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Analysis and Modeling of Academia's Collaborative Decision Support System Based on Key Performance Indicators and Degree of Certainty

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Abstract

Increasingly, academia is relying on a novel concept of virtual teams for Collaborative Decision Making (CDM) processes amongst the students across the globe (different cultures). To facilitate collaboration in international virtual teams there is a need to support cross-cultural decision making through a series of steps required to improve problem solving and decision making. In this paper we analyze the CDM processes in international virtual environment and discuss the opportunity to support CDM through the use of a Computer-Aided Collaborative Decision Making (CA-CDM). In CA-CDM students declare their knowledge in terms of the Degree of Certainty (DC) during the collaboration process. In this research, a process model based on various Key Performance Indicators (KPI) designed to figure out the key challenges, performance and differences in CDM. Based on these KPI variables and their scores, two different models are suggested to calculate the difference and similarity in CDM.The designed computer-supported environment supports CDM processes to address critical thinking, deep learning and knowledge transformation. In this computer program model, based on Degree of Certainty of each peer student, each student declares their communication certainty before starting a virtual interaction to support a CDM process. Incorporation of the suggested KPIs modeling; this learning environment will optimize the output of virtual team decision support collaboration.

Keywords: Decision making; Virtual team; Degree of Certain; Key Performance Indicators; Computer supported collaborative work

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1. Introduction

Today, the education system is not completely based on the specific classroom environment with a dedicated class educator with a specific number of students. Rather the traditional classroom is now just one of the dimensions of the education system. The education system has extended its boundaries into virtual environments and global learning contexts where a large numbers of students from different cultural and social backgrounds can be networked together via modern technologies like the inter-net. Apart from students, teachers also belong to a global environment. Students and teachers can work in global virtual teams. Each team has its own environment and they can work together in cooperation to solve a task. Advantages of this globally sourced learning include knowledge sharing and cultural sharing, which can stimulate innovative ideas. These ideas also support collective decision making and reaching a good solution. The main tool being used in this process is computer mediated communication and collaboration.

Computer mediated communication and collaboration is a complex activity. Ideally, the group members perceive and manage the competences of each other in order to complete the task. This is challenging in computer mediated collaboration, and it is even more difficult when the virtual team members lack experience as a team, resulting in a lower performance [1]. Ideally, each of the virtual team participants should develop appropriate group awareness of the knowledge and resources of the other virtual team participants in order to best coordinate on the collaborative task [2].

The virtual team participants involved in Collaborative Decision Making (CDM) could have varying levels of expertise affecting the quality of their contribution to the CDM. The evaluation of their own knowledge and the other team-mates' knowledge is essential for an effective CDM. There is a need to develop knowledge group awareness (KGA), "the inter subjective perception of teammates' knowledge" [3]. In computer supported collaborative work (CSCW) and learning (CSCL), KGA aims to "promote better collaborative processes as well as enhance better task performance" [4]. In the next section, we provide more detail on CDM, before discussing the importance of the KGA and the opportunities offered by the Group Awareness Widgets (GAw) and meta-cognitive supports for supporting the KGA.

The paper is composed as: in the section 2, collaborative decision making process is described, section 3 deals with knowledge diversity and degree of certainty in international teams. Section 4 is regarding computer aided collaborative decision making, section 5 is based on degree of certainty and Group Awareness widget. Section 6 is Key Performance Indicators (KPI) modeling followed by discussions and conclusions.

2. Collaborative Decision Making (CDM)

Collaborative Decision Making (CDM) requires a certain level of collaboration and consensus building [5] among a group of persons that could have different levels of knowledge. The quality of the decisions in CDM could be shaped by individual traits of the team members, their interaction processes, and also the computer supported environment that supports the CDM process. Reaching a consensus could be affected not only by the knowledge of the group members individually, the quality of the information [6], but also by the knowledge of each team-mates' have about their team-mates' knowledge and their capacity to collaborate via CDM. In some cases groups have difficulties reaching a consensus, but in the other cases, some groups are reach a groupthink agreement where the alternative decisions have not been correctly evaluated, leading to a premature consensus [6]. Among the different factors that are related to the efficiency of CDM, we focus our study on the different levels of knowledge of the team-mates, their Degree of Certainty (DC) and the effect of the DC elicitation in the CDM.

3. Knowledge diversity in international Virtual Teams

International virtual team-members could have diverse geographical, historical, sociological, and organizational cultures. Such diversity is at the same strength but also a challenge because of the need to have certain KGA in order to coordinate the different team members' expertise. The different levels (good, moderate, low) of prior knowledge of the virtual team members could affect the CDM process ended by the virtual team. Considering this diversity in a context of interdependence, each of the individuals should try to identify, organize and maximize the knowledge of each of the other members of the group in order to better achieve the group's objectives. For example, each of the members should consider the other team-mates' expertise in order to weigh the relevance and reliability of their contributions, before considering it in CDM. In educational contexts, where the group is graded as a whole for their CDM quality, students should consider not only their own knowledge but also their team-mates' knowledge.

3.1 Knowledge diversity and Degree of Certainty

In interdependent learning situations, it is important that the students share their ideas with the other members of the group in an elicited way [7], means student come up with ideas that brings out ideas in others minds . The team-mates' could also share their degrees of expertise in order to facilitate the process of co-regulation and identifying the more knowledgeable members to help the less knowledgeable ones. The individual contributions of the team members could be put in relation to the DC they declare in association to their knowledge [2]. This DC could be assumed in different ways, but it can be also made elicit inviting the students to declare their DC at the moment they share their answers in a Computer Learning Environment (CLE). Displaying a common visualization of the team-mates' DC elicitation could permit the team-mates' to develop a more accurate evaluation of their team-mates' knowledge, of "Feeling of Anothers' Knowledge" (FOAK)[8]. The FOAK refers to the evaluation of a correspondent DC in a collective situation. Some conversational aspects of the interactions could help to develop the FOAK within a pair or group of persons. In addition to the conversational aspects introduced by Brennan and Williams [8], we consider an elicitation mechanism to display in a shared display each of the team-mates' DC. We discuss this shared visualization of the DC in a Computer Learning Environment (CLE) as a Computer Aided Collaborative Decision Making (CA-CDM) in the next section.

4. Computer Aided Collaborative Decision Making

In collaboration tasks, small groups composed from 2 to 5 peers could benefit from cognitive tools [9], which could help the students represent what they know [10] and facilitate critical thinking, deep learning and transformation of information into knowledge. According to the authors [10], these tools can be semi-structured, as conversations between peers, or structured (ad hoc tools specifically designed to facilitate knowledge declarations). A shared visualization of personal knowledge is divided into a display,; showing the DC associated with the teammates' knowledge and monitoring (becoming aware of peer's DC)[11]. Monitoring can be shown to all the participants, leading to an interpersonal comparability of performances and knowledge[12]. In this computer-aided process, the peers' knowledge is easy to identify and their declaration is also easy. The main aim behind this computer assisted environment was to maximize the knowledge transformations among the students. In the actual experiments, when the students state their experience of using this computer assisted tool, we found a meaningful increase in their trust and knowledge sharing was helped by knowing the degree of certainty of their different peers.

5. Degree of Certainty and Group Awareness Widget

In order to analyze the impact of the DC elicitation in the context of a Collaborative Decision Making (CDM) situation, we created a prototype where the learners could introduce their DC before submitting an answer to their peers. The DC declaration tool is a Group Awareness widget (GAw) as shown in figure 1; it allows each of the virtual team members to choose among 10 different grades of DC.

Fig1.DC declaration tool - Group Awareness widget (GAw)

GAw evaluation

6. We conducted a quasi-experimental empirical study in order to evaluate the impact of the GAw. The participants that took part in this study were school and college going students and their age ranging from 10 - 18 years. These students are then divided into teams. Similar teams are made at different locations having same number of students and from same age group. Each of the virtual team members was allowed to choose among 10 different grades of DC [2, 3]. Only groups in the experimental condition could use this functionality that aims to support the elicitation and collaborative sharing of the students' DC.Degree of Certainty and Key Performance Indicators model

Modern management uses a scale to gauge the performance and output of their organizations in terms of Key Performance Indicators (KPI). These KPIs are different for different systems and their forming criterion is "best measuring scale" [13]. In our case, the KPIs are used to measure the variables composed in the DC that exist among the peers and their collaborative decision making. These are used to measure the differences in CDM of the teams participating in the computer assisted environment. The KPI variables 'relationship with DC and CDM is shown in the form of a diagram in figure 2, where all variables (V1-V5) of KPI are given with full descriptions.

Hypothetically in order to calculate the differences in CDM process we can further conduct a quasi-experimental empirical study to evaluate the impact of the KPIs within the GAw. As before, each of the virtual team members will be allowed to choose 10 different grades of DC, but now the degree of certainty will further be gauged on the five KPI variables. To get a quantified measure of the KPIs, all of the teams and peers will be shown 25 questions in the computer assisted environment, and their answers analyzed on a likert scale (scale from 1-5; with 1 as excellent and 5 as the lowest level) [14].The formula for the KPIs is designed so that it measures individual as well the team differences of CDM as shown figure 2. Further, the cumulative KPI formula is as follows:

$$5\ KPIs = \sum_{i=1}^{5} Vi = \Delta\ CDM \qquad (1)$$

V1= Cross-cultural awareness and collaboration
V2 = Team rules' understandings
V3 = Virtual trust among the teams
V4 = Communication medium's usage and alertness
V5 = Knowledge and information level

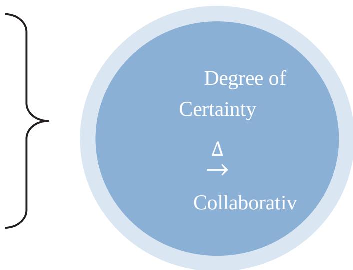

Fig 2. Key Performance Indicators (KPI) Model

In this equation (1), the differences of CDM (Δ CDM - here Δ sign indicates difference) among the teams and peers was ascertained via this cumulative KPI score; as they are directly proportional to the DC which in turns constitutes the CDM. The cumulative KPI scale values also correspond to range from 10 (1of the likert scale) to 100 (5 of likert scale). We theorize that cumulative KPIs scores must be greater than 50 for better collaboration in decision making. We hypothesize that the results; if cumulative KPIs score = 50 that shows the Δ CDM = 50 (as well as and CDM similarity = 50). If the cumulative KPIs score = 100, that shows DC = 1(100%) and Δ CDM = 0. Further, we believe a result above 80 shows excellent collaboration and shows 20% (100-80) difference in CDM (Δ CDM). If a certain teams and peers' results come out to be less than 50, then that team can be trained to gain awareness of DC; then the 5 KPIs score can be revaluated until the time they cross the threshold of 50.

6.1 Weighted Cumulative KPI Equation

All the KPI measures are important, but as a part of a parallel review, we developed an alternative equation that includes different weights for the five KPI factors (2). The biggest challenges in collaborative decision making is assumed as cross-cultural awareness and collaboration, the unawareness of the communication medium and diversified knowledge level due to differences in cultures. We assigned the weights "w" (constant term in the equation) based on the contributions of KPIs. We supposed that some variables are contributing more and some are contributing less and their contribution is not uniform. Here, we assumed that more impactful variables are contributing more as compared to the others; so we assigned values based on our assumptions in decimal figures, and the original equation (1) becomes:

1½ (Cross-cultural awareness and collaboration) **+** ½(Team rules' understandings) **+** ½ (Virtual trust among the teams) **+** (Communication medium's usage and alertness) + 1 ½ (Knowledge and information level) **= Δ CDM**

$$\sum_{i=1}^{5} \boldsymbol{Vi}\,(w_i) = \boldsymbol{\Delta}\ \mathbf{CDM} \qquad (2)$$

Now the equation is changed and each of the variables is different in terms of its contribution (w). The total cumulative KPIs score is till 100 but the contribution (w) of individual variables is changed. If we talk about the difference in CDM then difference in KPI cumulative score is a measure in the CDM. We believe that Learning and collaborative decision making are the key challenges of the academia modern educational system. If the student teams and their degrees of certainty are gauged correctly on correct scale then collaborative learning and decision making will be much easier and a global learning academic environment will ease students leaning knowledge and culture at the same time.

7. Results and conclusions

The results of the quasi-experimental studies show us an improvement in the users' awareness of the other teammates' knowledge in the second phase of the CDM task, where the experimental groups considered in a more accurate way their teammates' knowledge in a significant way. Collaborative decision making helps these students to think more globally. The computer assisted GAw environment, where they declare their DC, shows much better results as compared to the other conventional means [2.3].However, we do propose a method to calculate the significant differences in the CDM in their performance based on KPIs of DC. Further the KPI model is recommended to augment the measuring of DC; which highlights the challenges in terms of Δ CDM, and we have to work upon these challenges to mitigate them and improve their collaborative learning and reduce the CDM differences (Δ CDM). There are two different KPI models suggested in equations (1) and (2). The first model (1) is based on the notion that each of the variables of KPI contributes equally in the CDM and the cumulative KPI score ascertains the similarity or difference in CDM based on the total score. The second KPI model (2) is based on the assumption that the contribution of each variable is different in the equation and based on their individual contribution a new model is suggested. Cumulative KPIs score to be incorporated in GAw that may drive it towards novelty in CDM process and global leaning processes in academia. Nevertheless we observe a better awareness of the group members about their team-mates' knowledge which could benefit for coordinating better their task.

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