Facilitating Transactive Memory System (TMS) through Computer Supported Collaboration Script in Multidisciplinary Learning

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Abstract

Establishment of Transactive Memory System (TMS) among group members in multidisciplinary collaborative learning is vital in collaborative learning environments. Online platforms e.g. ICT-tools or Computer-supported Collaborative Learning (CSCL) has the potential for facilitation of TMS. This study investigates the extent to which establishment of various dimensions of TMS (specialization, coordination, credibility) is facilitated using computer-supported collaboration script i.e. transactive memory script. A pre-test, post-test design was used with 60 learners who were assigned in pairs based on disciplinary background and randomly divided in treatment condition or control group. The results shows that transactive memory script in form of question prompts not only facilitate establishment of TMS dimensions but also improve learners' satisfaction with learning effects, subjective learning experience, and performance.

Keywords: CSCL; multidisciplinary; transactivity; transactive memory system; transactive memory script

Introduction

Much attention has been given to learning processes and outcomes within multidisciplinary groups to prepare learners to adjust to and cope with today's complex issues. The main advantage of multidisciplinary learning is that learners from different background take advantage of one another complimentary expertise and bear on a problem from various perspectives and viewpoints. Although various viewpoints on a problem can be productive (Vennix, 1996), scientific evidence, however, indicates that multidisciplinarity is not always an advantage (e.g. Barron, 2003). The reason is that individual members of multidisciplinary groups need to establish a common ground which is vital to group performance but difficult and time consuming process to achieve (Courtney, 2001). Learners may thus engage in non-productive discussing such pieces of information that may already be known to all members from the start (Stasser & Titus, 1985). Hence, after extended periods of working together, they may start working efficiently on pooling their unshared knowledge. Speeding up process of pooling unshared information would be best achieved when group members have meta-knowledge about expertise and knowledge of the learning partners (Moreland & Myaskovsky, 2000), that is, Transactive Memory System (TMS, Wegner, 1987 & 1995). Virtual environments e.g. ICT-tools or Computer Supported Collaborative Learning (CSCL) play a key role in terms of potentials for establishment of TMS. Therefore, the purpose of this study is to examine the extent to which the establishment of TMS could be facilitated in multidisciplinary groups using computer-supported collaboration script i.e. transactive memory script. In addition, we examine the effects of this script on learners' satisfaction with the learning effects and subjective learning experience and performance.

Theoretical Framework

Following Wegner's (1987) about TMS, in collaborative learning, group members work best when they encode, store, and retrieve information distributed in the group. The TMS in a group comprises group members' views in terms of awareness of one another knowledge, the accessibility of that knowledge, and the extent to which they take responsibility for providing knowledge in one's own area of expertise (Lewis, 2003). That is why in scientific literature much attention has been given to the three dimensions of TMS including specialization, coordination, and credibility (Lewis, 2003). Specialization represents awareness and recognition of expertise distributed among group. Coordination represents group members ability to work efficiently on a task with less confusion, fewer misunderstandings but greater sense of collaboration. Credibility or trust represents the degree to which group members trust and rely on each other's expertise while collaboration (Michinov & Michinov, 2009). Much research has explored the role of TMS in organizational (e.g. Austin, 2003) and educational settings (e.g. Lewis et al., 2005). They report positive impacts of TMS on group performance (see Moreland et al., 1996; Stasser et al., 1995). For example, study by Michinov & Michinov (2009) showed positive relationship between TMS and performance essentially on coordination and specializations. In study by Lewis et al. (2005), TMS positively influenced group performance and learning transfer. In another study by Lewis (2004) with 261 members, positive relationship between TMS with team performance and viability were achieved.

Despite the vast research on TMS, no study has explicitly investigated the role of various stages of TMS (i.e., encoding, storage, retrieval, and integrative processes) in online learning environments. This is striking since virtual environments e.g. ICT-tools or online support systems for collaborative learning allow for embedding and representing various representational structures to facilitate establishment of TMS among group members. In online learning platforms, individuals knowledge, expertise, and resources can be shared among group members and be represented in a graphical implementation in form of schemes (Ertl et al., 2008), tables (Suthers & Hundhausen, 2003) or visualizations (Fischer et al., 2002) or in a textual implementation in form of cues or prompts (Ge & Land, 2004) or scripts (Weinberger et al., 2005 & 2007). These types of learning arrangement have been named CSCL and are seen as a promising context in which to facilitate collaborative learning (e.g. Rummel et al., 2009; Stegmann et al., 2007). Therefore, we implement a particular transactive memory script in an online learning platform to facilitate the establishment of TMS. We also measure the effects of this script on learners' satisfaction, experience, and performance.

Method

Context, Participants, and Procedure

Participants were 60 master students with two disciplinary backgrounds i.e. international water management and development studies at Wageningen University. Each pair was randomly assigned to one of the treatment condition or control group. The subject of the learning environment was the concept of "Community-Based Social Marketing (CBSM) and its application in Sustainable Agricultural Water Management

(SAWM). The task of the participants was to apply the concept of CBSM in fostering sustainable behaviour among farmers in terms of SAWM.

The experiment took 3,5 hr. with 4 phases including (1) introduction and pre-test phase (35 min), (2) individual phase (40 min), (3) collaborative phase (90 min), (4) post-test and debriefing phase (45 min) (see Table 1). An asynchronous text-based discussion board called "SharePoint" was customized for the purpose of our study. In control group, learning partners received no further support beyond being asked to analyse and discuss the problem case on the basis of the conceptual space and to type their arguments into a blank text box. Building on Wegner (1987), we expanded transactive memory script over three phases: encoding, storage, retrieval. For each phase, specific types of prompts were embedded in the platform. In encoding phase, learners were given 10 min to introduce themselves, compose a portfolio of their expertise, and indicate what aspects of their expertise apply in the given case. In storage phase, they were given 15 min to read the portfolios and discuss the case with the goal to distribute task in the group. In retrieval phase, the group members were supposed to analyse and solve part of the task from their expertise perspective in 15 min. They were subsequently given 40 min to reach to an agreement by discussing and sharing their individual solutions.

Measurements, instruments, and data sources

Measurement of TMS: We adapted a questionnaire from Lewis (2003) to assess TMS (see Table 2). This questionnaire included three dimensions of TMS with 15 items on a five-point Likert scale ranging from "strongly disagree" to "strongly agree". The reliability and validity of this scale have been reported adequate in various contexts. In this study, the reliability was sufficiently high for all dimensions of TMS i.e. specialization, coordination, and credibility (Cronbach α = .83, .85, and .88 respectively).

Measurement of learners' satisfaction with the learning effects and subjective learning experience: We adapted a questionnaire from Mahdizadeh (2008) to assess these items (see Table 3). This questionnaire comprised five sections and 32 items on a five-point Likert scale ranging from "almost never true" to "almost always true". The first section (10 items) assessed learners' Perceived Effects of Learning. The second section (4 items) captured learners' Attitude toward Computer-Assisted Learning. The third section (3 items) collected information on learners' opinion on the Ease of Use of Platform. The fourth section (4 items) assessed learners' Satisfaction with Learning Effects. The last section (11 items) collected information on learners' Appreciation of the Learning Materials. Cronbach Alpha was sufficiently high (around .90) for all five categories.

Measuring learning performance. Individual written analyses prior to and after collaboration for problem cases were analysed based on expert solutions. Two trained coders assigned marks for learners' analyses in the pre-test and post-test on a five-point Likert scale ranging from "very poor solution" to "very good solution" based on similarity of learner's solution with expert solutions. Both inter-rater agreement and intra-coder test-retest reliability were reported satisfactory. The difference in the scores from pre-test to post-test (M = t2-t1) was served as indicator for learning performance. The reliability coefficient was good for both pre-test and post-test (α = .81, .91 respectively).

Results

The effects of transactive memory script on three dimensions of TMS

The average scores for all three dimensions of TMS were higher for learners in treatment condition than for learners in control group. The difference between specialization means was significant, $F(1, 55) = 29.55$, $p < .01$, with treatment condition (M = 4.62, SD = .36) scoring higher than control group (M = 3.88, SD = .62). The difference in credibility means was significant, $F(1, 55) = 29.82$, $p < .01$, treatment condition (M = 4.64, SD = .49) scoring higher than control group (M = 3.93, SD = .43). Coordination means also differed significantly, $F(1, 55) = 12.41$, $p < .01$, treatment condition (M = 4.37, SD = .58) scoring higher than control group (M = 3.77, SD = .66). Figure 1 depicts these results.

The effects of transactive memory script on learners' satisfaction with the learning effects and subjective learning experience

The average scores for all dimensions of these items were higher for learners in treatment condition than for learners in control group except for the ease of use of platform. The difference between means for Perceived Effects of Learning $F(1, 55)$ = 30.22, $p < .01$, Web-Assisted Learning Attitude $F(1, 55) = 10.35$, $p < .01$, Learning Satisfaction $F(1, 55) = 4.88$, $p < .05$, and Appreciation of the Materials $F(1, 55) = 35.49$, $p < .01$, were significant, with treatment condition ($M_{PE} = 4.44$; $SD_{PE} = 0.49$; $M_{WA} = 4.32$; $SD_{WA} = 0.76$; $M_{LS} = 4.38$; $SD_{LS} = 0.62$; $M_{AM} = 4.51$; $SD_{AM} = 0.32$) scoring higher than control group ($M_{PE} = 3.62$; $SD_{PE} = 0.59$; $M_{WA} = 3.63$; $SD_{WA} = 0.79$; $M_{LS} = 3.99$; SD_{LS} = 0.69; $M_{AM} = 3.74$; $SD_{AM} = 0.57$). No significant difference was reported for average scores of learners in control group condition (M_{MA} = 4.10, SD_{MA} = .87) compared with learners in treatment condition (M_{MA} = 4.30, SD_{MA} = .82) regarding Ease of Use of Platform $F(1, 55) = .79$, $p = .37$. Figure 2 depicts these results.

The effects of transactive memory script on learning performance

The scores for learning performance of all learners improved significantly (F = 277.65; $p < 0.01$; M_{T1} = 1.34; M_{T2} = 2.68) from pre-test to post-test. Gain of knowledge for learners under treatment condition (M_{T1} = 1.35; M_{T2} = 2.93) was higher than that of learners in control group (M_{T1} = 1.32; M_{T2} = 2.43), F = 8.43; $p < 0.01$. Learners in both conditions did not differ significantly regarding their pretest scores (F = .08; p = .78). Both collaborative conditions improved learning performance, but this improvement was higher for learners in treatment condition than learners in control group (see Figure 3).

Conclusion, Discussion, and Scientific Significance of the Study

Despite the vast research on TMS and its effects on collaborative learning, no research on multidisciplinary context yet reported the use of transactive memory script for facilitation of TMS in online learning platforms. Based on our study, using transactive memory script can positively foster the establishment of dimensions of TMS (specialization, credibility, and coordination) in an online learning environment. This facilitation of TMS in the treatment condition not only resulted in higher scores for learners' satisfaction with learning effects than in control group condition, but also learning experience and performance.

Following step-by-step guidelines by learners in treatment condition helped them to label information of one another expertise domains, to store information with the appropriate individuals who had the expertise and to discover and retrieve needed information by each individual when collaboration (Rulke & Rau, 2000). Learners with transactive memory script could coordinate the process of problem-solving by assigning and acceptance of responsibility to the individual who had the most expertise in group. They then made sure that no information would be missed by the group if learners trust one another by sharing responsibilities for part of task that they have the most expertise (Rulke & Rau, 2000). In final stage, question prompts helped learners to retrieve required information by discovering and associating the label of information with sources of expertise from the expert who had the stored information (Wegner, 1987).

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Table 1: Overview of the procedure of the experimental study

(1)	***Introduction and pre-test phase***	*Duration*
	Introductory explanations	5 min
	Assessment of personal data (questionnaires)	10 min
	Assessment of collaboration and computer experiences, learning style, argumentation skill etc. (questionnaires)	20 min
(2)	***Individual learning phase***	
	Introductory remarks	5 min
	Individual study phase of the theoretical text (conceptual space and problem case)	15 min
	Pre-test of domain-specific prior knowledge (individual analysis)	20 min
(3)	***Collaborative learning phase***	
	Introduction to the CSCL platform	5 min
	Explanation of the procedure	5 min
	Collaborative learning phase (online discussion)	80 min
(4)	***Post-tests and debriefing***	
	Individual analysis of the problem case	20 min
	Assessment of satisfaction with the learning effects and subject learning experience	20 min
	Debriefing	5 min
Total time		**about 3.5 hr**

Table 2: Transactive Memory System Scale Items

Specialization	Each team member has specialized knowledge of some aspect of the case. I have knowledge about an aspect of the case that my partner has. Different team members were responsible for expertise in different areas. The specialized knowledge of my partner was needed to complete the task. I now know what expertise and specific areas my partner has.
Credibility	I was comfortable accepting procedural suggestions from my partner. I trusted that other partner' knowledge about the case was credible. I was confident relying on the information that my partner brought to the discussion. When my partner gave information, I wanted to double-check it for myself. (reversed) I did not have much faith in my partner "expertise." (reversed)
Coordination	Our team worked together in a well-coordinated fashion. Our team had very few misunderstandings about what to do. Our team needed to backtrack and start over a lot. (reversed) We accomplished the task smoothly and efficiently. There was much confusion about how we would accomplish the task. (reversed)

Table 3: Measurement for learners' satisfaction with the learning effect and subjective learning experience

Perceived Effects of learning	It motivated me to learn It provided useful social interaction It broadened my knowledge It improved my communication skills It improved the quality of my learning It had added value for students It was suitable for my learning It made me more interested in the topic It motivated me to do good work It helped me to learn a lot from peers
Web-assisted Learning Attitude	The quality of student learning is improved by using computers The quality of student learning is improved by using the platform I really enjoyed using platform to support my learning I really enjoyed using the platform to support my learning
Ease of Use of the Platform	Using the platform was easy Working with the platform was clear and understandable It takes only a short time to learn how to use the platform
Satisfaction with learning	I am satisfied with my learning while performing learning task I am satisfied with working in group while performing learning task I am satisfied with the discussion of our group I am satisfied with sharing my knowledge with my partner
Appreciation of the Materials	I enjoyed studying the materials I learned a lot from the materials The content of the learning materials was clear and understandable The time allocated for reading the learning materials was good enough The information in the learning materials raised my motivation to study The exercises have been clearly formulated The feedback given on my answers was clear Activities during the exercise session gave me insight into what was expected from me The questions and activities during the exercise session raised my motivation to study The explanation in this material helped me to understand important concepts Overall rating of the material and exercise

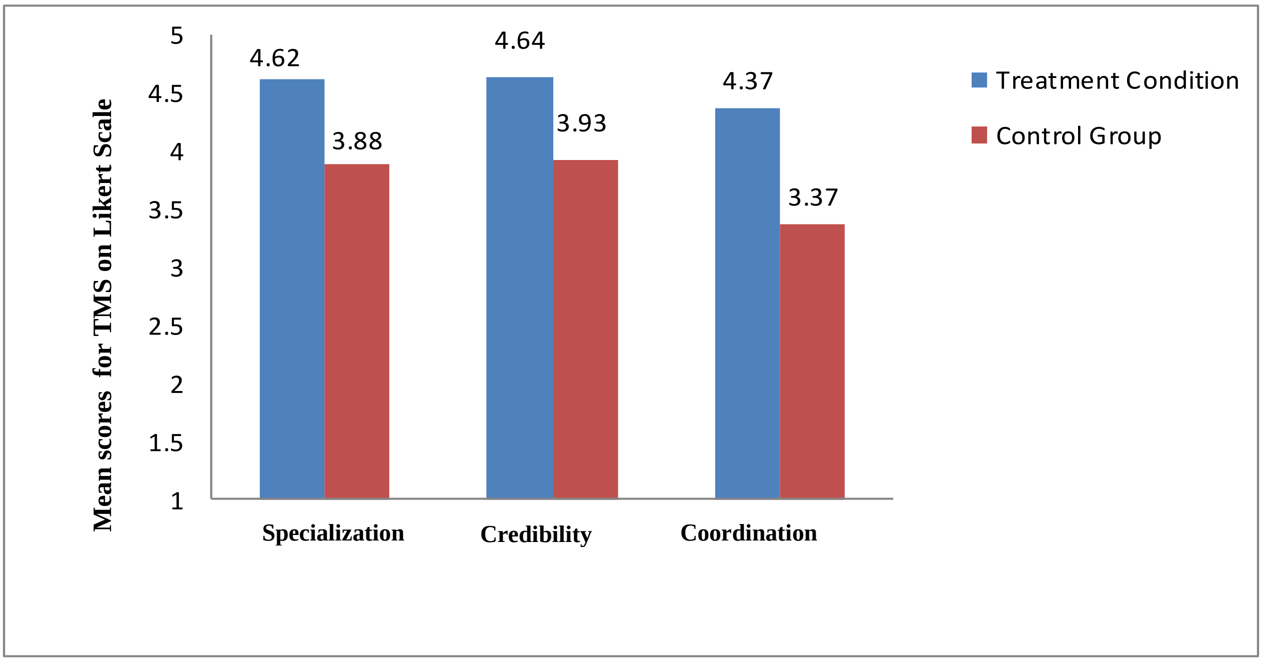

Figure 1: Mean score of learners for three dimensions of TMS in treatment condition and control group.

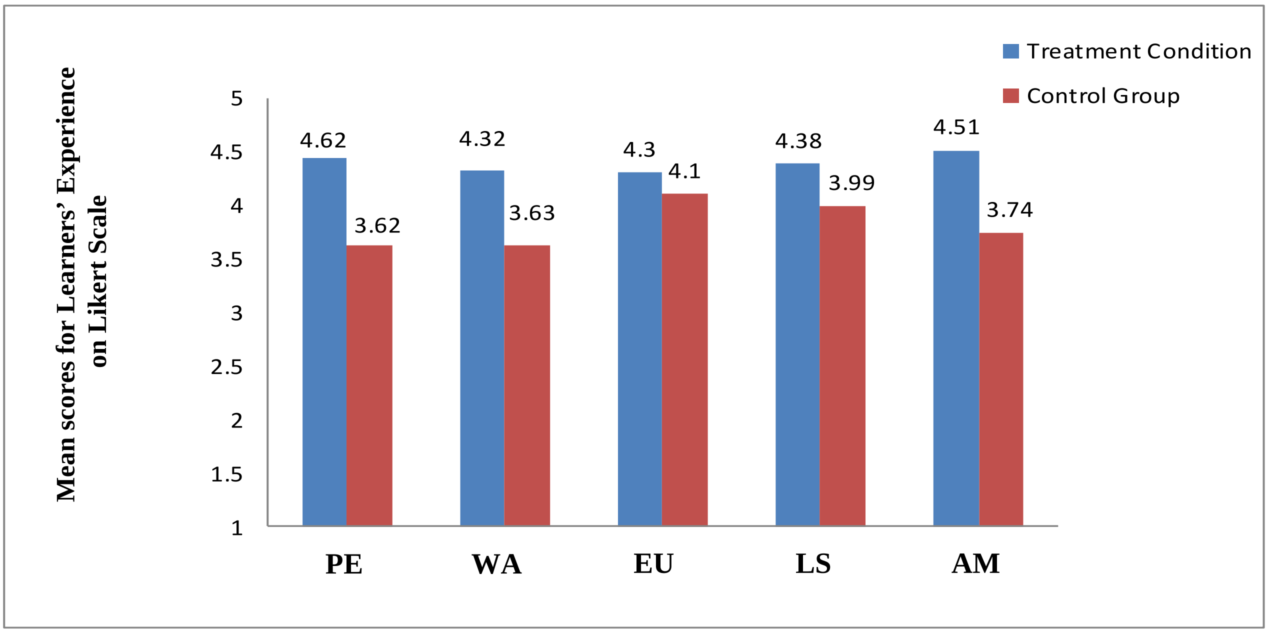

Figure 2: Mean score of learners' satisfaction with the learning effect and subjective learning experience in treatment condition and control group. PE=Perceived Effects of Learning; WA= Web-Assisted Learning Attitude; EU=Ease of Use of the Platform; LS= Learning Satisfaction; AM= Appreciation of the Materials.

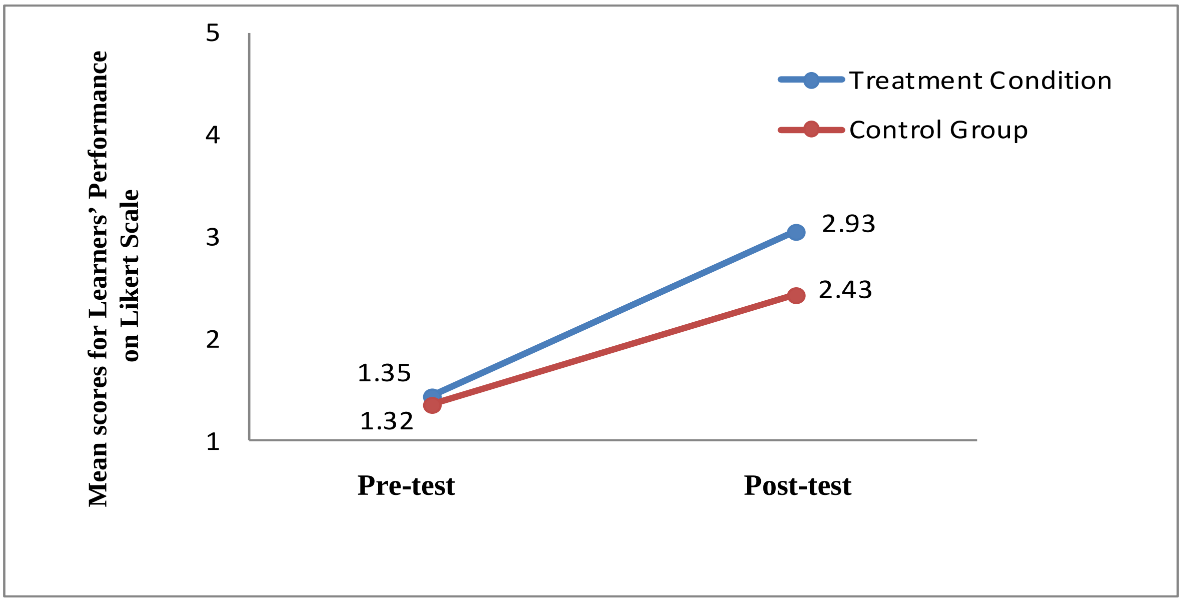

Figure 3: Mean score of learners' performance in treatment condition and control group.