Computers & Education 55 (2010) 378–390

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Computer-supported team-based learning: The impact of motivation, enjoyment and team contributions on learning outcomes

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ARTICLE INFO

Article history:
Received 18 April 2009
Received in revised form 1 February 2010
Accepted 5 February 2010

Keywords:
Team-based learning
Computer-mediated communications (CMC)
Learning outcomes
Collaborative learning

ABSTRACT

The benefits of teamwork and collaboration have long been advocated by many educational theories, such as constructivist and social learning models. Among the various applications of collaborative learning, the iterative team-based learning (TBL) process proposed by Michaelsen, Fink, and Knight (2002) has been successfully used in the classroom without computer support. This paper describes the implementation and evaluation results of a classroom application of the TBL process, which was modified to include computer mediation. We call this process computer-supported team-based learning (CS-TBL). This work extends learning in small teams from the traditional classroom to the hybrid classroom where students meet both face-to-face and online by emphasizing the importance of online team interactions. The outcomes are assessed through an evaluation model that considers the impact of motivation, enjoyment and team contributions on learning outcomes. The study results indicate that motivation influences the relationship between team interactions and perceived learning. Enjoyment is affected by motivation and perceptions of team members' contributions, with the implication that students who perceive that the team interactions are adding value to their education will better enjoy learning and will experience higher-level learning outcomes.

1. Introduction

Working in teams deepens the learning experience and promotes active learning (van Offenbeek, 2001). Team-based learning (TBL) is an instructional strategy defined by Michaelsen et al. (2002) that extends the business-world practice of working in teams to the classroom (Gomez, Wu, & Passerini, 2009; Michaelsen et al., 2002). In TBL environments, small student teams work together for the entire semester, use class time to discuss readings, solve problems, and apply concepts initially learned through individual reading assignments. TBL shifts the focus away from classroom lecturing by the professor to the in-class application of principles by student groups. A key aspect of Michaelsen's TBL is that lecturing is completely eliminated from traditional courses. To-date, Michaelsen's traditional TBL model has been deployed and evaluated essentially in face-to-face (FtF or on-campus) classrooms. In this study, we introduce computer-mediated tools and techniques to TBL by extending specific team interactions online, outside of the physical classroom. The results of this extension are evaluated and discussed.

The paper is organized as follows. In the next section, Michaelsen's TBL process is highlighted, followed by a discussion of its adaptation to an online learning environment supported by computer-mediated communication (CMC) tools. A brief literature review discusses the importance of team learning, and the educational theories that ground the application of the team learning approach. The evaluation framework used to assess the effectiveness of our computer-supported TBL implementation is then introduced, along with the assessment methodology and key findings. The paper concludes with a discussion of the study limitations and future research.

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doi:10.1016/j.compedu.2010.02.003

2. Team-based learning overview

2.1. Traditional team-based learning

Team-based learning (TBL) is an instructional strategy organized around team activities. The premise of TBL is to promote active and effective learning through small group interactions across a semester (Michaelsen et al., 2002). Courses that are suitable for TBL contain a significant body of information (content), which students need to understand, and involve problem solving, answering questions and resolving issues through team activities. TBL is also suitable to large courses. For example, Sibley (2008) sees TBL as an alternative to lecturing in large class settings. Most of the learning experiences occur when working in a team during in-class interactions (Michaelsen et al., 2002). Course materials are split into modules and the students are divided into teams following Michaelsen's guidelines described in Table 2 (traditional TBL column). There is little to no lecturing with the instructor taking the role of a facilitator of teams that are formed at the start of the semester. In TBL, a semester-long course is divided into 4–8 content-specific modules of 1–3 weeks in duration per module. Each module follows an iterative learning process which repeats a sequence of activities consisting of: (1) *individual preparation* through out-of-class reading of the learning materials, (2) *readiness assessments* through individual and team tests, (3) *application of course concepts* through multiple team activities, and (4) an (optional) *end of module test*. Fig. 1 summarizes the team-based learning iterative process.

In the traditional TBL implementation, each module starts with individual preparation (Michaelsen, Sweet, & Parmelee, 2008). The module materials are released for the students to read, prepare study notes and then take an individual readiness assessment test (iRAT). This preliminary test assesses individual preparation, before the team-readiness assessment test (tRAT) is administered. The tRAT is the same multiple choice test as the iRAT, only taken a second time in teams to benefit from the discussion of selecting correct answers. In this phase, students may also engage in an appeal process to review questions that should receive partial credits. The testing concludes the readiness assessment phase, which is a fundamental component of assurance of learning for each content module. The application of course concepts occurs through various team activities such as problem solving and case discussions based on the module materials. In this phase, most of the team knowledge sharing takes place both within and across teams. A post-module assessment may also be administered to identify any residual learning needs before moving to the next module. Table 1 below summarizes the activities repeated in each module indicating whether they are completed in-class or outside the classroom.

Team-based learning approaches are grounded in theory (see the literature review in Section 3) and promote active learning and participation. However, implementing traditional TBL approaches presents various challenges. In face-to-face TBL, the amount of time spent on completing the readiness assessment tests subtracts from the interactions. In addition, the in-class activities completion time may also vary per team, leaving limited space for general inter-team dialogues, which are often engaging and allow the instructor to clarify content and learning material. Computer-mediation supports better time management practices, since many activities can be completed independently in an asynchronous context, at the student own pace. Students needing more study time can have the unlimited access to materials available in an online repository. Taking advantage of a shared-repository, which extends classroom activities and better consolidates and codifies outcomes, has been one of the main drivers of the authors' exploration of TBL in hybrid classes, in which students meet both face-to-face and online, as described next.

2.2. Online extensions to team-based learning

With computer-supported TBL (CS-TBL), CMC tools and techniques can be used to support interactions between class meeting times and, thus, reduce the time constraints of the traditional classroom, which is limited to 2–3 h maximum duration once a week. The computer-mediated techniques used for this study focused on specific activities such as individual preparation, appeals and knowledge sharing across teams. Traditional TBL places an emphasis on the administration of all module reading materials at the start of each module. Our approach introduced asynchronous learning activities based on Larkin-Hein (2001) findings that learners can take an active role in the learning process by utilizing the asynchronous online discussion features of CMC tools.

In our computer-mediated TBL, students were encouraged to participate in online discussions, between FtF meeting times, based on the module reading materials. For example, students also replied to other students' contributions and were graded on their participation. Fig. 2 presents a visualization of the key aspects of TBL modules and the details its application within a CMC-mediated environment. If we focus our attention on the "individual activities" of Fig. 2, there is no engagement between students/teams in traditional TBL prior to the team in-class activities. With the introduction of CMC individual activities, students are able to engage in active learning while preparing for the new module by completing their readings, posting study notes, and discussing selected aspects of the preparation materials.

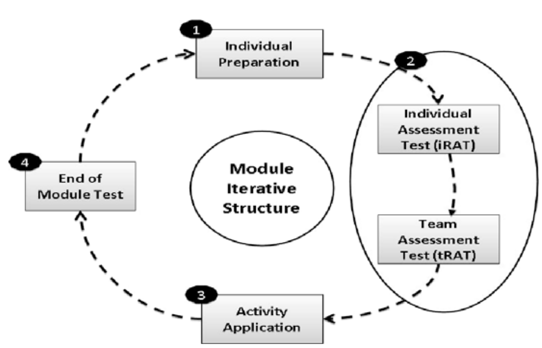

Fig. 1. Team-based learning iterative process.

Table 1
Traditional team-based learning phases per module.

Activity	Activity locus
(1) Individual preparation	
All required module reading materials are assigned and distributed to the students during the first meeting of a module	*In-class*
Students complete the assigned readings	*Outside class*
(2) Readiness assessment (individual and team)	*In-class*
The individual readiness assessment test (iRAT) is administered to each student	*In-class*
Upon completion of the iRAT, the same test is given to each team (tRAT)	*In-class*
(3) Activity application (team and class)	
Students advance to team activities. They begin with a discussion of the topics, initiating an information exchange process that proceeds on rotation until all team members have contributed to the interaction	*In-class*
Students participate in reviews of other teams and provide feedback	*In-class*
Sharing across teams provides an opportunity for the instructor to present supporting materials to the class whenever she realizes that further elaboration is needed	
(4) End of module test	
A final (optional) assessment may be completed to verify that module materials are sufficiently learned before moving to the next module	*In-class*

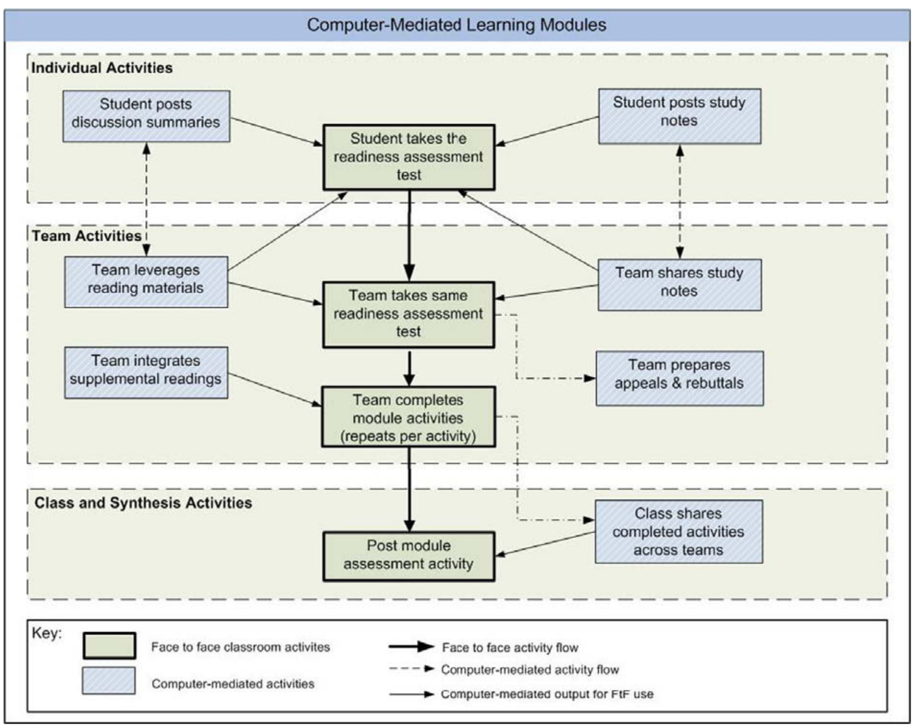

Fig. 2. Computer-mediated TBL activities.

2.2.1. CMC tools used in the study

We used WebBoard as the discussion board to facilitate TBL online activities. WebBoard is one type of learning management tools with a threaded discussion forum component (see http://www.webboard.com), similar to the ones on WebCT, Blackboard or the open-source Moodle. WebBoard's asynchronous learning environment provides an online discussion forum resulting in an accessible repository and archive of team interactions. The instructor creates structured discussion threads to facilitate the team building process, such as posting self-introductions and playing "ice-breakers" online activities such as a collaborative puzzle game. The instructor then releases the module components and publicly posts all TBL activity instructions, such as reading materials. Throughout the semester, WebBoard acts as the main asynchronous online forum for teams to work on TBL modules, coordinate and learn from the variety of TBL activities. An example of the WebBoard interface is shown in Fig. 3 and more details about its use are discussed in the following subsections.

2.2.2. Module organization

In TBL, a module forms a coherent work unit or theme within the course. Each module requires individual preparation. Traditional TBL team activities generally do not span more than one class period. CMC tools release this time constraint. In our implementation, computer-mediated discussions and the compilation of exam notes were introduced as a supplementary online requirement to complete prior to the in-class readiness assessment (individual and team), the multiple team activities, and the post-module assessment.

2.2.3. Team formation

At the start of the semester, teams are formed and remain together for all team activities all semester. For our CS-TBL implementations, we adapted the recommendations from traditional TBL to reflect experience with technology and classroom diversity. Table 2 highlights these CS-TBL adaptations.

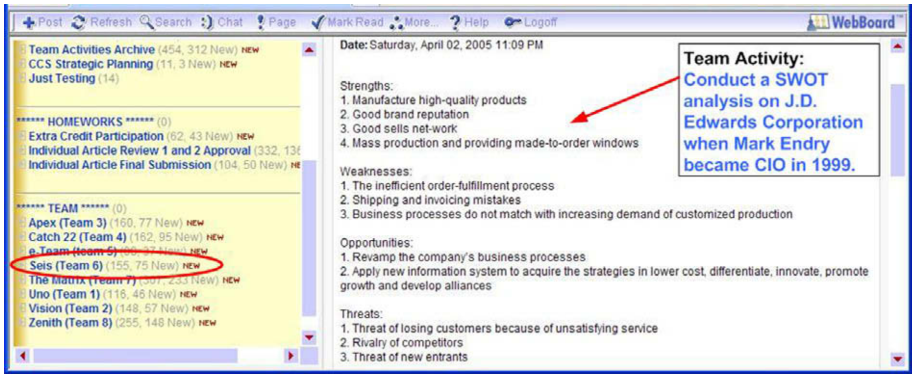

Fig. 3. Sample team assignment on WebBoard.

Table 2
Team formation comparison.

Team characteristic	Traditional TBL	Computer-supported TBL
Team size	5–7	5–6 Students for each team
Team arrangement	Same groups	Same groups working together all semester
Team roles	No assigned roles	Roles not assigned
Team composition	Not specified	Balanced distribution (i.e. gender, work experience)
Team diversity	Recommended that diverse groups are formed randomly	Students were assigned to teams based on their computer experience
Team building	Achieved through initial tRAT, team exercise to determine grade weights and choose a team name	Achieved through "ice-breakers" such as online crosswords and interactive games (course related)

2.2.4. Individual preparation

In traditional TBL, all core reading materials are assigned at the start of the new module. In our online extension of TBL, we also used supplementary readings, which were released through a phased approach as the interactions progressed. The discussion of core and supplemental readings was transferred to the CMC discussion board (WebBoard). Students were required to post questions related to the reading materials and reply to questions posted by other students. The thorough organization of the reading materials and the individual study-time are valuable components to test readiness. Students are asked to structure their study materials by producing one page of notes for the individual readiness assessment test (iRAT) and to share their notes in their CMC team discussion area before taking the iRAT.

2.2.5. Readiness assessment tests (rat)

Michaelsen et al. (2002) suggest approximately twenty multiple-choice questions at the start of each new module for the readiness assessment test. The questions span the module reading materials and are designed to evaluate conceptual understanding. The iRAT and tRAT include the same set of multiple-choice questions. In TBL, this repetition is carried out based on the finding that teams generally perform better than individuals, and the discussion of test answers helps engender the team spirit (Gomez, Wu, Passerini, & Bieber, 2007).

Our implementation used a point system for the team-readiness assessment test where teams were given a scratch card to track points for multiple answers on the same questions. Points were awarded with decreasing value (i.e., five points at the first try; three points at the second try, and one point at the third try). As in the traditional TBL, teams were allowed to appeal the grading by providing 5–10 supporting sentences that ensured a concise and well thought out rebuttal (Michaelsen et al., 2002). In our design, the appeal process was completed only online, leaving more time for asynchronous interactions and encouraging individual participation from each team member.

2.2.6. Multiple team activities

Multiple team activities per module were deployed with increased levels of complexity. The ideal activity involved case studies and problem-solving. After each team activity, deliverables were reviewed and critiqued by the other teams. With CS-TBL, deliverables were posted online for the class to review. The review and critique was moved to the computer-mediated environment (online) between face-to-face classes to increase available time for knowledge sharing. The objective was to store the comments and learning outputs to provide both students and the instructor with an opportunity to provide feedback. CMC expanded the collaboration opportunities via online team activities both during and in-between weekly classes. An example is presented in Fig. 3.

The assignment displayed in Fig. 3 is a team activity and part of the Business Systems learning module 4. Module 4 spans 2 weeks of face-to-face class meeting times. The reading materials at the start of module 4 include textbook chapters and three journal articles. The journal article from where the team activity was generated required each team to "Conduct a SWOT analysis on J.D. Edwards Corporation when Mark Endry became CIO in 1999." The students prepared notes from the reading materials at the start of the module. The notes were shared within their respective teams in WebBoard before meeting in the face-to-face classroom. Students were allowed to bring in one page of notes to class, to use as a reference during the individual readiness test, which then focused on business system concepts (including SWOT analysis). The team readiness test followed the individual readiness test (during the same class session), with the team activities

Table 3
CS-TBL Phases per Module.

Activity	Activity locus
(1) Individual preparation	
Instructor assigns reading materials using the learning management system (LMS). Reading materials remain available online for consultation throughout the course	*Outside class*
Students post short summaries or RAT notes in their team forum. Short summaries are designed to team discussion whereas the RAT notes are designed to share before taking the iRAT	*Outside class*
(2) Readiness assessment (individual and team)	
Students complete the Individual readiness assessment test's (iRAT) online (for some implementations) by using utilities, such as quizzes and survey tools available in most LMSs	*Outside class*
Teams complete the Team-readiness assessment tests (tRAT) in the face-to-face classroom. In-class tRATs allow sharing of answers and free discussion within teams	*In-class*
(3) Activity application (individual, team and class)	
Students prepare to engage in team activities by reading newly assigned supplemental materials, cases and mini-assignments	*Outside class*
Teams engage in activities that begin in the face-to-face classroom for synchronous interactions. Activity discussion but may continue outside of the classroom based on activity complexity	*Primarily in-class – can continue outside class*
Classroom teams share activity results beginning in the F2F classroom. Discussions place emphasis on key points and continue online "as-needed" for thorough clarifications and additional interactions	*Primarily in-class – can continue outside class*
Instructor introduces (i.e., mini-lecture) supplemental learning materials or clarifies points raised during the knowledge sharing process on an as-needed basis	*In-class*
(4) End of module test	
Final (individual) tests can be completed online for quick scoring and feedback. LMS offer various online assessment options.	*Outside class*

completed by the second week of the module. As shown in Fig. 3, students working in teams continued their SWOT analysis interactions online. Post assessment was undertaken at the end of each module or spanned multiple modules. In summary, our adaptation of TBL is presented in Table 3, which highlights which activities were specifically transferred online.

3. Literature review

Team learning is a long-standing educational approach supported by a number of educational theorists as an effective instructional strategy (Bandura, 1977; Brown & Palincsar, 1989; Leidner & Jarvenpaa, 1995). Michaelsen's team-based learning approach uniquely pushes team learning to its extreme by organizing all the learning activities around the team socialization and interaction process (Michaelsen et al., 2002). The key grounding theories (constructivism and social learning theories) for this approach are highlighted next, followed by specific applications of such theories that focus on collaborative group learning and problem-based learning approaches. The review of the literature also briefly introduces findings on the effective use of computer-mediated communication tools in the educational field since our implementation supplements the traditional team-based learning approach with CMC applications.

3.1. Constructivism and social learning theories

TBL primarily uses a constructivist approach (and its derivations briefly described herein, that represent different adaptations of the main paradigm). Constructivism converts the learner from a passive to an active agent (Bruner, 1986, 1990, 1996; Piaget, 1970; Wu, Bieber, & Hiltz, 2009), thus deviating from the traditional teacher-to-learner knowledge transfer approach associated with the objectivist paradigm. In the constructivist learning environment, students play a more active role as learners as they contribute to developing their own knowledge. They need to engage in various in-class activities, e.g., facilitate class discussions, be able to take challenges from their peer learners and instructors, be agents of their own learning. The team-based learning approach implements constructivism by emphasizing the role of the learners as masters of their own educational experiences. The constructivist approach focuses on fostering students' critical thinking in multiple ways in order to achieve higher-level learning. For example, Taylor, Pountney, and Baskett (2008) discuss the importance of using multiple representations of a problem to help learners identify multiple solutions. In our implementation of computer-supported TBL, the iterations and multiple face-to-face and online activities around of the same study materials contributed to further engage the students in identifying multiple solutions and representations.

Bandura's (1977) social learning theory provides another important foundation for TBL as it recognizes the role played by team experiences for learning and development. Bandura, who initially started from behaviorist and objectivist approaches to learning, sustains that behavioral and learning outcomes of the individuals are influenced by observing and modeling the behavior of others. Bandura established that positive and negative behaviors are not necessarily mimicked because of a stimuli, reward or incentive (as the original behaviorists maintained) but occur due to simple observation, retention and replication of actions of others. The context of learning, and in particular social learning, plays a role on attention, memory and motivation.

The extension of a social learning process, such as team-based learning to an online environment (supported by electronic means of communication such as discussion forums) and the ability to archive the outcomes of the interactions and team processes extends the opportunity to refresh and reuse the team experiences over a longer timeframe. The archived interactions capture the codified outcomes from social learning beyond the transient face-to-face interactions. In particular, when such interactions are also visible across teams (such as in our online learning environment) they may further incentivize collaboration. We anticipated that the online visibility of the team learning process would support motivation, enjoyment, as well as replications from other teams, thus enhancing perceptions of learning. We tested this assumption using the evaluation framework described in Section 4 of this paper.

3.1.1. Collaborative learning

Collaborative learning relates to the foundational constructivist and social learning theories as it places an emphasis on learner-centered approaches and team interactions. Alavi and Dufner (2005) list a series of studies that have established higher learning in face-to-face collaborative approaches as opposed to individualistic learning (Brown & Palincsar, 1989; Leidner & Jarvenpaa, 1995), and discuss the positive extension of the collaborative learning benefits on motivation and quality of learning outcomes through the use of CMC. Several other authors have recognized the potential of CMC tools in enhancing the quality of discourse, community building, trust and mutual learning (Coppola, Hiltz, & Rotter, 2004). The implementation described in this study provides an additional forum for understanding the learning and motivational opportunities opened by the use of CMC in team-based collaborative learning activities.

3.1.2. Cooperative and small group learning

TBL adds complexity to cooperative learning, a technique described by Leidner and Jarvenpaa (1995) in which organized small group activities depend on the social exchange of information between learners. The higher amount of structure of the team activities is a key characteristic differentiating cooperative learning models from collaborative learning models (Alavi & Dufner, 2005). The instructor-driven structure of the team process aligns TBL to cooperative learning. The freedom of student self-organization within each module aligns it with collaborative learning. TBL's two key additions to cooperative learning models include: accountability at the individual level, and team contributions to motivating both individual learning and learning from others (Kluge, McGuire, Johnson, & Johnson, 1999). Small group learning produces higher achievement, and healthier and more positive relationships among students, than competitive relationships or individual experiences (Johnson, Johnson, & Smith, 1991). Forming small groups for the duration of the course turns the learning experience into a process that improves the quantity and quality of the learning by leveraging long-term caring and peer relationships (Johnson & Johnson, 1999).

3.1.3. Problem-based learning and team-based learning

Problem-based learning (PBL) is a pedagogical approach within the constructivist and social learning paradigms whereby students collaborate to solve specific problems. This approach was originated in medical education and is based on a hypothetical-deductive reasoning process (Barrows & Tamblyn, 1980). PBL has a few characteristics: (1) students work on complex tasks, such as challenging, open-ended or often ill-structured problems, (2) students work in small groups and conduct self-directed learning, and (3) teachers act as "facilitators" of learning. In reality, a PBL environment still offers guided and structured instruction through scaffolding (Hmelo-Silver, Duncan, & Chinn, 2007). For example, a mini-lecture or benchmark lesson presenting key information to students is used when students understand the necessity of that information and its relevance to their problem-solving and investigation.

In comparison, PBL and TBL have many similarities and overlaps; however, each approach has different foci and purposes. Firstly, PBL is mainly focused on complex problems which often need various scaffoldings for guiding student problem-solving activities, in particular, at the beginning when the problems are introduced. TBL is not limited to complex and open-end problems, but it is open to any context which allows students working in teams with a pre-defined procedure of various team activities. Secondly, PBL still involves many self-directed learning processes, but when student groups work together, they collaborate. TBL has the similar practice in nature, but students mainly work in teams after students have completed individual work. Thirdly, PBL's key focus is problem-solving not on building long-term team experiences as a professional, which is TBL's main goal. The same TBL teams work together throughout the entire semester following common professional practices in the field. Its purpose is not only to study specific subjects, but also to foster necessary professional teamwork habits to be ready for future careers. Finally, the instructor's role in PBL is different from TBL's. Although the PBL instructor also plays the role of "facilitator," the nature of complex problems, such as mathematics, still requires extensive guidance from the PBL instructor at the beginning of introducing problems to students with the aid of many forms of scaffolding. In the TBL environment, instructor's role is minimized from little lectures to none, ideally a pure "facilitator," thus making TBL less likely to fit complex hypothesis-driven reasoning problems, typical of PBL applications in the medical field.

3.2. Computer-mediated communication and learning

In general terms, information technology can enhance the learning experience by facilitating both the delivery and management of instruction. Leidner and Jarvenpaa (1995) identified four different processes (automating, informating up, informating down, and transforming) where the use of information and communication technology is an enabler of instruction. They defined a taxonomy with two dimensions – the purpose of instruction (knowledge dissemination vis à vis knowledge creation), and the control of pace and content of learning – and mapped information technology applications to the learning models they support.

More specifically, computer-mediated communication tools provide a medium that enables groups of people to exchange ideas and opinions and to share information resources at anytime and anywhere. The key benefits of CMC are convenience, place-independence, time-independence and the potential for users become part of a virtual community (Berge & Collins, 1993). Moreover, recent research suggests that effective CMC environments are supported by *learner characteristics*, *instructional structure*, and *interaction*, all of which are considered in computer-mediated communication (Liaw, Huang, & Chen, 2007). In our study, learner characteristics are taken into account during team formation (i.e. computer experience, gender, etc.), instructional structure is optimized through the use of the traditional TBL modular structure, and interactions (on and off-line) are facilitated by the mix of participation models and the use of online forums.

Through examining the influence of time and perception of task demonstrability on information sampling and decision quality in computer-mediated and face-to-face groups, Campell (2006) reports that the computer-mediated group recalled more unshared information and had the highest solution rates because of ample time and flexibility offered by CMC compared to the regular face-to-face group. Lowry, Roberts, Romano, and Cheney (2006) found that face-to-face groups with CMC support had higher level of communication quality than pure virtual CMC groups. ALN online discussion research (Wu & Hiltz, 2004) found that online discussions on CMC platforms improved student learning in a face-to-face class setting. In a few words, the literature on CMC points to beneficial outcomes, positive outcomes that we further tested in our study.

4. Evaluation framework and analysis

In the previous sections, we introduced the TBL model, explained our computer-supported adaptations of such a model, and introduced the literature that supports the use of TBL, and specifically CS-TBL. In this section, we explain how our CS-TBL implementation results were assessed and our findings in terms of the value of the hybrid (both face-to-face and online) learning experience. We conducted this assessment by using an evaluation framework grounded in the literature, emphasizing on the behavioral impact of the CS-TBL approach. The evaluation took place in the hybrid master-level information systems classes called "Information Systems Principles" during two consecutive semesters at a US East Coast public research university.

4.1. Computer-supported team-based learning (CS-TBL) evaluation framework

The constructivist approach, cooperative and collaborative theories and models provide the background for the elaboration of the team-based learning evaluation framework used in this study to assess the impact of CS-TBL (Fig. 4). Research on participatory examinations (Wu, Bieber, Hiltz, & Han, 2004; Wu et al., 2009) and collaborative examinations (Shen, Cheng, Bieber, & Hiltz, 2004) form the basis for the expected relationships in Fig. 4. In order to succeed in CS-TBL, students should prepare first, so that they can contribute their insights to the whole team. Individual preparedness may lead to higher regard of team members' contributions to problem solving, allowing students to integrate and gain more insights from their team members (Michaelsen et al., 2002). Overall, we expect that the entire CS-TBL process would provide the students with an enjoyable and motivating learning experience, thus enhancing their perception of learning quality.

The evaluation framework adopted and modified a few existing validated constructs—"perceived learning," "perceived motivation" and "perceived enjoyment"—from research on asynchronous online communications (Wu & Hiltz, 2004). Detailed question items for each construct are presented in Tables 5–9. The two independent variables are "individual preparedness" and "perceived team-member valuable contributions" (as measured through his/her contributions to the team). "Perceived motivation" and "perceived enjoyment" serve as intervening variables, and "perceived learning" is the outcome variable (dependent variable). Based on the described assessment framework, we set out to investigate the following research questions:

- Do students' opinions on the value of their team members learning contributions impact their perception of learning from the computer-supported TBL process?
- Does individual preparation affect perceptions of computer-supported team-based learning experiences?
- Do motivation and enjoyment impact the computer-mediated learning experience?

In the next few paragraphs, we explain the variables used in the assessment framework and relate them to prior studies.

4.2. Perceived individual preparedness

Built upon Bandura's social learning theory, Staples (2007) found that individual team member's judgments and abilities to perform a series of tasks can potentially lead to successful teamwork. In this study, individual preparedness, measured as a self-reported student assessment of deep versus superficial learning of the materials during the semester, is posited to positively impact the perception of team member's value assessed through his/her contribution to the team-learning experience. If individuals prepare for team activities, they will be more active when dealing with problem solving in teams and will also help establish trust and improve communication among team members (Gomez et al., 2007). This assumption follows Michaelsen et al. (2002) findings that individual contributions to team-output promote team development and reduce social loafing and, therefore, will have a higher impact on the overall team-based learning experience. Hence, we define the following three hypotheses:

- *Hypothesis 1a:* Higher individual preparedness will increase students' perceived motivation from CS-TBL.
- *Hypothesis 1b:* Higher individual preparedness will increase students' perceived enjoyment from CS-TBL.
- *Hypothesis 1c:* Higher individual preparedness will increase the perception of team-members' valuable contributions to the CS-TBL process.

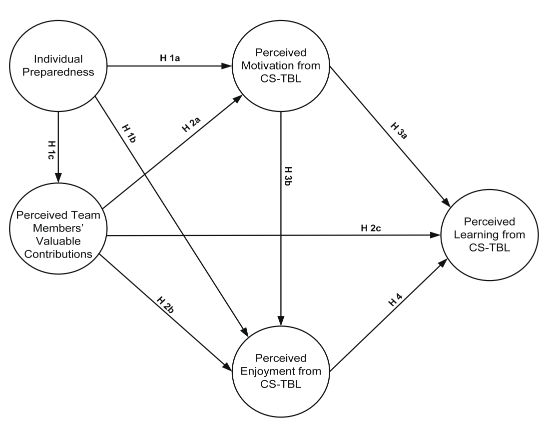

Fig. 4. Computer-supported team-based learning (CS-TBL) evaluation framework.

Table 4
Factor structure matrix of loadings.

Constructs		Loadings	Composite reliability	AVE
Individual preparedness (IP)	IP1	−0.211	0.605	0.522
	IP2	0.999		
Perceived team-members' valuable contributions (PTMV)	PTMV1	0.770	0.881	0.712
	PTMV2	0.849		
	PTMV3	0.906		
Perceived motivation (PM)	PM1	0.874	0.888	0.799
	PM2	0.913		
Perceived enjoyment (PE)	PE1	0.755	0.890	0.621
	PE2	0.855		
	PE3	0.830		
	PE4	0.652		
	PE5	0.830		
Perceived learning (PL)	PL1	0.808	0.906	0.619
	PL2	0.849		
	PL3	0.822		
	PL4	0.855		
	PL5	0.581		
	PL6	0.773		

Table 5
Perceived learning from CS-TBL (PL).

Question items strongly agree = 1 → strongly disagree = 5	SA (%)	A (%)	N (%)	D (%)	SD (%)	N	Mean	SD
The learning quality of course materials was improved by the team activities (PL1)	34.2	52.1	9.6	2.7	1.4	73	1.85	0.81
CS-TBL has broadened my knowledge of course related materials (PL2)	32.9	46.6	15.1	5.5	0	73	1.93	0.84
CS-TBL improved my ability to integrate concepts from different parts of the semester's materials (PL3)	33.3	50.0	12.5	2.8	1.4	72	1.89	0.83
CS-TBL was useful to my learning (PL4)	36.1	43.1	15.3	2.8	2.8	72	1.93	0.94
The learning quality of course materials was improved by the team tRAT (PL5)	31.5	54.8	8.2	4.1	1.4	73	1.89	0.83
I learned a great deal from my team (PL6)	47.9	39.7	9.6	1.4	1.4	73	1.68	0.83

Note: SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree, N = number of responses, SD = standard deviation.
The above notations apply to all other tables in this paper.

Table 6
Perceived motivation from CS-TBL (PM).

Question items strongly agree = 1 → strongly disagree = 5	SA (%)	A (%)	N (%)	D (%)	SD (%)	N	Mean	SD
CS-TBL motivated me to do my best work (PM1)	29.2	43.1	18.1	6.9	2.8	72	2.11	1.00
I feel my motivation to learn increased with CS-TBL (PM2)	26.0	45.2	21.9	5.5	1.4	73	2.11	0.91

Table 7
Perceived enjoyment from CS-TBL (PE).

Question items strongly agree = 1 → strongly disagree = 5	SA (%)	A (%)	N (%)	D (%)	SD (%)	N	Mean	SD
I enjoyed sharing my knowledge of course related materials with my team through CS-TBL (PE1)	48.6	37.5	9.7	2.8	1.4	72	1.71	0.86
I enjoyed CS-TBL more than regular classes with lectures (PE2)	38.4	27.4	23.3	6.8	4.1	73	2.11	1.13
I like CS-TBL (PE3)	36.1	29.2	23.6	6.9	4.2	72	2.14	1.12
CS-TBL improved my communication skills (PE4)	30.1	45.2	17.8	4.1	2.7	73	2.04	0.95
I found myself more interested in the subject with CS-TBL (PE5)	23.3	43.8	21.9	11.0	0	73	2.21	0.93

Table 8
Perceived team member's valuable contributions to CS-TBL (PTMV).

Question items strongly agree = 1 → strongly disagree = 5	SA (%)	A (%)	N (%)	D (%)	SD (%)	N	Mean	SD
Most classmates' comments are very valuable (PTMV1)	24.7	42.5	19.2	8.2	5.5	73	2.27	1.10
Most of my teammates' comments are very useful (PTMV2)	33.3	38.9	15.3	11.1	1.4	72	2.08	1.03
CS-TBL activities are worth my time (PTMV3)	30.6	45.8	13.9	8.3	1.4	72	2.04	0.96

4.3. Perceived team-members' valuable contributions

The independent variables in this study are introduced as two antecedents and drivers of affective and performance outcomes (enjoyment, motivation and learning). In particular, a positive perception of the value of teamwork is considered key to the pleasantness and effectiveness of the learning experience. The management literature shows that strong team orientation and involvement in teamwork

Table 9
Individual preparedness to CS-TBL (IP).

Question items strongly agree = 1 → strongly disagree = 5	SA (%)	A (%)	N (%)	D (%)	SD (%)	N	Mean	SD
When preparing for the RAT, I read the materials and tried not to study by memorizing the information (IP1)	4.1	32.9	26.0	32.9	4.1	73	3.00	1.00
When preparing for the RAT, I read the materials and did study (IP2)	9.7	30.6	16.7	36.1	6.9	72	3.00	1.16

are key determinants of satisfaction with performance outcomes. Especially a strong team orientation is elicited when team members' perceptions of their interactions, communication patterns, and participation are directed towards the group goal (Hare, 1976; Isabella & Waddock, 1994). Therefore, assessing the perceived team-members' valuable contributions to the final goal (in this study, the project activities and class goals) can help in understanding the affective and performance perceptions of individual students. In our survey, students were asked whether they perceive teammates' contributions as valuable, useful, and worth their study time investment.

- *Hypothesis 2a:* Higher perceptions of team-members' valuable contributions to CS-TBL will increase motivation.
- *Hypothesis 2b:* Higher perceptions of team-members' valuable contributions to CS-TBL will increase enjoyment.

Some researchers found that a strong team orientation can exist independently from the achievement of consensus on outcomes (Bourgeois, 1985; Janis, 1972). What emerges is that a strong team orientation will make individuals more certain about their own roles and assessments (Isabella & Waddock, 1994). Building on these earlier studies, we posit that a higher perception of team members' value through their contributions—which we use as a proxy of a higher team orientation—will lead to higher expectations of performance outcomes (perceived learning). In other words, the higher the team orientation, the higher the student perception of learning.

- *Hypothesis 2c:* Higher perceptions of team-members' valuable contributions to CS-TBL will enhance perceived learning from CS-TBL.

4.4. Perceived motivation

The motivation construct has been analyzed by the literature in multiple ways. Often, a distinction is drawn between intrinsic and extrinsic motivation factors. Extrinsic motivators are those factors external to the learners that will influence the student interest and attitudes towards the learning experience. They include grades, teacher influence, rewards and incentives from learning. Intrinsic factors are motivational states that influence the predisposition for learning, intellectual curiosity, and predisposition for challenges (Harter, 1981). The motivation scale items used in this study attempt to capture intrinsic and extrinsic variables which have been observed in the literature. Two questions were used in the motivation construct. The extrinsic question item captures whether team-based learning techniques motivated learners to do their best work. The intrinsic motivation question attempts to capture students' perception of their motivation to learn (and whether it increased).

Malhotra and Galletta (2003) study motivation factors with regard to the implementation of knowledge management systems. Furthermore, they discard the traditional distinction between intrinsic and extrinsic factors as opposites. Intrinsic and extrinsic motivation is seen as part of a continuum where users (and learners) transition from a status of lack of motivation, through a series of externally-driven regulations and incentives, to reach a self-determined level of intrinsic regulations which increases their curiosity and determination to achieve a specific objective. Although Malhotra and Galletta's findings review participation in a health-care knowledge management system implementation, their study highlights the role of motivation in the learning process. They define intrinsic motivation as "the inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn." In this study, we follow Malhotra and Galletta's definition and posit that there will be a positive relationship between students' perceived motivation and their perceived learning outcomes.

- *Hypothesis 3a:* Higher perceived motivation will lead to higher learning from CS-TBL.

4.5. Perceived enjoyment

The perceived enjoyment questions were adapted from prior studies (Gomez et al., 2007). Perceived enjoyment is an affective variable that is considered important as an antecedent of a user's cognitive behavior. Adapting from the original definition from Davis, Bagozzi, and Warshaw (1992), enjoyment is defined as the extent to which the learning activity (the team-based learning experience) is perceived to be pleasant and satisfactory to the learners. Other authors (Scanlan & Simons, 1992) define enjoyment as the positive affective response that reflects general feelings such pleasure, liking and fun. More simply, the learners feel that the learning experience was pleasurable to them.

Perceived enjoyment is an important concept in learning as it can explain a state of cognitive absorption of the students with the learning materials. Agarwal and Karahanna (2000) explained cognitive absorption as a state of deep involvement of a user with a specific piece of software, which impacts interaction and behavioral intentions. Extending this concept to the cognitive domain, a higher perceived enjoyment of the learning experience will lead to a deeper involvement with the learning materials and, therefore, higher learning. In this study, five items were used to define the perceived enjoyment construct. The question items focused on perceived enjoyment from the team-based learning experience such as enjoyment with sharing course content; level of interest in the course compared to courses with limited or no team-based learning activities; and overall pleasantness of the experience compared to traditional lecture-based courses. Three of the scale items adapt Davis et al. (1992) perceived enjoyment construct (PE) and the additional two scale items focus on team-based learning specific experiences and comparisons with traditional courses by modifying Wu and Hiltz (2004) validated construct.

In studies conducted in the sports management area (Boyd & Yin, 1996), enjoyment has been regarded as an intrinsic motivator. Deci and Ryan (1985) argue that enjoyment is derived from achievement perceptions which are intrinsically motivating and provide a perception of competence.

- *Hypothesis 3b:* Higher perceived motivation will lead to higher enjoyment from CS-TBL.

Extending the analysis to the learning environment, we expect that perceived enjoyment will be a key component of the learners' experience influencing their interest in the course and their perception of learning achievement. Therefore, we expect to find a positive correlation among perceived enjoyment and perceived learning.

- *Hypothesis 4:* Higher perceived enjoyment from CS-TBL will lead to higher perceptions of learning.

4.6. Perceived learning

The perceived learning construct is adapted from research on asynchronous learning networks and participatory examinations (Wu & Hiltz, 2004; Wu et al., 2004, 2009). This earlier research shows that a positive correlation exists between perceived motivation and learning, and between perceived enjoyment and learning. The prior models focused on evaluating individual perceptions of learning related to personal factors that affect the value of the team experiences. Our study also focuses on perceived learning outcomes based on specific class requirements, as perceptions may better explain motivational drivers that may impact the future success of the students.

Malhotra and Galletta (2003) state that extrinsic motivators may play a role in achieving learning objectives at the beginning of a learning experience. The extrinsic factors may determine a transition from lack of motivation to commitment. However, for the commitment (and the learning experience) to display a lasting impact, these external factors (for example, rewards and incentives) need to be internalized to ensure a participant's long-term commitment and self-efficacy. As emerged in the studies from the sport management field (Boyd & Yin, 1996), it is this self-confidence and self-perception of achievement that drives the longer term success.

We focus our analysis on perceived learning and we rely on a grounded construct that captures different aspects of the learning experience. Six questions were used to determine the overall perceived learning score. These questions focus on the perception of the course quality; usefulness and extent of individual learning. They also require students to evaluate the depth of their learning experience (broadened knowledge of course materials and integration of multiple concepts) that enable an assessment of the higher (analysis and synthesis) levels of the Bloom's learning taxonomy (Bloom & Krathwohl, 1956).

5. Methods and sampling

To test the hypotheses, questionnaires were used in two hybrid classes of a master-level information systems course called "Information Systems Principles" over two semesters. A total of 73 students volunteered to participate in our CS-TBL assessment. Among 73 respondents, 61 students disclosed their demographic information. Over 50% of them were full-time students, about 33% were part-time, and the rest were non-matriculated students, studying without officially being admitted to degree programs. About 60% were males, 36% females, and three people did not provide their gender information. The majority of the respondents were between 21 and 30 years old, and about 16% were between 31 and 40 years old.

5.1. Data analysis, procedures and results

The data collected in the survey questionnaires referred to the variables listed in the CS-TBL evaluation framework (Fig. 4). In order to test the underlying relationships among the validated constructs, a latent structural equation modeling (SEM) technique called Partial Least Squares (PLS) was utilized because of our small sample size (Chin, 1998; Lohmoller, 1989). In this study, PLS-Graph 3.0 software was selected. The measurement model was first assessed (through construct validity and scale reliability analyses reported next), and then the structural relationships were examined.

The psychometric properties of the scales are assessed in terms of item loadings, discriminant validity, and internal consistency. In order to keep as many construct items as possible, we set up 0.55 as our threshold. The majority of factor loadings are over 0.75. Only one item for the Individual Preparedness construct has a negative, low factor loading, because the question item was somewhat ambiguous (when students individually prepare for a module, learning materials should not be studied by rote; the question and its interpretation may not have been clear) Table 4 presents the factor loadings, composite reliabilities and average variance extracted (AVE) values for each construct. In terms of composite reliability values, except "individual preparedness," all other constructs have reached acceptable composite reliability values (>0.88).

The composite reliability of perceived learning construct is 0.906. The means and standard deviations of the construct variables are illustrated in Table 5. The reliability results for the perceived learning construct are possibly attributed to the use of scale items that have already been validated in previous studies (Wu et al., 2004). In addition, questions specific to the readiness assessment test and Michaelsen et al. (2002) methodology for team-based learning represent validated measures of learning (although this work refers to actual perception of learning by the students, and not on actual learning scores).

In terms of frequencies distribution, over 86% of the respondents agreed or strongly agreed that the quality of the course materials were improved by using the team-readiness assessment test (tRAT); a total of 79.15% agreed and strongly agreed that the CS-TBL process broadened their knowledge of the course materials. In general, the majority of students reported that they have greatly learned from their team interactions.

Perceived motivation (Table 6) also shows an acceptable reliability level (0.888). 72.3% of the respondents strongly agreed and agreed that their motivation to learn and to perform their best work increased with CS-TBL.

Overall, students enjoyed the CS-TBL learning process (Table 7). With regard to the perceived enjoyment construct, about 86% of the students reported that they enjoyed sharing their knowledge with their team, and over 65% believed that they enjoyed CS-TBL more than traditional lecture-based classes. Over 75% perceived that the CS-TBL process also improved their communication skills. The majority of the students (67.1%) found that they were more interested in the subject with CS-TBL. The perceived enjoyment construct also shows a high composite reliability (0.890).

With regard to the perceived team members' value (Table 8) to CS-TBL, the average mean for the questions representing this construct is 2.13. The composite reliability is 0.881. Respondents recognized that working with their classmates was a very valuable experience (24.7% strongly agree and 43.5% agree). They also found that the comments presented by their classmates were useful (33.3% strongly agree and 33.9% agree) and that the CS-TBL experience was worth their time commitment (only 1.4% strongly disagreed).

Individual preparedness was measured through reported strategies for preparation and study (reading and memorizing the materials act as a proxy for superficial learning). The composite reliability for the construct is 0.605. This construct's lower reliability is discussed later in the paper. Average results for each question show a substantial split (with about 30% agreeing and about 34% disagreeing). The average mean values are equal to 3 (Table 9).

We also obtained satisfactory results for discriminant validity assessment (Bloom & Krathwohl, 1956) as highlighted in Table 10 that shows that the calculated square roots of the AVEs listed in Table 4 are all larger than the inter-construct correlations. Table 11 summarizes the results from the hypotheses testing in our evaluation model (Fig. 5). Overall, 49% of the whole model variances are explained from the original model.

Table 10
Descriptive statistics and inter-construct correlations.

	Mean	SD	IP	PTMV	PM	PE	PL
IP	3.001	0.658	**0.722**				
PTMV	2.136	0.892	0.246	**0.844**			
PM	2.111	0.865	0.184	0.308	**0.893**		
PE	2.309	0.800	0.213	0.541	0.739	**0.788**	
PL	1.873	0.671	0.219	0.418	0.633	0.654	**0.787**

Note: The numbers in bold in the diagonals are the square roots of AVE values in Table 4.

Table 11
Summary of hypotheses results.

Hypotheses	β Value	Significant p-value	Supported (yes/no)
H1a (IP → PM)	0.115	Ns	No
H1b (IP → PE)	0.012	Ns	No
H1c (IP → PTMV)	0.246	Ns	No
H2a (PTMV → PM)	0.280	$p < 0.05$	Yes
H2b (PTMV → PE)	0.344	$p < 0.001$	Yes
H2c (PTMV → PL)	0.137	Ns	No
H3a (PM → PL)	0.357	$p < 0.01$	Yes
H3b (PM → PE)	0.631	$p < 0.001$	Yes
H4 (PE → PL)	0.316	$p < 0.05$	Yes

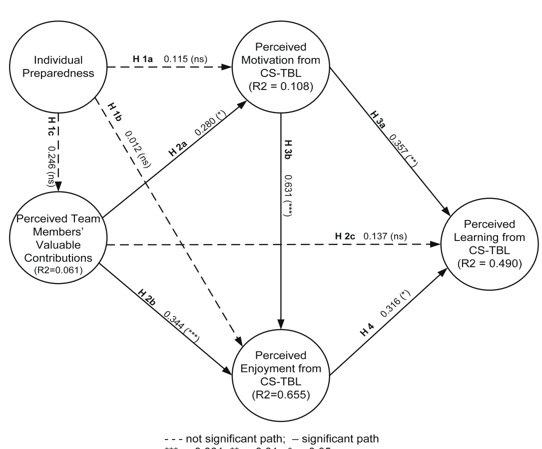

Fig. 5. CS-TBL structural model.

5.2. Discussion

Fig. 5 shows that H2a, H2b, H3a, H3b and H4 are all strongly supported. We found that "perceived team member value" greatly impacts the student enjoyment (H2b) and motivation (H2a). "Perceived motivation" strongly impacts the enjoyment of learning (H3a), and both "perceived motivation" (H3b) and "perceived enjoyment" (H4) have significant relationships with the students' "perceived learning." Although there is no direct significant relationship found between "perceived team member value" and "perceived learning" (H2c), perception of team members' value is positively related to learning. Team activities may help students enjoy more what they need to learn, eventually achieving higher learning. Table 11 summarizes the results from the hypotheses testing in our original evaluation model (Fig. 4). Overall, 49% of the whole model variances are explained from the original model.

Three hypotheses (H1a, H1b and H1c) relevant to "Individual Preparedness" construct are not supported. We suspect that these not significant results are related to an instrument-limitation. The Individual Preparedness construct requires additional scale items that relate this construct to other team activities. The Individual Preparedness construct will need to be expanded in future work to also capture individual strategies to prepare for teamwork execution.

A second modified model was tested by removing "individual preparedness" because of the limitations with the current construct. The modified model SEM results show that while still about 49% of the variance is explained in the modified evaluation model, the relationship between perceived enjoyment and perceived learning becomes non-significant and the strength of the path between perceived motivation and learning decreases significantly. We stipulate that the original construct of "individual preparedness," although weak, may play a role that needs to be further investigated, as discussed next.

This study does not address additional factors, leading to a number of *limitations*. First, it was conducted in the same types of graduate classes at a single university, thus impacting generalizability. Future work will conduct more CS-TBL assessments with multiple courses and disciplines at multiple universities. Second, the outcomes from the SEM analysis show that individual preparedness does not impact perceptions of the team-based learning experience. The correlation values among individual preparedness and other variables are not significant. While the SEM analysis does not show any significant relationships between "individual preparedness" and other constructs in the framework, removing this construct is not a viable alternative since individual preparedness mediates the relationship between learning and other relevant constructs. The reliability and construct validity of the "individual preparedness" construct will nevertheless need to be enhanced in future work by testing additional questions that refer not only to individual learning strategies, but to understanding how individuals prepare or team tasks.

There might also be an interaction effect of the experimental conditions: the CS-TBL process design itself might also 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 may explain the increase in the students' motivation, enjoyment and perceptions of learning even when the self-assessment individual preparation is low. We could speculate that the tests might have been easy. Alternatively, this may indicate that many students found the TBL process valuable, even when they did not prepare as they or the instructor expected. These results show that our second question on the role of individual preparedness needs further investigation and analysis.

6. Conclusion and future research

Earlier research on computer-mediated communications (CMC) has shown that CMC tools can be used to enhance the learning experience by engaging students in becoming active learners and fostering high quality communication exchanges (Berge & Collins, 1993; Campell, 2006; Lowry et al., 2006; Wu & Hiltz, 2004; Wu et al., 2009). Based on the findings and the CMC potential for student engagement, we extended a grounded team-based learning pedagogical approach (Michaelsen's team-based learning model) to an online environment using CMC tools, namely WebBoard for the study at hand. The objective was to facilitate learners' involvement and engagement beyond the FtF classroom, thus enhancing their perceptions of learning. We tested whether such approach had the desired positive impact on learners by using an evaluation framework that focused on perceived learning, motivation and engagement. Findings from the evaluation show that the use of team-based learning with the support of computer tools supplements the learning experiences by extending the interactions beyond the classroom. Students were satisfied with their online learning experiences, and they perceived they learned well with CS-TBL.

Future work will focus on overcoming some of the limitations of the evaluation model. In particular, additional research will be needed to assess the impact of individual preparedness and the role of "trust," which was not studied here, in enabling the learning experience. We expect that the independent variables of individual preparedness and perceived team-members' valuable contributions to TBL will impact the level of trust and openness of communication within the teams, indirectly influencing motivation and enjoyment. Establishing trust early (swift trust) in online communities has been found to have a positive impact (Coppola et al., 2004) on learning. Future work will also include the use of online testing tools to conduct the iRAT and tRAT assessments.

TBL has the potential to revolutionize learning by fostering knowledge sharing in a social context. CS-TBL strengthens TBL with online tools and makes it accessible to students through alternative delivery modes. While TBL has been strongly advocated by others, this study contributes a systematic investigation of the described TBL model and adds computer-supported activities that positively impact students learning outcomes. We invite colleagues to further investigate the critical value of employing constructivist learning approaches both in face-to-face and virtual team environments. In the latter environments, the use of team-based learning however difficult to set up and moderate may indeed yield longer-term positive results, at least in terms of higher enjoyment of the learning experience.

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