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative learning. In P. Reimann & H. Spada (Eds.), *Learning in humans and machines: Towards an interdisciplinary learning science* (pp. 189-211). Oxford: Elsevier.

Entwistle, N., Tait, H., & McCune V., (2000). Patterns of response to an approaches to studying inventory across contrasting groups and contexts. *European Journal of Psychology of Education*,*15*, 33-48.

Felder, R. M., Felder, G. N., Mauney, M., Hamrin, Jr., C. E., and Dietz, E. J (1995). A longitudinal study of engineering student performance and retention. III. Gender Differences in Student Performance and Attitudes. *Journal of Engineering Education*, *84 (2),* 151.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of *knowledge in computer conferencing. Journal of Educational Computing Research, 17,* 397-431.

Hakkarainen, K., Lipponen, L., & Järvelä, S. (2002). Epistemology of Inquiry and Computer-Supported Collaborative Learning. In T. Koschmann, R. Hall, and N. Miyake (eds.). *CSCL 2: Carrying Forward the Conversation.* Lawrence Erlbaum, 129-156.

Hakkarainen , K. & Palonen, T. (2003). Patterns of female and male students' participation in peer interaction in computer-supported learning. *Computers and Education, 40 (4),* 327-342.

Harasim, L., Hiltz, S., Teles, L., & Turoff, M. (1998). *Learning Networks: A Field Guide to Teaching and Learning Online.* Cambridge, MA: The MIT Press.

Hare, A.P. (1994). Types of roles in small groups: A bit of history and a current perspective. *Small Group Reasearch, 25,* 443-448.

Harper, B., Squires, D. & McDougall, A. (2000). Constructivist simulations: A new design paradigm. *Journal of Educational Multimedia and Hypermedia, 9(2),* 115-130.

Illera, J. (2001). Collaborative environments and task design in the university. *Computers in Human Behavior, 17(5-6),* 481-493.

Jeong, H., & Chi, M.T.H. (1997). Construction of shared knowledge during collaborative learning. In R. Hall, N. Miyake, & N. Enyede (Eds.), *Proceedings of Computer-Supported Collaborative Learning '97* (pp. 124-128). Toronto, Ontario, Canada.

Johnson, D., Johnson, R., & Holubec, E. (1998). *Cooperation in the classroom*. Boston: Allyn and Bacon.

Kollar, I., Fischer, F., & Hesse, F.W. (2003). Cooperation scripts for computer-supported collaborative learning. In B. Wasson, R. Baggetun, U. Hoppe, & S. Ludvigsen (Eds.), *Proceedings of the International Conference on Computer Support for Collaborative Learning* -CSCL 2003, COMMUNITY EVENTS-Communication and Interaction (pp.59-61). Bergen: InterMedia.

Kumar, V.S. (1996). Computer-Supported Collaborative Learning: Issues for research. 8th Annual Graduate Symposium on Computer Science, University of Saskatchewan, Canada. Retrieved August 16, 2004, from http://www.cs.usask.ca/grads/vsk719/academic/890/project2/project2.html

Mäkitalo, K.,Weinberger,A., Häkkinen, P., & Fischer, F. (2004). Uncertainty-reducing cooperation scripts in online learning environments. Retrieved July 14, 2004, from http://www.iwm-kmrc.de/workshops/sim2004/pdf_files/Makitalo_et al.pdf

O'Donnell, A. N., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. In R. Hertz-Lazarowitz, & N. Miller, *Interactions in cooperative groups. The theoretical anatomy of group learning* (pp. 120-141). Cambridge, MA: Cambridge University Press.

Quinn, C. N. (1997) *Engaging learning*. ITForum Paper #18. Retrieved July 12, 2004, from http://itech1.coe.uga.edu/itforum/paper18/paper18.html

Rasbash, J., Browne, W., Goldstein, H., Yang, M., Plewis, I., Healy, M., Woodhouse, G., & Draper, D. (1999). *A user's guide to MLwiN*. London: Institute of Education.

Rose, M. A., (2002). Cognitive dialogue, Interaction patterns, and Perceptions of Graduate Students in an Online Conference Environment under Collaborative and Cooperative Structures, Indiana University.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Methodological Issues in the Content Analysis of computer conference transcripts. *International Journal of Artificial Intelligence in Education, 12,* 8-22.

Salomon, G., & Globerson, T. (1989). When teams do not function the way they ought to. *International Journal of Educational Research, 13 (1)*,89-99.

Schellens, T., & Valcke, M. (2000). Re-engineering conventional university education: Implications for students' learning styles. *Distance Education, 21(2),* 361-384.

Schellens, T., & Valcke, M. (in press). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior*.

Schellens, T, Van Keer, H., & Valcke, M. (2004). *Learning in asynchronous discussion groups: A multilevel approach to study the influence of student, group, and task characteristics.* Manuscript submitted for publication.

Slavin, R.E. (1995). *Cooperative learning: Theory, research and practice*. Boston: Allyn & Bacon.

Spiro, R., Feltovich, P., Jacobson, M. & Coulson, R. (1988). *Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advanced KnowledgeAcquisition in Ill-Structured Domains.* Retrieved September 20, 2002, from http://www.ilt.columbia.edu/ilt/papers/Spiro.html

Sternberg, R.J. (1997). Thinking styles. Cambridge University Press, NY.

Strijbos, J. W., Martens, R. L., Jochems, W. M. G., & Broers, N. J. (2004). The effect of functional roles on group efficiency: Using multilevel modelling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35(2)*, 195-229.

Sweller, J. (1994). Cognitive Load theory, learning difficulty and instructional design. *Learning and Instruction, 4,* 295-312.

Veerman A., & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In P. Dillenbourg, A. Eurelings, & K. Hakkarainen (Eds.), *European Perspectives on Computer-Supported Collaborative Learning. Proceedings of the First European Conference on CSCL*. Maastricht: McLuhan Institute, University of Maastricht.

Weinberger, A. (2003). *Scripts for computer-supported collaborative learning. Effects of social and epistemic cooperation scripts on collaborative knowledge construction.* Unpublished doctoral dissertation, Ludwig-Maximilians-Universität.

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2003). *Facilitating collaborative knowledge construction in computer-mediated learning with structuring tools.* In R. Bromme, F. Hesse, & H. Spada (Eds.), *Barriers and biases in net based communication*. Norwell: Kluwer.

Westrom, M. (2001). *Constructivist strategies for e-Learning*. Course paper prepared for the Ewha Women's University. Retrieved July 12, 2004, from http://www.cust.educ.ubc.ca/westrom/CSeL.htm

Workman, M.(2004). Performance and perceived effectiveness in computer-based and computer-aided education: do cognitive styles make a difference? *Computers in Human Behavior, 20 (4),* 517-534.