DETERMINING CORE COMPONENTS OF COMPUTER-SUPPORTED COLLABORATIVE LEARNING WITHIN EDUCATIONAL MANAGERIAL GAME CONTEXT

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Abstract: *The exploratory factor analysis has been used to determine which selected inner components of computer-supported collaborative learning (CSCL) should be considered as the core components. The research itself builds on three models of group learning, namely cooperative learning elements, the "Big Five" in the teamwork model and the theoretical framework of CSCL. The analysis of data collected from university students participating in a managerial group game suggests that future research in the field of CSCL should consider social identity, helping behavior, shared mental models, mutual performance monitoring and team orientation as the most important components of group learning activities.*

Keywords: *CSCL, group learning, models, learning components, factor analysis*

1. Introduction

This study is a report on searching for computer-supported collaborative learning (CSCL) core components within the context of an educational simulation group game. The *collaborative learning* is comprehended here – in accordance with [2, 7, 21, 30] – as a group learning activity where groupmates have to discuss, negotiate and coact on a group task whereby they learn from each other and become knowledge creators. Computer support in CSCL indicates afterwards that an important part of a group learning activity takes place in a virtual space using digital technologies. Concepts similar to collaborative learning such as *cooperative learning* or simply *group learning* are understood as synonyms in this study.

Not every group activity can be perceived as collaborative learning [16, 18]. But the sole existence of the group produces opportunities to form relationships between group members and establishes inner-group rules. It is therefore possible to identify series of group components which would have influence on promoting and, in consequence, on efficiency of collaborative learning. For example, in empirical studies where authors ask students which components of CSCL were the most challenging for them, the results point to clarity of objectives, teamwork, motivation of the group members, time management and accountability [19] or course structure, emotional support and communication medium [30].

For a comprehensive insight into the CSCL internal mechanism, however, it is essential to differentiate which of those components represent the core – e.g. are indispensable – and which of them are just subcomponents of the core components. From a set of core components it is therefore possible to build a model of CSCL, which should be a relevant base for future research in the field.

2. Known models of learning in a group

According to previously published work, there already exist some models of collaborative learning showing what to implement in order to obtain an effective group learning method. This section introduces models relevant for their own enquiry. Other models can be found for example in [1], [14], [23] or [27].

2.1 Key elements of cooperative learning

Probably the oldest and best known relevant model is a quintuple of cooperative learning *key elements* postulated by Johnson brothers [16, 17]:

1) *Positive interdependence* – by the words of authors: "the first requirement for an effectively structured cooperative lesson is that students believe that they 'sink or swim together'" [16]. The 'positive' expresses here an essence of collective outcome – a group mate succeeds if and only if other group members succeed. That is in contrast to competitive learning based on 'negative' interdependence where a student succeeds only if others fail. The concept of positive interdependence is appreciated by several researchers [11, 22, 23], but as it is noted in [7], it is not easy to achieve this relationship, particularly in an online learning environment.

2) *Individual accountability* – this key element arises when "performance of individual students is assessed, the results are given back to the individual and the group, and the student is held responsible by group mates for contributing his or her fair share to the group's success" [16]. [11] agree with the individual accountability principle as they claim that "is it also important for all individuals in the group to feel they are providing a unique and visible contribution to the group effort". Without individual accountability within the group there is a risk of social loafing – a phenomenon when a group member exerts less effort than others.

3) *Interpersonal and small-group skills* – builds on the premise that "We are not born instinctively knowing how to interact effectively with others. Interpersonal and small-group skills do not magically appear when they are needed" [16]. Interpersonal and small-group skills like ability to learn independently, good communication skills, ability to adapt to changing circumstances or critical

thinking skills therefore have to be acquired. "Many of the learners do not know that they do not know how to work collaboratively online" [32].

4) *Group processing* – consists of evaluating a group activity and giving appropriate feedback. Authors of the model declare that "effective group work is influenced by whether or not groups reflect on (i.e. process) how well they are functioning" [16]. Some feedback should come from the tutor, but the tenet of this component is on anticipation of reciprocal feedback between group members. Feedback can encompass both group member behaviors and work outcomes and can affect levels of cooperation, communication, motivation and even satisfaction with group learning [24].

5) *Promotive interaction* – is distinguished by sharing useful resources, helping behavior and mutual assistance. Equally important here are elementary utterances such as complements, acknowledgements or encouragements from a colleague [14], which generate a friendly atmosphere within the group. Requirement for reciprocal helping and supportive behavior of group members is derived from Vygotsky's social-constructivistic concept of *zone of proximal development* in which "learners who receive help can perform an activity they would not be able to perform by themselves" [33]. Initially, the model of cooperative learning assumed that promotive interaction is an exclusive part of face-to-face communication, yet subsequently authors acknowledged that it is possible to convey them even through digital technologies [17].

2.2 Big Five in teamwork

As the work teams and the learning groups have many similar attributes, there is an obvious effort to adapt teamwork models to collaborative learning. Primarily suitable is the "Big Five in teamwork" model developed by Salas, Sims and Burke [28] under which the following components significantly influence the effectiveness of work teams:

1) *Team leadership* – is present in learning groups, albeit in a different form compared to the work teams. In [9] it is claimed that "effective learning in learning teams, especially in virtual learning teams, tends to benefit more from shared leadership than individual leadership". So the decision-making process in a learning group can be defined as a type of participatory process in which multiple individuals collectively analyze problems, consider and evaluate alternative courses of action and select the best solution [3]. Measuring the leadership grade of learning groups can be done using a concept of hypothesis-driven thinking developed in [1]. It is a group ability to consider all possible options by asking "What will we do if …" and make decisions on this basis.

2) *Mutual performance monitoring* – is defined as an "ability to develop common understandings of the team environment and apply appropriate task strategies to accurately monitor teammate performance" [28]. It is known that the more complex a task is, which means the greater the number of elements and the higher the degree of interactivity between those elements, the more important the mutual performance monitoring will be [9]. In essence, there are combined two group issues, namely common understanding of the collective work and awareness of the work of others. The evidence of the importance of these group issues can be found e.g. in [2] or [4].

3) *Backup behavior* – is a group ability to evaluate and flexibly react to events within the group.

4) *Adaptability* – is a group ability to identify changes and opportunities for innovation and subsequently optimize routines. It is possible to conclude from full description in [28] that *adaptability* together with former *backup behavior* are subcomponents of Group processing presented in the cooperative learning model.

5) *Team orientation* – compared to previous components it is an attitudinal issue of group members. It means "not only a preference for working with others but also a tendency to enhance individual performance through the coordination, evaluation, and utilization of task inputs from other members while performing group tasks" [28]. However, implications for collaborative learning are disputable as in [9] it is suggested that "it is a condition that is difficult to control in the educational context, since students usually have no say in team formation and/or choice of assignments, and is therefore not a variable that could/should be influenced".

Additionally to the previous components, the authors of the "Big Five" model introduced the following three "supporting and coordinating mechanisms" as the necessary pillars of the whole model:

1) *Shared mental models* – build on a common understanding and the awareness of team and task aspects essential for becoming effective as a team [9, 28]. In practice this means that learning teams are developing certain *group norms* which determine the expected behavior of group members. Thanks to the established norms, teammates should be able to better predict behavior of their colleagues and thus save time, profit from shared resources and avoid work duplication [8, 14].

2) *Closed-loop communication* – entails that "message was received and that the content and meaning was understood as intended" [9]. Closed-loop and the same time flexible communication is conditional for follow-up actions on which communicating counterparts agreed [25]. According to [6, 10] long delays between messages and unclosed conversations are common problematic issues in the online asynchronous communication tools such as a discussion forum or e-mail.

3) *Mutual trust* – is expected to be important for successful online interactions. As [15] summarize, trust between people allow them risk more, share knowledge, exchange resources and overcome embarrassment or threat. Despite – or maybe because of – Smith [29] argues that "trust represents one of the most critical issues facing online collaborative groups". The reason is that without mutual trust group members will expend time and energy inspecting each other and rather they will perceive behavior of others as disagreement, missed deadlines or similar damaging activity disrupting group integrity [28, 29].

2.3 Theoretical framework of learning in CSCL

The last model presented here is a theoretical framework designed by Kwon *et al*. [22], in which authors took into account some specifics of CSCL. Their framework is divided into two main parts – *group regulation* and *socio-emotional interaction*. The first part consists of many already mentioned components: group process, individual responsibility, positive interdependence, monitoring process, evaluating strategies and outcomes and high interactivity among members (similar to closed-loop communication). In addition, there are two new ones:

1) *Identifying goals and tasks* – this component declares that without common group objectives accepted by all group members it is not possible to effectively collaborate on a task. "A clear identification of the goals and the responsibilities of each member will result in elaborating an adequate working methodology, good planning and timing, and a fair and viable assignment and distribution of the constituent tasks to be performed" [6]. Empirical evidence of the importance of common group objectives can be found in [5] or [19].

2) *Time management* – is considered to be a mandatory skill of every CSCL participant. "The learner must work to develop new time management strategies so that they do not miss important interactions or fall behind with activities and assignments" [12]. Time management as the most important factor influencing group learning was recognized for example in [19] or [31].

Finally, there is *socio-emotional interaction* as the second part of the model. As authors liken: "If the group regulation is fuel of an engine, the socio-emotional interaction is the motor oil that lubricates movement of members and protects them from friction" [22]. Socio-emotional interactions are even more important in CSCL setting, as theirs appearances are limited and therefore they are not naturally granted [21].

3. Research aim and methodology

The objective of this research is to cross-check 13 selected components of CSCL and identify which of them are the most important and should be labeled as *core components*. On input, there were almost all components from models presented in the previous section: *interpersonal and small-group skills*, *group processing* (including backup behavior and adaptability), *positive interdependence*, *mutual trust*, *individual responsibility*, *promotive interaction* (aka *helping behavior*), *team leadership*, *mutual performance monitoring*, *shared mental models (*aka *group norms*), *closed-loop communication*, *identifying goals*, *time management* and *socio-emotional interaction*. Only team orientation was not selected as Fransen *et al*. [9] argued that this component is not relevant for learning teams.

A semestral simulation managerial game 'Manahra', whose participants are students of economics at Masaryk University, was chosen as the testing environment. Groups of students represent management teams of car manufacturers and tackle a wide portfolio of tasks and duties requiring collaboration and communication through digital technologies. At the end of the semester all students were asked to complete a survey, which among other things investigated the presence of the selected components during the group learning activities. For every component four statements were prepared, such as: 'our group always carefully thought out our decisions', 'most group members managed their group obligations on time' or 'I would like to work with this group in the future'. Students responded on the scale *definitely agree – rather agree – rather disagree – definitely disagree – not sure*. A reductive search method of core components consists in the principle that uniform responses to different statements indicate equal dimension of issue (i.e. equal component). An exploratory factor analysis is used to ascertain this fact.

4. Findings

During autumn 2015, 168 students divided into 10 groups participated in the managerial game Manahra. The survey was completed by 56 students (6 leaders, 12 subgroup leaders and 38 ordinary members) from all groups. The grade distribution of respondents is similar to the grade distribution of all students. The low number of rows in the data matrix, however, has become a limiting factor for the analysis, which was confirmed by the reliability test of input data. Thus it was necessary to omit more than a half of statements from the input in order to carry out the factor analysis. In the end, it was possible to compile a set of 22 statements with very high inner reliability (Cronbach's $\alpha = .91$). Finally, the exploratory factor analysis (KMO = .687) reveals 5 components explaining 70.65% of values as seen in Table 1.

Tab. 1: Statements grouped by the factor analysis

Component #1 – Social identity
I would like to work with this group in the future.
I am proud I have been part of our group.
Component #2 – Helping behavior
Members of our group kept to themselves some important information that should be shared with others.
We were unable to complete group assignments without cooperation between the members of our group.
I provided all required resources to support other group members.
A friendly atmosphere prevailed in our group.
Component #3 – Shared mental models
We were able to sort out all personal conflicts and disagreements.
The norm of our group was that one helps others with group assignments.
We have set a way to deal with differences of opinion within the group.
Component #4 – Mutual performance monitoring
We were able to take advantage of unique skills and abilities of each group member for better group results.
Our group always carefully thought out our decisions.
My group members depend on me for information and advice.
When my group members succeed in their jobs, it works out positively for me.
We regularly take time to inform others about our work progress.
Component #5 – Team orientation
In our group we can rely on each other to get the job done.
For our group it would be a big loss if one of us was moved and we continued to work without them.
For certain actions within the common assignment, a sufficiently capable person missed in our group.
I think that all group members felt responsibility for accomplishing the group task.
I think that we have set acceptable deadlines for completing the task.
Most group members managed their group obligations on time.
Discussion in our group was chaotic and disorganized.
In our group, we usually quickly agreed on what we needed to settle.

There is already empirical evidence that between selected components of CSCL exist strong relations (see for example [9], [14] or [26]. Therefore, it was expected that the factor analysis would combine some of input components together, e.g. there would be no difference between them from the statistical point of view. In reality, however, the factor analysis rearranged the measured statements into new units. It is therefore necessary to inductively derive the meaning of final components from the advice of newly grouped statements. The principle of factor analysis suggests that every final component should expresses one specific issue of collaborative learning within the context of an educational simulation game.

The first final component indicates the level of a student's identification with his or her group, which means a certain subset of a component initially considered to be labeled as 'socio-emotional interaction'. This partial result suggests assumption that social interactions promoting 'sense of community' are the most prominent within learning groups. This is in accordance with the theoretical concept of *social identity*, which is based on an individual's knowledge that he or she belongs to a certain social group and that it means certain consequences [15, 26]. The impact of this social identity component could be crucial, because the direct effect of an identification process is the acceptance of group rules and norms [13]. Additionally, according to a model described in [27] social identity influences group cohesion, group norms of collaboration, social accountability of group members and the overall level of cooperation between group members.

The second final component confirms the significance of *helping behavior* and *promotive interaction* that lead to a friendly group atmosphere. The third final component then fits into the concept of *shared mental models*. Is it because statements within this final component display awareness of important group aspects and existence of rules according to which group members behave. It is also in accordance with a two-dimensional model in [14] explaining why learners are willing to join a CSCL process – the explanation is that it is norms of collaboration and task conflict that are crucial for effective group learning. The meaning of the fourth final component is quite obviously the *mutual performance monitoring*.

The situation in the last final component is the most complicated as there are eight statements initially considered for six other CSCL components. Accountability, positive interdependence, mutual trust, time management, competencies as well as flexible communication are mixed here. What does it mean? Consistent attitudes to these statements told us that group members were reliable, responsible, competent, communicative and organized. Briefly, it is possible to say that they were disciplined toward group work. This approach is very close to the component of *team orientation* from the "Big Five" model. Authors declare that "team orientation is not only a preference for working with others but also a tendency to enhance individual performance through the coordination, evaluation, and utilization of task inputs from other members while performing group tasks" [28]. Although team orientation was not expected to be a subject of testing, the results of the factor analysis indicate that it is this component which should be considered as the one of the core components of computer-supported collaborative learning.

5. Conclusion

It is necessary to consider some limitations of this research such as the simulation game environment of learning groups or not such a high quantity of rows in the data matrix. The results, therefore, suggest existence of at least five distinctive core components of CSCL, which should not be omitted during research of long-lasting educational group activities with computer support. Namely they are *social identity*, *helping behavior*, *shared mental models*, *mutual performance monitoring* and *team orientation*. The social dimension is strongly represented here, as not only social identity but also helping behavior builds on emotional relationships between members. The outcome interpretation on the general level is that for an efficient learning group in CSCL settings students have to identify themselves with theirs group, set up and adhere group norms, prioritize work for group instead work on their own and monitor, support and help each other. Other input components such as positive interdependence, mutual trust, closed-loop communication, time management, etc. will probably be subcomponents with some relationship to these core components. This should be the topic of follow-up research with more accurate measuring.

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