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Quality not Quantity: Comparing Interaction Patterns of a Balanced and Non-Balanced Teams Engaged In Model-Building within a Computer-Supported Collaborative Learning (CSCL) Environment

Abstract: Roberts and Nason (2003) found that teams within a CSCL environment balanced by Team Role Preference (TMP) produced better quality knowledge building than non-balanced teams. This study extended the work of Roberts and Nason by investigating the interaction patterns of the balanced and non-balanced teams' on-line discussion forum discourse utilising the Poole and Holmes (1995) Functional Category System (FSC). This study found that although the non-balanced teams engaged in more interactions than the balanced teams, quantity of interaction did not equate with quality of interaction; the balanced teams demonstrated more efficient and effective knowledge building interactions than non-balanced teams. These findings indicate that CSCL researchers need to focus not only on the quantity but also on the quality of interactions when designing social infrastructures within CSCL environments.

Keywords: CSCL, Interaction, Team Role Theory, Model-Building

Introduction

The difficulty of establishing and sustaining knowledge-building peer interaction within CSCL environments has been reported in the literature for some time (e.g., Bielacyck & Collins, 1999; Kreijns, Kirschner, & Jochems, 2002; Sorensen, 1999; Stahl, 2002). As Sorensen (1999) pointed out, “[a]chieving peer interaction in distributed collaborative CSCL designs has manifest itself to be a recurrent problem, very complex to approach and comprehend” (p. 582).

According to Kreijns et al. (2002), there appear to be two major pitfalls impeding achievement of the desired interaction in CSCL environments: taking social interaction in teams for granted and the lack of attention paid to the social psychological dimension of social interaction outside of the task context. This has been reflected in CSCL research where until recently, most focus has been on the development of technology scaffolds that are incorporated within the CSCL tools to structure and facilitate online collaborative discourse and construction of knowledge (Roberts & Nason, 2003). The cognitive scaffolds provided within Knowledge Forum® are typical examples of technology scaffolds. However, as Bielacyck and Collins (1999) pointed out, cognitive/technology scaffolds by themselves are not sufficient to ensure that the engagement and interaction necessary for knowledge-building discourse do occur within CSCL environments; they contend that social interactions also need to be planned for within CSCL environments. Indeed, Bielacyck (2001) claimed that the central challenge facing CSCL lies in creating the appropriate social infrastructure around the CSCL tool with its technological/cognitive scaffolds. Social infrastructure refers to the supporting social structures enabling the desired interaction between collaborators using the CSCL tool.

The issue of creating appropriate social infrastructures within CSCL environments that will enable knowledge-building interaction between participants within a CSCL community has been addressed in recent times by a number of researchers within the field of CSCL.

Kreijns et al. (2002), for example, have addressed the challenge of creating appropriate social infrastructures by proposing the insertion of intelligent software tools called group awareness widgets (GAWs) within CSCL environments to initiate and sustain the learners' social interactions. GAWs provide a learner with an awareness of other learners within the CSCL environment and also enable him/her to initiate communication episodes with them. The theoretical framework underlying these intelligent tools is based on an ecological approach to social interaction which sees social affordances as the main determinants for enhancing the sociability of CSCL environments.

Most other current solutions to the problems of creating appropriate social infrastructures have focused not on the development of intelligent tools but on what the teachers/instructors need to do. Scardamalia (2002), for example, pointed out the necessity for the establishment of CSCL communities that contain participants capable of bringing a diversity of ideas to the on-line discourse. According to Scardamalia, idea diversity is essential to the development of knowledge advancement, just as

biodiversity is essential to the success of an ecosystem. She claimed that to understand an idea is to understand the ideas that surround it, including those that stand in contrast to it. Idea diversity thus creates a rich environment for ideas to evolve into new and more refined forms. Scardamalia also pointed out the need for teachers/instructors to establish and maintain a culture of psychological safety within a CSCL community where people feel safe in taking risks, revealing ignorance, voicing half-baked notions, and giving and receiving criticism. According to Scardamalia, in cultures such as this, all ideas are treated as improvable and participants work continuously to improve the quality, coherence, and utility of ideas.

The notion of creating cultures such as those envisaged by Scardamalia is one of three levels of social infrastructure identified by Bielacyck (2001) as being necessary for knowledge-building interactions within CSCL environments. She also identified two other levels of social infrastructure that needed to be considered: Activity Level and Tool Level. Activity level refers to the congruence between the on-line activities with the CSCL tool and the off-line learning activities that form part of normal classroom activities. Bielacyck found that knowledge-building discourse and interaction within a CSCL environment were more likely to occur if the offline learning activities complemented the online activities. Tool level addresses questions such as: 1) How has the end-user modified the environment? and 2) How are the affordances of the CSCL tool actually used in practice? Bielacyck found that issues concerning the use and adaptation of different tool capabilities are central to the success or otherwise of CSCL tools. She also believes that other components such as the teacher's role, the level of curriculum integration, and the curriculum content, are also critical issues to consider in the creation of appropriate social infrastructures for CSCL environments.

Roberts and Nason (2003) adopted an alternative approach for creating a social infrastructure within a CSCL environment. They utilized Margerison and McCann's (1995) Team Role Preference Theory to purposively structure the composition of the CSCL teams. Margerison and McCann's Team Role Preference Theory asserts that the effectiveness of teams can be improved if emphasis is placed on ensuring a balance within teams in terms of each individual's 'team-role preference' (Belbin, 1993; Coleman, 2001; Margerison & McCann, 1995). Team-role preference is defined as the tendency of an individual to behave, contribute and interrelate with others at work in certain distinctive ways (Belbin). Margerison and McCann believe that teams need not be of a certain size but are successful when between them, members are comfortable in working across all team-role preferences listed in the Team Management Wheel (Figure 1). To establish team role preferences, each individual completes a Team Management Profile Questionnaire. This is "a sixty item normative, forced-choice instrument which measures work preferences along the four key factors of relationships, information, decisions and organisation. The scores on these constructs are then mapped on to the Team Management Wheel resulting in a major role preference and two related roles" (Margerison & McCann, 1995, p. 26). For a fuller description of this process see Roberts and Nason (2003).

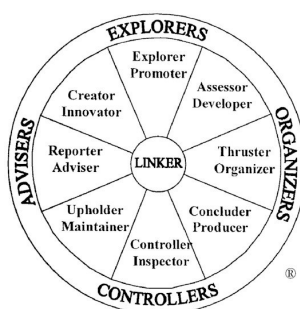


Figure 1: Margerison-McCann Team Management Wheel (Source: Margerison, C. J., D. J. McCann, Davies, R. V. (1998, p. 27)

The participants in the Roberts and Nason (2003) study were a cohort of 30 pre-service business education teachers enrolled in a BEd (Secondary) business curriculum subject at a major metropolitan university in Queensland, Australia. Twenty-one of the participants were on-campus students; the other nine participants were external students. In the study, the participants were required to collaboratively develop online a 'Guiding Principles Model' that could be used to inform the development of business curriculum units and lesson plans. Through developing the Guiding Principles Model, it was envisaged

that the participants would be required to develop, reflect upon and share understandings about promoting optimal learning experiences for students they will teach. The participants were divided into teams of three. Where possible, each team of three consisted of two on-campus students and one external student. The nine off campus students formed the base for nine of the ten teams; the tenth team consisted solely of on-campus students. Six of the teams were balanced in terms of team role preference (as measured on the Margerison-McCann TMP); that is, members were allocated so that there was a balance of roles and where the greatest possible spread of work preferences was covered. The other four teams had members randomly allocated in terms of team role preference (Originally, there were six random teams. However, the fifth and sixth random teams were lost due to withdrawal of team members from the course). To ensure academic equivalence between the 'balanced' and 'random' teams, minor adjustments were made to the membership of each of the teams to ensure that the average aggregated scores for subject-matter and pedagogical content knowledge of the balanced and random teams were as equivalent as possible. In the end, the average of the aggregated scores for the six balanced teams was marginally lower (2%) than average for the four random teams.

In this study, the balanced teams generally produced better models than the random teams. Four of the five top-ranked models were generated by balanced teams. This trend was broken by one of the random teams which generated the third-ranked model. However, when the composition of this team was analysed, it was found that this team was by pure chance essentially balanced in terms of TMP profiles. Within this team were the major team roles of Explorer-Promoter, Thruster-Organiser and Controller-Inspector and a fortuitous spread of related roles. A preliminary analysis of the on-line discourse also indicated that the teams balanced in terms of TMP profiles tended to focus more on knowledge-building activity than the random teams. In order to gain deeper insights into why the balanced teams tended to generate better models, the interaction patterns of each of the team's on-line discussion forum discourse were further analysed utilising the Poole and Holmes (1995) Functional Category System (FSC) presented in Table 1.

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1. Problem Definition
 - 1a. Problem analysis: Statements that define or state the causes behind a problem
 - 1b. Problem critique: Statements that evaluate problem analysis statements (may be assigned a positive [+] or negative [-] valence)
 2. Orientation
 - 2a. Orientation: Statements that attempt to orient or guide the group's process
 - 2b. Process reflection: Statements that reflect on or evaluate the group's process or progress
 3. Solution Development
 - 3a. Solution analysis: Statements that concern criteria for decision-making or general parameters for solutions
 - 3b. Solution suggestions: Suggestions of alternatives
 - 3c. Solution elaboration: Statements that provide detail or elaborate on a previously stated alternative. They are neutral in character and provide ideas or further information about alternatives
 - 3d. Solution evaluation: Statements that evaluate alternatives and give reasons, explicit or implicit, for the evaluations. They may be assigned a positive [+] or negative [-] valence
 - 3e. Solution confirmation: Statements that state the decision in its final form or ask for final group confirmation of the decision. They may be assigned a positive [+] valence if they argue for confirmation, or neutral (/) valence if they merely ask for confirmation. Negative responses are to 3e are coded 3d-
 4. Nontask: Statements that do not have anything to do with the decision task. They include off-topic jokes and tangents
 5. Simple agreement
 6. Simple disagreement
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Table 1 – Functional Category System (Poole & Holmes, 1995, p. 104)

Analysis of interactions

A doctoral and master's student from the medical sciences field were trained for three hours in the Poole and Holmes (1995) Functional Category System (FCS) (see Table 1). The two coders independently categorised the communication acts within each team's on-line discussion forum transcript and achieved an inter-rater reliability of 0.829. This initial categorisation was completed with the coders working on hardcopy transcripts, using coloured highlighter pens to indicate each of the communication categories. Where agreement was not achieved a consensus approach between the two coders and the researcher was used. The approach taken in this study is very similar to the application of the FCS by Jonassen and Kwon (2001) in their study of communication patterns in computer-mediated versus face-to-face contexts in a group problem solving activity. The following examples are taken from the on-line discussion forum transcripts to illustrate the categorisation of the communication acts:

1. Problem Definition

- 1a. Problem analysis: Statements that define or state the causes behind a problem

From what I understand of this project we are supposed to create a model! The purpose of the model is to draw on the notes we have made to construct something (i.e. a model) that can be used as a guideline.

- 1b. Problem critique: Statements that evaluate problem analysis statements (may be assigned a positive [+] or negative [-] valence)

They were all very interesting and it made start to realise that within learning and teaching, it is important for us to cater for and recognise that children have different intelligences - not just academic and that if a child is enduring some sort of emotional conflict then they are less likely to learn as effectively as normal. I think that these are ideas or points that we can also probably address within our framework.

2. Orientation

- 1a. Orientation: Statements that attempt to orient or guide the group's process

I'll wait for your comments/suggestions/updates/changes on the concept map before I progress any further with it so will check in again tomorrow at about 6:00 a.m.

- 1b. Process reflection: Statements that reflect on or evaluate the group's process or progress

I think we are on track.

3. Solution Development

- 1a. Solution analysis: Statements that concern criteria for decision-making or general parameters for solutions

I think what we need to do is get a basic model with headings first and then we can look at where we include all the supporting information e.g. helping students set goals for their learning could be a dot point under the heading "teaching strategies" (the heading is just an example too!). The model itself needs to be simple - and understandable on its own - with the dot points providing additional and supporting information.

- 3a. Solution suggestions: Suggestions of alternatives

Based on your postings of information and possible headings, and the information that I'm finding, I'm starting to think that we could draw some sort of circular flow model with dot points underneath expanding each item.

- 3b. Solution elaboration: Statements that provide detail or elaborate on a previously stated alternative. They are neutral in character and provide ideas or further information about alternatives

I've expanded the previous flow chart model a little further so it encompasses the questions and our responses in a little more detail.

- 3c. Solution evaluation: Statements that evaluate alternatives and give reasons, explicit or implicit, for the evaluations. They may be assigned a positive [+] or negative [-] valence

I'm really happy with what we have. Although it seems quite basic we can't get into that much detail with such a small amount of space.

- 3d. Solution confirmation: Statements that state the decision in its final form or ask for final group confirmation of the decision. They may be assigned a positive [+] valence if they argue for confirmation, or neutral (/) valence if they merely ask for confirmation. Negative responses are to 3e are coded 3d-

Kia, Brian seems happy with what we've got, I am now too. So if you are happy with our final product and can't think of anything else you can post it up if you like

4. Nontask:

Statements that do not have anything to do with the decision task. They include off-topic jokes and tangents

Don't worry you are not the only one who loves to talk. By the sounds of things we would get on great - although we would probably fight over who would speak next.

Sorry if this sounds slack, but it's not my fault (stupid world of technology). Hope you both had a great w/end!

5. Simple agreement

Sounds fine to me - OK!

6. Simple disagreement

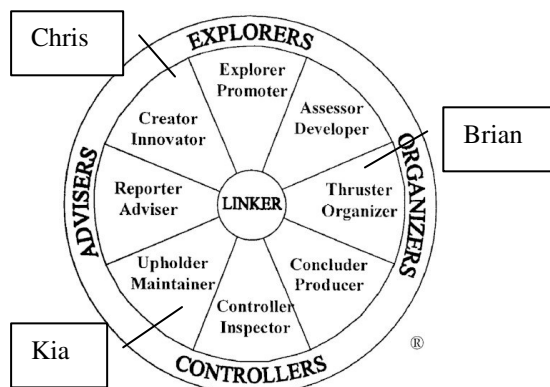
No - not a good idea

Having achieved consensus on the categorisation of each of the communication acts, electronic versions of the discussion forum transcripts were imported to NVivo (developed by QSR International, the makers of NUD*IST - now known as N4, N5 or N6). Within the NVivo program the communication acts were coded as per the categorisations generated by the FCS process. NVivo eased the task of determining the number of occurrences of any particular communication act each day over the duration of the online task. To enhance the readability of the NVivo output it was exported to an Excel spreadsheet for formatting. (see Figure 3)

Interaction Patterns

Two distinct patterns of interaction emerged within this study, exemplified in each case by the interaction patterns of Team A (balanced in terms of TMP profiles) and Team B (non-balanced in terms of TMP profiles). Team A's completed knowledge artefact was rated best by a panel of academics whereas the same panel rated Team B's artefact eighth overall. Team A consisted of Chris and Kia (internal students) and Brian (external student). Within this team, the team role preferences of these individuals were as follows: Chris (Major role - Creator-Innovator; Related roles - Reporter-Advisor and Upholder-Maintainer), Kia (Major role - Controller-Inspector; Related roles - Upholder-Maintainer and Concluder-Producer) and Brian (Major role - Thruster-Organiser; Related roles - Concluder-Producer and Assessor-Developer). Team B consisted of Hanna and Krista (internal students) and Lesley (external student). Within this team, the team role preferences of these individuals were as follows: Hanna (Major role - Thruster-Organiser; Related roles - Concluder-Producer and Assessor-Developer), Krista (Major role - Thruster-Organiser; Related roles - Concluder-Producer and Controller-Inspector) and Lesley (Major role - Assessor-Developer; Related roles - Explore-Promoter and Thruster-Organiser). Figure 2 below indicates the spread of Major roles in Teams A and B. Whereas Team A's Major roles are well spread around the Team Management Wheel (as are their related roles) Team B's major roles are heavily skewed in the 'organisers' quadrant of the Team Management Wheel.

TEAM A



TEAM B

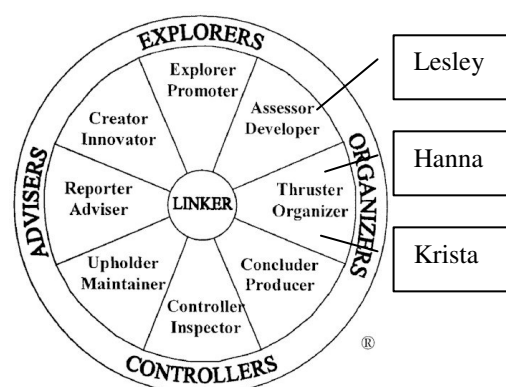


Figure 2: Team A and Team B's spread of Major Roles when plotted on the Margerison-McCann Team Management Wheel.

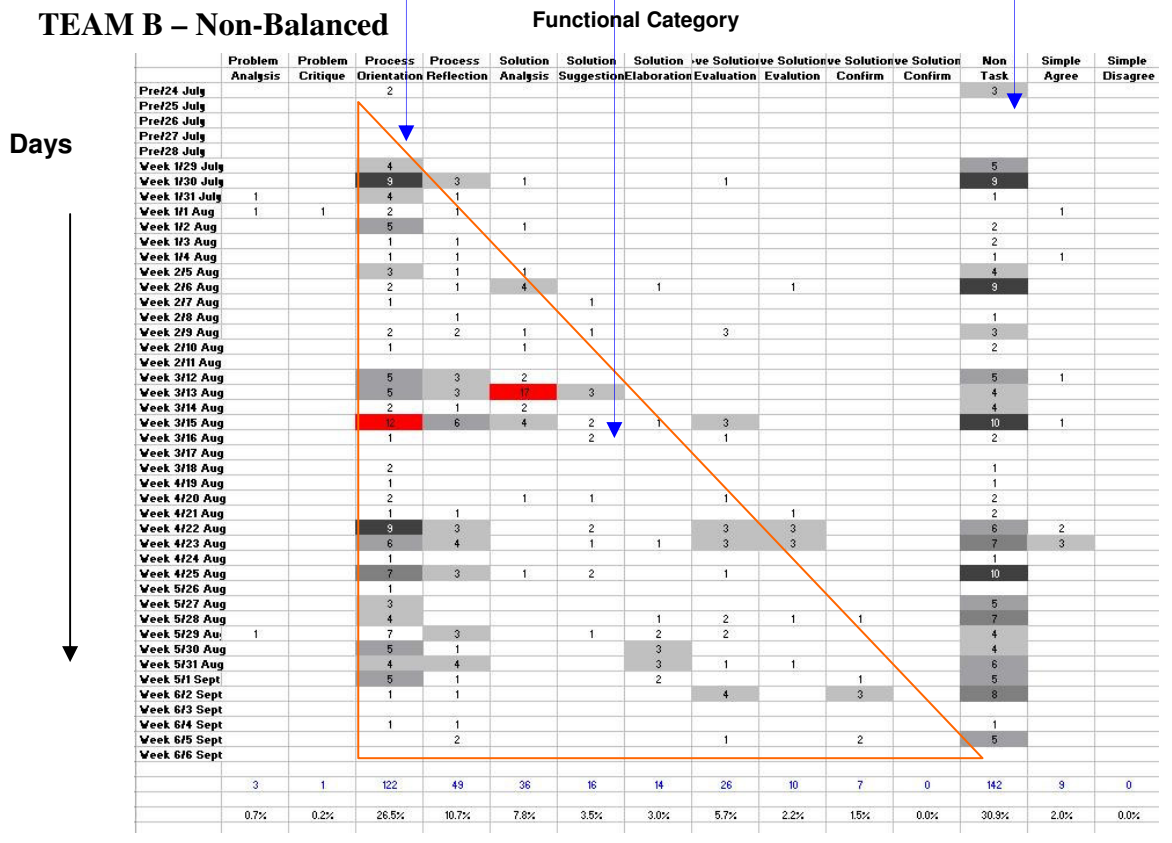
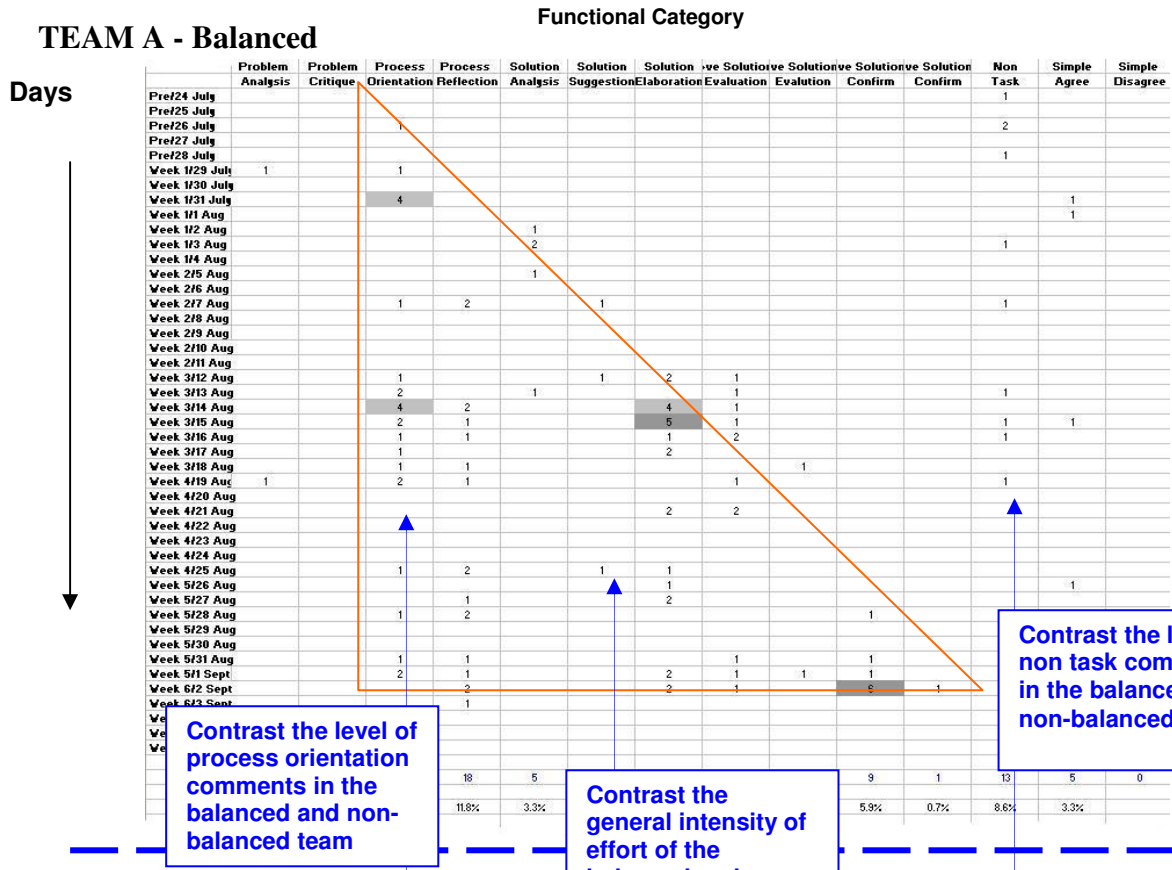


Figure 3: The Excel enhanced representations of the interaction patterns of Team A and Team B.

Conclusions and Discussion

The different patterns of interaction shown by balanced and non-balanced teams provide insights into Roberts and Nason's (2003) earlier finding that balanced teams generally demonstrated better knowledge building activity and produce better knowledge artefacts than non-balanced teams.

Put simply, balanced teams such as Team A not only demonstrated better knowledge building capability, they were able to do so with greater ease than teams who had been arbitrarily allocated. This differential of required effort was more pronounced in relation to those teams that were heavily skewed around one or two team roles. While the findings of this study supported the researchers' initial hypothesis that balanced teams would produce better knowledge artefacts, not supported was the researchers' hypothesis that the better knowledge building would result from the diversity of team roles preferences causing rigorously contested positions and higher volumes of interactions. In fact, what was found within this study was that the teams balanced by team role preference were able to readily synthesise the diversity of inputs such that the exchanges between the team members were more productive in terms of the overall efficiency and effectiveness in knowledge building. The development of the knowledge artefact, as it were, was achieved with a minimum of fuss.

An initial glance at the level of discussion activity within the non-balanced teams would lead an observer to conclude that these teams were far more actively engaged with the task - indeed that the desired interaction was present. However, when analysed it was found that the non-balanced, and in particular the teams that were heavily skewed around one or two team roles (Thruster-Organisers and Assessor-Developers), spent much of the time merely trying to orientate the effort of the team. In tandem with the high level of orientation activity, these teams also engaged in a high number of non-task exchanges. This constant reorientation and non-task discussion was to the detriment of the quality of the knowledge artefacts ultimately produced by the non-balanced teams. It would appear that the lack of diversity of team role preferences, while leading to a social ease, failed to produce the types of interactions that were required to contribute to the quality of the final knowledge artefact.

The qualitative differences in the interaction patterns between the balanced and non-balanced teams indicate that while interaction is a necessary condition for knowledge building, in and of itself it is a poor catalyst for or an indicator of the quality of knowledge building. The nature of the interaction is vitally important to the quality of knowledge building activity. The clear implication of this is that if the challenge of creating social infrastructures that enable knowledge-building interaction between participants within a CSCL community is to be met, then designers of CSCL environments need to look beyond scaffolds that initiate and sustain learners' social interactions (such as those suggested by Kreijns et al., 2002). Instead they should look more closely at the manner in which teams within CSCL environments are formed to maximize the probability that they will engage in knowledge building interactions similar in nature to those observed in the teams balanced in terms of TMP profiles in this study.

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