Designing an Instructional Model for Smart Technology-Enhanced Team-Based Learning

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Abstract: The purpose of this study is to explore and develop a new instructional approach to a technology-enhanced collaborative learning environment called Smart technology-enhanced Team-Based Learning (denoted as S-TBL). We designed a novel instructional model that combines mobile technology, collaborative teamwork, problem-solving process, and a variety of evaluation techniques in the perspective of a conventional team-based model. Team-Based Learning (TBL) is an instructional model that is based on procedures for developing high performance learning teams that can enhance the quality of student learning in various fields. TBL has the following defining characteristics and procedures: (1) Lesson Panning, (2) Pre-Class Preparation, (3) Readiness Assurance Process, and (4) Application Exercises. The traditional TBL has been implemented across a broad range disciplines and school levels, and proven to be educationally effective in various academic domains. We believe emerging technologies that are now available in classrooms will bring us new opportunities to maximize the merits of TBL even further. Along with the revision of the traditional TBL model, we integrated smart learning technologies (such as iPad or Galaxy Tab for 1:1 mobile computing): 1) to provide a holistic learning environment that integrates learning resources (including reading assignments), assessment tools, and problem solving spaces; and 2) to enhance collaboration and communication between team members, and between an instructor and students. The S-TBL instructional approach combines: 1) individual learning and collaborative team learning; 2) conceptual learning and problem-solving & critical thinking; 3) individual assessment and group assessment; 4) self-directed learning and teacher-led instruction; and 5) personal reflection and publication.

Keywords: *Team-Based Learning, Smart Technologies, Learning Method, S-TBL*

I. Introduction

In these days, smart technologies and smart devices including smart phones, smart pads (e.g., iPhone, iPad, Galaxy Tab) are becoming indispensable in our everyday life. People are Internet surfing, shopping, and social networking through these smart technologies. Smart technologies have also changed education and schools as well as our everyday life. Emerging technologies have provided education with both opportunities we have dreamed of as well as challenges we need to overcome. The role of technology on teaching and learning is getting more attention from educators these days than ever before. Upon understanding the importance and potential of smart technologies, Korean government developed the "Smart Education Strategic Plan" and has made efforts to support schools to implement "Smart Education" using smart technologies and smart devices in the field. The Ministry of Education in Korea collaborates with schools and teachers to diffuse smart education by appointing research schools that adopt innovative technologies, and develop and implement new instructional models and materials for smart education.

Smart education through smart technologies is the most appropriate to design social media based learning environments in which a large number of learners can learn through collaboration and cooperation utilizing various Apps and wire- or wireless Internet. In addition, smart education has high potentials to provide customized learning contents based on individual learner's needs, and problem-based case learning through peer collaboration rather than teacher-directed lectures. Smart education also promotes knowledge sharing and exchanges among learners so that same contents found in traditional textbooks can be re-constructed and re-generated. Smart technologies can also enable interactive collaboration and cooperation between students and between a teacher and students. Moreover, smart technologies can bring changes on teacher's role being a facilitator rather than a knowledge transfer; students' role being a self-directed and self-regulated learner; and curriculum being more customized and differentiated based on students' unique needs.

However, technology itself does not promise anything regarding teaching and learning effectiveness. In order to bring the best educational benefits out of technology, careful research, development, and implementation are critical. While many researchers are paying attention to possibilities and potentials of smart education, others are rather skeptical about smart education. They have pointed out the fact that the same pitfalls and problems with e-learning or ICT (Information Communication and Technology) education can be repeated with smart education. Smart education can be only another fad entailing emerging technologies and devices. Technology itself cannot guarantee desirable learning outcomes that many researchers and teachers are hoping for. As Clark (1983) has argued, new media itself cannot guarantee to cause a positive effect. It is not the media itself but the way those media are utilized in a learning environment can change teaching and learning, and in turn those changes can lead to desirable outcomes of learning.

Thus, it is important to research how to maximize the educational potentials of smart technologies by designing and developing instructional models, strategies, methods, and materials which can be worked in the education. As one of promising instructional models, we propose smart technology-enhanced Team-Based Learning (denoted as S-TBL). Team-Based Learning (denoted as TBL) is known for a well-structured learning process that is effective for promoting problem-solving, collaboration, and communication skills. If we implement Team-Based Learning in smart technology-enhanced learning environments, we can expect promising learning outcomes from a synergy between the two – i.e., smart technologies and TBL.

Nevertheless, further research is needed to develop an appropriate and specific model for Team-based Learning in smart technology-enhanced learning environments and specific guidelines for how to implement the model in the classroom. As the first step for further research, this paper presents a conceptual model for Smart technology-enhanced Team-Based Learning(S-TBL). The conceptual model will provide a blueprint for actual development and implementation of S-TBL in the real classroom by providing a modified Team-Based Learning model that is designed to be worked best in smart technology-enhanced learning environments where wireless Internet and smart devices are available for individual learners.

Research questions in this paper are as follows: 1) what design principles can be employed to develop Smart technology-enhanced Team-Based Learning? ; 2) what are the learning processes in Smart technology-enhanced Team-Based Learning environments?; and 3) what are the specific learning activities in Smart technology-enhanced Team-Based Learning environments?

II. Review of the Conventional Team-Based Learning Model

The conventional Team-Based Learning model is composed of the following four stages; 'Lesson Planning' – 'Pre-Class Preparation' - 'Readiness Assurance Process' – 'Application Exercises'(Michaelsen, Knght, & Fink, 2004; Michaelsen, Sweet, & Parmelee, 2009).

First, the *Lesson Planning* stage involves a systemic planning of learning processes that will be implemented in real educational settings. It includes setting up learning objectives, analyzing learning environments, analyzing learners, selecting & sequencing learning contents, developing learning materials, and designing an assessment and evaluation system. Setting up learning objectives involves identifying and specifying learning objectives and outcomes that should be accomplished as students learn through Team-Based Learning. Analyzing learning environments involves identifying and surveying whether the current school and classroom environments are appropriate for Team-Based Learning and whether they are all equipped with necessary resources and equipments. Analyzing learners involves identifying and assessing participating students' prior knowledge, skills, attitudes, and learning styles. Selecting and sequencing learning contents involves selecting contents which will be covered during Team-Based Learning, and sequencing the contents based on the structure of the model. Developing learning materials and strategies involves selecting from ready-made necessary learning materials or creating new materials including reading materials, references, individual & team assessments, and concept-applied authentic problems. Designing an assessment and evaluation system involves developing evaluation methods and a scoring system to assess both individual and team achievements.

Second, the *Pre-Class Preparation* stage requires learners to individually study pre-assigned materials before the class. It includes examining learning materials, studying reading assignments, searching & integrating references, and organizing key concepts. Examining learning materials and studying reading assignments involve prior learning of the concepts and materials that will be covered during the class. Individual learners are required to study before the class and are responsible for their own conceptual learning of topics for the TBL lessons. The contents of reading assignments should include key concepts for the lessons, and understanding of those key concepts will be assessed at the next stage, i.e., *Readiness Assurance Process*. Instructors can also ask learners to search additional information and references for given topics and integrate those information and references with other learning materials. Organizing key concepts involves summarizing, reviewing, and integrating key concepts learners have read and studied during the *Pre-Class Preparation* stage. Through these processes, individual learners prepare for the following *Readiness Assurance Process*.

Third, the *Readiness Assurance Process* stage involves introducing a TBL lesson, individual & team test, team appeal, instructor's feedback, and summarizing key concepts & understanding. A TBL lesson in the class begins with the *Readiness Assurance Process*. Introducing a TBL lesson includes orienting students about TBL, forming teams, developing team rules, and checking students' prior learning of topics for the lesson. Then, students are asked to complete an individual test, which is often a multiple choice test with 4-5 questions. The purpose of the test is to check whether students have understood fundamental knowledge and concepts covered in the learning materials and reading assignments they studied during the prior *Pre-Class Preparation* stage before the class. After the individual test, a team test follows. The team test has the same questions as the individual test. During the team test, team members are encouraged to discuss and debate whenever they have different answers. After team discussions each team decides their team answers for the test and writes down the answers on a paper or a team board. An instructor asks teams to raise the answer board simultaneously and then the instructor is able to quickly check whole class understanding. If answers are not correct, students return to the test questions and discuss further. Then, the teams are invited to appeal in writing answers they got incorrect due to ambiguity in questions or ambiguity in readings. The instructor can provide a mini lecture or clarifications on topics that many students showed difficulties or misconceptions. Through these processes, the instructor can assure that all students have acquired the fundamental knowledge and concepts necessary for the next stage, *Application Exercises*.

Fourth, the *Application Exercises* stage asks student teams to solve authentic problems by applying the knowledge and concepts that they studied prior the class and re-checked during the *Readiness Assurance Process* stage. This stage involves solving real-life problems, presenting & evaluating solutions, and evaluating team members. The instructor presents the class authentic problems from real-life cases. As a team, students solve the problems through collaboration and discussion. Often, the teams create artifacts to show their best solutions for the problems and they also need to justify their solutions. Student teams present and share their solutions/artifacts and they evaluate the solutions and justifications with each other. Through this *Application Exercises* stage, students will be able to make a link between conceptual knowledge they have acquired in the classroom and authentic problems that they would encounter in the real-life. Students are asked to peer-evaluate team members for their individual contribution to the team solutions. As a closure of the lesson, the instructor summarizes the lesson and students' accomplishments.

III. Design Principles for an S-TBL Model

For this paper, we developed instructional design principles for the Smart technology-enhanced Team-Based Learning (S-TBL) model by reviewing previous research on smart education and the TBL model in the field of educational technology, cognitive psychology, computer sciences, and instructional methods. The instructional design principles we developed for the S-TBL model are below.

- Principle 1. S-TBL should employ the same basic process of TBL as an instructional model.
- Principle 2. S-TBL should make a clear link between concepts and problems.
- Principle 3. S-TBL should provide authentic problems through a multimedia problem-set.
- Principle 4. S-TBL should provide various Internet resources in a structured way.
- Principle 5. S-TBL should systematically evaluate students' individual and team learning.
- Principle 6. S-TBL should promote effective interactions between students.

These six design principles will be able to guide us to develop an S-TBL model that can be effectively implemented in the classroom.

Principle 1. S-TBL should employ the same basic process of TBL as an instructional model.

The first design principle of S-TBL is to follow the same basic process of TBL, which is validated as an effective learning model. The new model should take advantage of smart technology-enhanced learning environments while maximizing the benefits of TBL as an instructional model. In other words, we adopt TBL as an instructional model, and in order to boost learning potentials of TBL we will utilize features and functions of smart technologies. For example, online learning environments can provide more dynamic, up-to-date, and various resources. Using smart devices, instructors can provide more immediate and individualized feedbacks. Interactive communication tools can foster inter- and intra-team communication and collaboration. In addition, we believe S-TBL should be worked in regular schools and classrooms where necessary smart technologies and devices are available rather than implementing in entirely online learning environments. Thus, we see TBL as the primary instructional model with smart technologies being background conditions and tools. From this principle, we will first analyze learning processes and activities of TBL that are validated to be effective in previous studies. Second, we will examine features and functions of smart technologies and smart devices available in regular schools and classrooms. Then, we will match learning processes and activities of TBL with supporting technologies.

Principle 2. S-TBL should make a clear link between concepts and problems.

Traditional textbooks often include general concept-based knowledge and principles. Contents in the textbooks are static and limited in the nature. Textbook-based instructions (often in the form of lectures) are also limited to concept learning. Students are given a limited chance to apply those concepts to real-life situations. On the other hand, Problem-Based Learning (PBL) focuses on problem solving processes. While PBL is widely employed in educational settings as an effective learning model to promote problem solving skills, the importance of conceptual understanding that is necessary to solve problems is often overlooked in PBL. There is no structure for learners to ensure concept understanding in the process of PBL. As a consequence, learners with limited prior knowledge often show difficulties in solving real-life problems. It is a distinctive feature of TBL that addresses the importance of both concept learning and authentic problem solving. TBL addresses the importance of real-life application of concepts and knowledge. The main activity of TBL is the Application Exercises stage, but in order to solve authentic problems at the Application Exercises stage, students should build understandings and acquire necessary concepts and knowledge through Pre-Class Preparation and Readiness Assurance Process. The links between concepts and real-life problems can be made both by instructor's guides or learners' own inferences and reasoning. As accumulating exercises with various related concepts, problems, and real-world cases, learner's schema will advance with more complicated and complex integration of concepts, problems, and real-world cases.

Principle 3. S-TBL should provide authentic problems through a multimedia problem-set.

The TBL model is designed to give learners responsibility for their own learning. Students should be ready for the class through their prior learning at the Pre-Class Preparation stage. Students are asked to solve real-life problems, applying their knowledge and understanding which are assumed to be acquired by individual studies.

Through learning materials and reading assignments at the Pre-Class Preparation stage and problems at the Application Exercises stage, students encounter various cases and problems. These cases and problems are complicated and unstructured problems found in real-life situations. S-TBL should present these complicated and unstructured authentic problems through multimedia such as movies, animations, images and sounds. In addition, S-TBL should develop an online multimedia problem-set so that learners and instructors can search and select appropriate problems for a given TBL topic. The problem-set should also provide necessary scaffolding and supports for solving the problems.

Principle 4. S-TBL should provide various Internet resources in a structured way.

S-TBL will allow learners to search, explore, and utilize various Internet resources related to concepts, problems and cases throughout the whole learning processes. Based on wireless Internet environments and individual smart devices, learners can engage in Resource-Based Learning. However, unlike Resource-Based Learning which learners are given a high level of control and responsibility for topics they explore, TBL sets boundaries for topics and themes learners investigate according to the specific processes of TBL. TBL instructors should review and pre-select Internet resources and provide them in a structured way. For example, instructors need to organize Internet information and resources, and present them as reading assignments. One way to organize Internet resources is categorizing information and resources by themes or topics, and hyperlinking related websites.

Principle 5. S-TBL should systematically evaluate students' individual and team learning.

One of the most promising features of S-TBL is a possibility of collecting students' learning activities and achievement records throughout the whole learning process, and in turn, evaluating performance based on various evaluation criteria. Evaluation in the traditional TBL includes the readiness assurance process for conceptual understanding; the quality, creativeness, effectiveness, and practicality of solutions to real-life problems; peer-evaluation on team members' contribution; and instructor's assessment on the degree of students' participation. Through these multiple evaluation processes at multiple points across the whole learning processes, instructors can effectively evaluate both individual and team performance based on learning activities and achievements within team practices. In addition, students are required to evaluate other teams' solutions (between teams evaluation), which becomes another learning opportunities for learners. Despite the merits of those multiple evaluation processes of TBL, it takes up too much time in evaluation. S-TBL has a potential to save times for evaluation by collecting related learning activities and achievement records (both individual and team) online and analyzing the records and providing evaluation results in real-time. Immediate and ongoing evaluation system on S-TBL will provide both instructors and students with on-time feedback.

Principle 6. S-TBL should promote effective interactions between students.

The Pre-Class Preparation stage in the conventional TBL is quite restricted to individualized learning as homework assignments. Thus, interactions between students rarely occur during this stage. S-TBL provides learners with an opportunity to interact more easily even during the Pre-Class Preparation stage through various communication tools. Both synchronous and asynchronous communications can be used for effective interactions. Moreover, multiple interactions like one-to-one interaction, one-to-many interactions, and many-to-many interactions can occur. However, if students are only interested in individual performances and accomplishments in this students-directed learning stage, interactions between students should be fostered through scaffolding and specific guidelines for effective interaction processes. In addition, during team activities, collaboration, and discussion among team members can be fostered through effective interaction and communication tools. Off-line and online communication and interaction can complement each other. Also, online communication and sharing tools enable students to exchange and co-construct multimedia artifacts and collective knowledge.

IV. Overview, Process, and Activities of the S-TBL Model

In referring to the six design principles, we have discussed in the previous section, we developed the S-TBL model. The S-TBL model allows learners to develop understanding through both individual and team activities. Learners will engage both interdependent and independent activities to produce desirable outcomes within a given timeline. S-TBL is expected to maximize the merits of the conventional TBL by taking advantage of

emerging smart technologies. The S-TBL model should create synergistic effects of TBL and smart technologies rather than a mere implementation of TBL in smart technology-enhanced environments. While S-TBL is based on TBL as a learning model, S-TBL should be able to further advance the conventional TBL model as adding on features and potentials of more effective learning.

Overall, S-TBL will follow the basic processes and stages of TBL. First, at the Lesson Planning stage instructors make a plan for S-TBL lessons. To make an S-TBL lesson plan, instructors first should decide for which subject area, which grade level, which time of an academic year S-TBL will be implemented. For example, some instructors may choose to employ S-TBL when they teach a regular subject in the curriculum, while others may decide to teach an after-school extra-curricular program, applying the S-TBL model. Some instructors may design a whole semester to be taught based on the S-TBL model, whereas others only plan an S-TBL based lesson on a specific topic only. Instructors can choose a subject or topic from the curriculum which is more suitable for the S-TBL model in its nature, or create a new topic for S-TBL by re-arranging and integrating existing topics and themes in the curriculum. After instructors choose subjects and/or topics of the S-TBL lesson, they need to identify future learners' levels of prior knowledge on the topic, Internet and smart technology experiences, and basic learning skills. Since familiarity and proficiency of smart technologies may vary across leaners, tutors or facilitators can be arranged to provide necessary personal supports during the class or during a pre-workshop. In addition, it is critical to check availabilities and conditions of smart technology facilities, devices, software, and contents beforehand. Instructors should have enough proficiency of operating smart technology devices and applications as both learning and teaching tools.

Moreover, it is important to develop a Learning Management System that is link to the S-TBL model. Learning Management System denoted as LMS should provide features and functions which allow to record individual learners' learning histories and to support information sharing and interaction among learners – e.g., discussion boards, 1:1 instant massaging or chatting and e-mail system. LMS can also support learners' Pre-Class Preparation by systematically presenting necessary information and resources. Concepts, information, related cases, and real-life problems are organized and stored in a database in multiple formats including text, movie, animation, graphic image, sounds, etc. Learners can find information or resources by searching through the database. LMS also collects all learning activities and artifacts throughout the whole processes and can analyze the activities and achievements. Instructors' feedback, peer-evaluation, and self-evaluation system are also available on S-TBL LMS.

Second, at the Pre-Class Preparation stage, learners will access to LMS, and review learning resources and readings concerning a topic of the lesson. Self-directed learning of key concepts, related cases and problems will be encouraged. When a learner encounters difficulties due to his level of understanding, an adaptive coaching system will guide the learner through scaffolding appropriate for his current competency level and learning potential. The Pre-Class Preparation involves not only acquiring key concept understanding, but also developing understanding for how those concepts can be applied in solving real-life problems. Through this stage, learners will find out which concepts they need to understand and which aspects of those key concepts are critical for the following learning processes.

Third, the basic process of the Readiness Assurance Process of S-TBL will be similar to the conventional TBL. Instructors can form teams (each team with 3-4 students) based on learners' achievement level and other characteristics. Instructors save information regarding team formation in LMS and then LMS automatically present related information to appropriate learners. Some information is available to everyone, while other information can be shared among team members only. At the beginning of this stage, each individual learner logs on to LMS and completes an online individual test. Instructors can compose a test by selecting appropriate test items from a database or an item bank. The individual test is automatically scored, and test results will be stored in LMS as one of individual learning achievement records. Both individual learners and the instructor can check the results, and personal feedback can be provided to learners. Then, as a team students complete a team test with the exact same questions as the individual test. During this team test, active interactions among team members are encouraged. Team members can discuss or debate when discrepancies in their answers occur. They can keep a record of their discussions and findings for future use. After discussion, each team decides their answers for the test, and the answers are stored and scored in LMS. The stored scores will be used to evaluate individual and team performance at the end. The instructor then check each team answers immediately and can judge which concepts learners have difficulties in understanding. Therefore, the instructor can more easily provide customized and immediate feedback. In turn, learners can clarify and strengthen their conceptual understanding.

Forth, at the Application Exercise stage, the instructors select appropriate real-life cases or problems from the problem-set database and present them to learners. Those cases and problems are not presented in a mere text form. Rather, they can be presented in various multimedia forms most appropriate to the nature of real-life cases or problems. Learners as a team solve the problems by applying concepts they have acquired from the previous

stages and also utilizing Internet information and resources. Solutions to the problems can be in a text form or multimedia artifacts. Learners share their solutions online and other teams are invited to evaluate the solutions/artifacts. Learners can decide which final products should be public and which interim products and processes should be shared within a team only. However, the instructor can view the whole learning processes of individual and team activities. After between team evaluation on team solutions/artifacts, students are asked to complete self-evaluation and peer-evaluation. Self-evaluation helps each student reflect their own learning processes and performance. Through self-evaluation, learners can be more aware of the responsibility for their own learning. Peer-evaluation asks students to assess the level of participations and contributions of team members. Team scores are based on the effectiveness, creativeness, and practicality of the solutions; or other criteria that the instructor and the class have set for the lesson can be used. Finally, the instructor wraps-up the lesson by summarizing the concepts, cases and problems investigated during the lesson.

IV. Conclusion and Suggesion

This paper proposed a new learning model called S-TBL, which is based on the conventional TBL model with adding on known merits of smart technologies. S-TBL is expected to maximize the effects of TBL by utilizing smart technologies – e.g., wireless Internet, 1:1 smart devices, and appropriate applications. In particular, S-TBL can be effective to foster self-directed learning skills and at the same time collaborative problem solving skills. However, in order to ensure the effects of S-TBL in the real classrooms, a verification process of the model is required. Field research is needed to verify the effectiveness of the conceptual model and to enhance usability and usefulness of the model in real classroom settings. Developmental research or formative research can be implemented to verify the effectiveness of the model, and revise & improve the conceptual model to be more practical working model. Also future research should evaluate validity of the model and assess the completeness of the model. One to one expert evaluation, small group evaluation, and focus group interviews can be employed to identify problems and issues of each element of the model. A survey of current status of Internet and smart technologies in schools is important. In particular, the Learning Management System should be customized to support features and functions specific to S-TBL such as Pre-Class Preparation, Readiness Assurance Process, and various evaluation processes.

In order to implement the S-TBL model in the real schools, both a short-term and long-term plan for introduction and adaption of the S-TBL model are critical. In addition to research on the learning model itself, it is important to raise awareness of S-TBL among teachers, students, parents, and school administrators through workshops and guidebooks. Also media literacy of instructors should be strengthened to prepare for smart technology-enhanced learning environments. Concerning technological innovations in schools, often teachers are regarded as a critical changing agent who can bring a visible and lasting success in technology-rich learning and teaching experiences. Some teachers are tech-savvy and willing to accept changes, whereas many more teachers are reluctant to changes. Thus, professional development for S-TBL should consider not only technical aspects of S-TBL implementation, but also fundamental discussions on learning and teaching issues in technology-rich environments. Finally, specific guidebooks and manuals on how to implement S-TBL in schools will enhance usability of the S-TBL model in the field.

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