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Introducing Computer-Supported Team-Based Learning: Preliminary Outcomes and Learning Impacts

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ABSTRACT

Team-based learning (TBL) is an active learning instructional strategy used in the traditional face-to-face (FtF) classroom. Computer-mediated communications (CMC) is a medium that complements the FtF classroom and enables active learning between FtF class times. This paper introduces a model for assessing computer-supported team-based learning that leverages a combination of collaborative learning techniques, extending them to an on-line environment through the use of CMC tools. The model has been empirically tested through field studies in the course of two semesters at a US public technological university. The empirical findings of this paper indicate perceived learning with computer-supported TBL is higher than perceived motivation, enjoyment and learning in traditional CMC-supported courses. In addition, our findings show that perceptions of team members' contributions impact individual learning experiences. Computer tools successfully facilitate team interactions, peer assessment, and individual accountability in achieving higher-level learning.

1. INTRODUCTION

Instructors of both traditional face-to-face (FtF) and online classrooms seek active learning techniques that engage the learner. Nowadays, the increased use of computer-mediated communications (CMC) as a computer support tool supplements the FtF classroom ("blended learning") to enable active learning between FtF class times. CMC is regarded as an efficient computer support tool to facilitate student participation (Phillips and Santoro, 1989). Prior research (Wu and Hiltz, 2004) reports that adding asynchronous online discussions through CMC platforms enhances students' learning quality in a FtF class setting. Although various CMC-based learning strategies have been applied in the field, e.g., online collaborative learning, limited research focuses on computer-supported team-based learning (TBL) in a FtF classroom. TBL is an instructional strategy that promotes active learning in small groups that form a team over time (Michaelsen et al., 2002).

Our goal is to assess the impact of the introduction of TBL in a face-to-face classroom that utilizes CMC as a supplemental learning tool between classes, thus increasing team interaction across the semester. A CMC platform called WebBoard™ was utilized in our computer-supported TBL research to facilitate team learning activities. This paper begins with a literature review which buildings on constructivist learning theory and small group theory. We provide an example on our computer-supported TBL implementations and then introduce our framework for assessing computer-supported TBL. As part of the framework, our research questions, hypothesis and test methods are presented including a brief data analysis and concluding with a summary and the direction of future research.

2. THEORETICAL BACKGROUND

2.1 Constructivist Learning Theory

Leidner and Jarvenpaa classify learning models and discuss their relevance and impact in information systems educational approaches (1995). The broadest categories of this classification are objectivism and constructivism. Objectivism posits that learning occurs in response to an external stimulus. Learners respond to the stimulus by modifying their behaviors. This model assumes that abstract representations of reality and knowledge exist independently from the learners. Teaching consists of transferring knowledge from the expert to the learner. Opposite to objectivism, constructivism posits that learning is not a process of knowledge assimilation but an active process of constructing individual mental models, in which knowledge is created in the mind of the learner. In this model each individual controls the pace and depth of his/her instruction. The instructor is only a moderator in the process of hypothesizing, questioning and discovering the conceptual relationships between and among various objects.

Team-based learning uses a constructivist approach which converts the learner from a passive to active learner. This differs from the traditional teacher-learner or objectivist approach. Students in this constructivist learning environment play a more active role as learners, since they need to be well-prepared in order to effectively engage in various class activities, e.g. to facilitate class discussions, to be able to take challenges from their peer learners and instructors etc. Therefore, the constructivist approach is aimed to facilitate students' critical thinking to achieve higher-level learning.

This research explores how the constructivist approach can be utilized to promote team-based learning in a computer-supported environment. Building on experiences from FtF TBL teaching (Michaelsen et al., 2002), computer-mediated communication (CMC) is adopted to expand the collaboration opportunities via online team activities between weekly classes. Suitable technologies used in this context are listservs (email distribution lists with a Web-based interface) and asynchronous learning network (ALN) systems (e.g., WebBoard or similar technologies provide both a synchronous and an asynchronous discussion environment).

2.2 Small Group Learning and Team-Based Learning

The importance of small groups learning and knowledge creation has been increasing in both education and industry. TBL focuses on fixed small groups, which are established for semester long collaboration instead of temporary purposes. Small groups promote each other's learning and success by holding each other personally responsible for the fair share of the work (Johnson, 1991). This turns the learning experience into a process, which improves the quantity and quality of the learning by leveraging long-term caring and peer relationships (Johnson, 1999). TBL simulates the similar peer collaboration experience in a real world. Therefore, the team-based learning experience may represent a useful training for students' long-term career success.

The main emphasis of TBL is the organization around modules (work units) across the semester, consisting of 5-7 three phase sequences (Michaelsen et al., 2002). Each sequence includes preparation, application and assessment before moving to the next unit. Teams should be 5-7 members in size. They evolve through four essential procedures: team formation, student accountability, team activities, and high quality feedback (Michaelsen et al., 2002). Our research uses these four procedures as the basis for the introduction of computer-supported techniques.

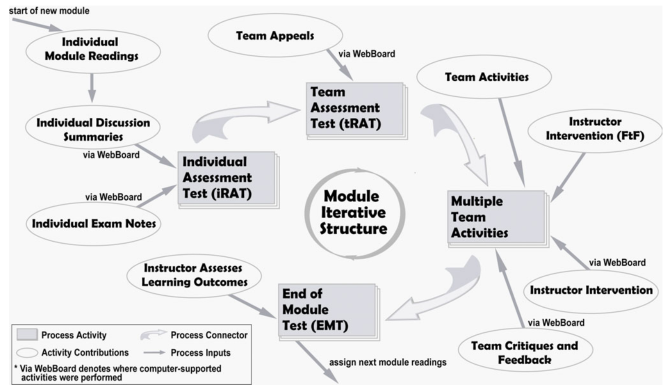
3. AN EXAMPLE OF COMPUTER-SUPPORTED TBL IMPLEMENTATIONS

Computer-supported team-based learning in a FtF environment was introduced in a graduate course at a US public technological university during the Fall 2004 and Spring 2005 semesters. The graduate courses met weekly in a FtF classroom setting across a 15 week semester, and leveraged asynchronous learning network (ALN) WebBoard system for active learning activities outside of the FtF classroom between weekly classes. An end-of-semester survey completed by students measured motivation, perceived value of team member's contribution, and perceived learning along with open-ended questions. Peer evaluations were also conducted at the end of the semester.

The course was re-modeled, according to Michaelsen et al. (2002), with several steps modified to incorporate the use of computer-supported tools progressively across the two semesters of the study (Gomez and Bieber, 2005). For example, students posted preparation materials on WebBoard in the first semester. In the second semester, teams posted results of their work on WebBoard instead of handwriting on posters. The instructor acted as a facilitator, who is responsible for hypothesizing, questioning and discovering the conceptual relationships between and among various concepts (Passerini and Granger, 2000), and focused more time on preparation of the readiness assessment tests (RAT) and team activities. The RAT is a two-step process with the student taking the exam individually followed by the team taking the same exam. These two forms of preparation ensure both individual and team readiness before advancing to the deeper learning team activities. Constructivism posits that reality differs for each individual, who controls the pace and depth of his or her own learning. Learners thus are active participants of the instructional process. An iterative process called for adjustments from module to module based on observations in the class.

The first class period introduced the computer-supported TBL instructional strategy. The class was divided into teams of five to six students, including at least one women and at least one student with a wireless laptop. The course materials were divided into six modules, with no midterm or final. Two out-of-class individual article reviews were assigned to the students.

Figure 1. Computer-supported TBL events



TBL's iterative structure (figure 1 below) caused a considerable amount of reading material to be assigned at the start of each module. Students needed to structure their time to read all of the materials before the start of a new module in preparation for the individual readiness assessment test (iRAT). Two additional tasks in preparation for the iRAT were online WebBoard summaries of the reading materials and one page of notes to be used for the iRAT and team readiness assessment test (tRAT). These tasks were completed during the week in the on-line course environment on Webboard.

The purpose of the iRAT was to determine individual readiness before engaging in the tRAT and associated team activities that built upon the module's contents. The iRAT and tRAT were the same multiple choice exam where students were tested primarily at the conceptual level. After the tRAT, teams were permitted to appeal any question they deemed ambiguous for a grade adjustment.

Multiple team activities were assigned after the tRAT process. After each team activity, deliverables were reviewed and critiqued by the other teams possibly for extra credit. The review and critique occurred in the FtF classroom for the first semester and using WebBoard for the subsequent semester. The premise was to deepen the learning and reinforce the objectives of the activity, while providing the instructor an opportunity to comment. Additionally, an end-of-module test (EMT) was introduced to assess learning outcome. Figure 1 summarizes the TBL iterative process and where computer-supported activities were introduced in this study.

4. A FRAMEWORK FOR ASSESSING COMPUTER-SUPPORTED TBL

In exploring the relationships and impacts of computer-supported TBL, we focused on a number of factors that could impact students' perceptions of learning. We adopted and modified a few validated constructs—"perceived learning," "perceived motivation" and "perceived enjoyment"—from asynchronous online discussion research (Wu & Hiltz 2004). In addition, we created two new constructs called "individual preparedness to computer-supported TBL" and "perceived team members' value/contributions." The overall computer-supported TBL research framework (and the results from the analysis) is shown in Figure 2. More specifically, we expect that the collaboration experiences and team-based activities completed by the teams throughout the courses will have a positive impact on perceived learning. Individual preparedness, measured as a self-reported student assessment of their deep versus superficial study of the materials, will positively impact the perceived value and contribution of the team-learning experience. This assumption follows Michaelsen et al.'s (2002) findings that individual contributions to team-output will promote team development and reduce social loafing and, therefore, will have a higher impact on the overall team-based learning experience.

Prior research (Wu & Hiltz, 2004; Wu et al., 2004) shows a positive correlation between perceived motivation, enjoyment and learning, when students participate in designing, answering and grading exam questions on an ALN tool. These findings occur in the context of students' learning experience from online discussions through CMC platforms for blended classes, which mixed traditional classroom lecturing with asynchronous online discussions.

Individual preparedness and perceived member contribution to computer-supported TBL are expected to have a positive impact on learning, as well as on motivation and enjoyment of the TBL experience. In particular, motivation and enjoyment will act as intervening variables (see Figure 2). We also expect motivation to positively impact the overall enjoyment of the team-based learning exercises. Following Thorndike's "Law of Intensity" and "Law of Readiness" (Thorndike, 1932), we expect that students who are engaged in the learning process through the multiple collaboration experiences embedded in the course organization, will be more motivated to learn, and will enjoy the learning experience better.

Lastly, we expect that the independent variables of individual preparedness, perceived team member value and contribution to computer-supported TBL will impact the level of trust and openness of communication within the teams, indirectly influencing communication and enjoyment. Establishing trust early (swift trust) in on-line communities has been found to have a positive impact (Coppola et al., 2004) on the learning experience. While we do not report results on trust measures (further analysis and reiteration are needed as trust measures were collected only in the Spring 2005 reiteration of the field study), we include trust and communication as an important variable to consider in a computer-supported TBL model, which will be influenced by the individual preparedness and team contributions. As discussed in the future research section of this paper, additional observations in the Summer and Fall semester 2005 will supplement our preliminary observations.

4.1 Research Questions and Hypotheses

Based on the above discussion, our research is set out to investigate the following general questions:

1. Does students' perception of team contributions impact their learning from the computer-supported TBL process?
2. Does individual preparedness affect perceptions of computer-supported TBL experiences?

A number of research hypotheses are therefore derived from the proposed research framework (see Figure 2).

Hypothesis 1a&b: Higher individual preparedness will increase students' perceived motivation and enjoyment from computer-supported TBL process.

Hypothesis 1c: Higher individual preparedness will increase the perception of team members' value and contribution to the computer-supported TBL process.

Hypothesis 2a&b: Higher perceived team members' contributions to computer-supported TBL will increase perceived motivation and enjoyment from this process.

Hypothesis 2c: Higher perceived team members' contributions to computer-supported TBL will enhance perceived learning in this process.

Hypothesis 3a&b: Higher perceived motivation will lead to higher enjoyment and learning from the computer-supported TBL.

Hypothesis 4: Higher perceived enjoyment from the computer-supported TBL will lead to higher learning.

4.1.1. Methods and Sampling. To test the hypotheses, survey questionnaires were used in the same masters-level information systems course called "Information Systems Principles" during Fall 2004 and Spring 2005 semesters. A total of 73 students volunteered to participate in our computer-supported TBL study. Among 73 respondents, sixty-one students disclosed their demographic information. Over 50% of them are full-time students, about 33% are part-time, and the rest are non-matriculated students, who are studying without officially being admitted to degree programs. About 60% are males, 36% are females, and three people did not provide their gender information. The majority of the respondents are between 21 to 30 years old, about 16% are between 31 to 40 years old, and the rest are between 41 to 50 years old.

4.2 Data Analysis and Discussion

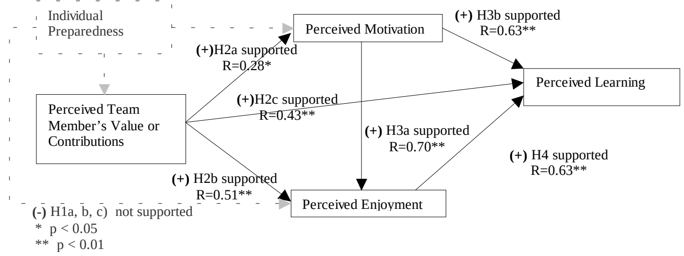
In this study, the majority of data was collected from the surveys, which covered all variables proposed in the computer-supported TBL research framework (Figure 2). The results of the survey questionnaires were used to evaluate the validity of the constructs and the reliability of the scale used in the study. All the constructs returned a Cronbach's Alpha higher than 0.70.

Bivariate correlation analyses were run to identify relationships. Based on the results of the bivariate correlations, we found that hypothesis 1 (a, b, and c) is not supported. The other hypotheses are supported at the p=0.01 (**), with the correlation between team contributions and motivation significant at the p=0.05 (*) level (see figure 2 below).

The data analysis suggests that how individuals value their team members' contribution has significant correlations with their perception of enjoyment and learning quality from the computer-supported TBL. These results address the first research question on how team interactions positively impact the whole computer-supported TBL learning experiences. In addition, individual opinions on team members' contributions also have a positive impact on their perceived motivation from the computer-supported TBL, although the Pearson's R value is not high (R = 0.28). It might be caused by other potential factors from the computer-supported TBL experience, which could decrease students' motivation. For instance, if the team leader is more dominant, his control might impact other team members' motivation.

In our study, individual preparedness does not impact perception of the computer-based TBL experience. The correlation values among individual preparedness and other variables are not significant. The results also show that their correlation values are negative. There might be a few reasons. First, because this study is an exploratory study, the "individual preparedness" construct may not be well-designed (fact that may explain the diverse distribution of students' responses). Second, there might be an interaction effect of the experimental conditions: the computer-supported TBL process design itself might greatly impact the results. The team assessment tool (tRAT) is the same test as the individual readiness assurance test (iRAT). Although the overall team scores are better than individual test scores, the test repetition (*instrumentation bias*) may explain the decrease in the students' motivation and enjoyment of computer-supported TBL. Alternatively, this simply may indicate that many students found the computer-supported TBL process valuable even when they did not prepare as the instructor expected. These results show that our second research question on the role of individual preparedness needs further investigation and analysis.

Figure 2. Computer-supported TBL bivariate correlation results



5. SUMMARY AND FUTURE RESEARCH

Computer-supported TBL learning provides a powerful instructional experience and reduces some of the disadvantages many instructors and students have found with traditional small-group work. Blending the benefits of the face-to-face classroom with computer-mediated communication extends the learning process between the weekly face-to-face sessions keeping the team learning progress and group dynamics growing.

Our research places emphasis on key variables that affect learning in computer-supported TBL. Computer-supported TBL is still a relatively new pedagogical approach, and to the best of our knowledge, this is the first study blending CMC with the iterative TBL modular approach proposed by Michaelsen (2002). The use of CMC learning techniques places emphasis on individual and team learning outcomes. The surveys indicated a high-perception of learning, motivation, and enjoyment. These findings have deemed computer-supported TBL an approach for further investigation both in the FtF classroom and for online learning.

The emphasis of future research will be on team-assessments and group cohesion in a purely online learning environment. The findings around the team activities will allow for additional adjustments in the TBL process before it is introduced in a completely online learning mode. Blending the FtF class with CMC provided a means to gauge the ALN process. Future studies will extend the analysis of the computer-supported TBL model and research framework using the structural equations model (SEM), trust, communication, and team leadership factors. Further review of individual and team preparedness is also needed. The progressive nature of the readiness exam process and team activities should ensure individual preparation. Further content analysis of team activities posted on WebBoard can support the evaluation of individual preparedness for each module. Actual grades and peer evaluation results will also support the measurement of task completion levels.

Team-based learning presents a promising technique employing small teams that actively engage students in learning. We look forward to the day when instructors can effectively use computer-supported TBL as a standard approach in both face-to-face and online classrooms.

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