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# 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 (S-TBL). We designed a novel instructional model that combines mobile technology, collaborative teamwork, a problem-solving process, and a variety of evaluation techniques from the viewpoint of a conventional team-based model. Based on the traditional TBL model, we have integrated smart learning technologies: 1) to provide a holistic learning environment that integrates learning resources, assessment tools, and problem solving spaces; and 2) to enhance collaboration and communication between team members and between an instructor and his or her students. The S-TBL instructional approach combines: 1) individual learning and collaborative team learning; 2) conceptual learning and problem-solving & critical thinking; 3) both individual and group assessment; 4) self-directed learning and teacher-led instruction; and 5) personal reflection and publication.

Key words : Team-Based Learning, Smart Learning, Smart Technologies, Instructional Model

# 스마트 테크놀로지를 활용한 팀 기반 학습 모형 설계 연구

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**요 약**

본 연구의 목적은 스마트 테크놀로지를 활용한 팀 기반 학습(Smart technology-enhanced Team-Based Learning, S-TBL) 모형 설계를 위한 디자인 원칙과 S-TBL의 개요, 절차 및 활동을 개념화하는 것이다. 이를 위해 기존의 팀 기반 학습(Team-Based Learning, TBL) 모형을 기반으로 모바일 테크놀로지, 협력학습, 문제해결학습과 다양한 평가 모형들을 종합한 학습 모형을 설계하였다. 기존의 TBL 모형을 기반으로 스마트 테크놀로지 학습 환경에서 적용 가능한 학습 모형을 설계함에 있어 1) 학습 자원, 평가 도구, 문제해결상황과 문제해결과정을 통합하는 총체적인 학습 환경을 제공하고, 2) 팀 구성원 간 및 교수자와 학습자 간 협력과 커뮤니케이션을 증대시킬 수 있는 환경 개발에 중점을 두었다. 이러한 S-TBL 모형은 1) 개별 학습과 협력적인 팀 학습을 통합하고, 2) 개념

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학습과 문제해결 및 비판적 사고력 신장을 위한 학습을 통합하며, 3) 개별 평가와 그룹 평가를 통합하고, 4) 자기주도적 학습과 강의식 설명 학습을 통합하고, 5) 개인적 성찰과 산출물의 공유를 통합할 수 있도록 설계되었다.

키워드 : 팀 기반 학습, 스마트 교육, 스마트 테크놀로지, 학습 모형

## 1. Introduction

These days smart technologies and smart devices including smart phones, smart pads (e.g., iPhone, iPad, Galaxy Tab), are becoming indispensable in our everyday lives. People are Internet surfing, shopping, and social networking with these smart technologies. Smart technologies have also changed education and schools not just our daily lives. Emerging technologies have provided education with both opportunities and challenges; opportunities we have dreamed of and challenges we need to overcome. The role of technologies on teaching and learning is getting more attention from educators, now more than ever before. Understanding the importance and potential of smart technologies has increased, leading the Korean government to develop the "Smart Education Strategic Plan" has made efforts to support schools to implement "Smart Education" using smart technologies and smart devices in the field[1][2]. The Ministry of Education in Korea has collaborated with schools and teachers to diffuse smart education by appointing research schools that adopt innovative technologies, and has developed and implemented new instructional models and materials for smart education.

Smart education through smart technologies is the most appropriate way 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 a high potential to provide customized learning content based on an individual learner's needs and problem-based cases, where students learn through peer collaboration rather than teacher-directed lectures[7]. Smart education also promotes knowledge-sharing and exchanges among learners, so that the content that is found in traditional textbooks can be reconstructed and regenerated. Smart technologies can also enable interactive collaboration and cooperation between students and between a teacher and his or her students. Moreover, smart technologies can bring advantageous changes to the teacher's role of being a facilitator, rather than an agent of knowledge-transfer. The students' role changes as well; they become self-directed and self-regulated learners; and the curriculum becomes 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 the possibilities and potential of smart education, others are rather skeptical of it. They have pointed out that the same pitfalls and problems with e-learning or ICT (Information Communication and Technology) education can be repeated with smart education. Smart education could become yet another fad that involves emerging technologies and devices. Technology itself cannot guarantee the desirable learning outcomes that many researchers and teachers are hoping for. As Clark (1983) has argued, new media itself cannot be guaranteed to cause a positive effect[9]. It is not the media itself, but the way those media are utilized in a learning

environment, that can change teaching and learning; and in turn, those changes can lead to desirable outcomes for learning.

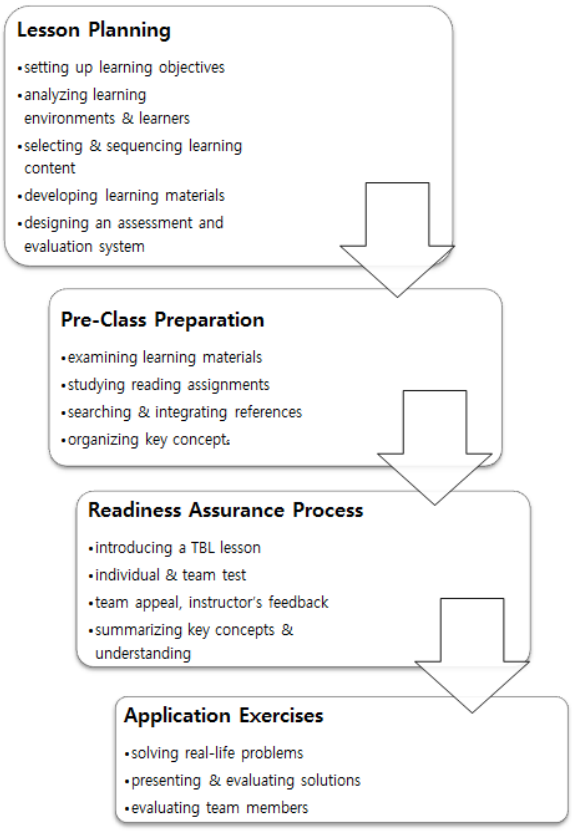
Thus, it is important to research how to maximize the educational potential of smart technologies by designing and developing instructional models, strategies, methods, and materials, which can be worked out in authentic educational settings[6]. As one promising instructional model, we propose Smart technology-enhanced Team-Based Learning (S-TBL). Team-Based Learning (TBL) is known to be 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 the 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 the actual development and implementation of S-TBL in the real classroom by providing a modified Team-Based Learning model that is designed to work 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?

## 2. Review of the Conventional Team-Based Learning Model

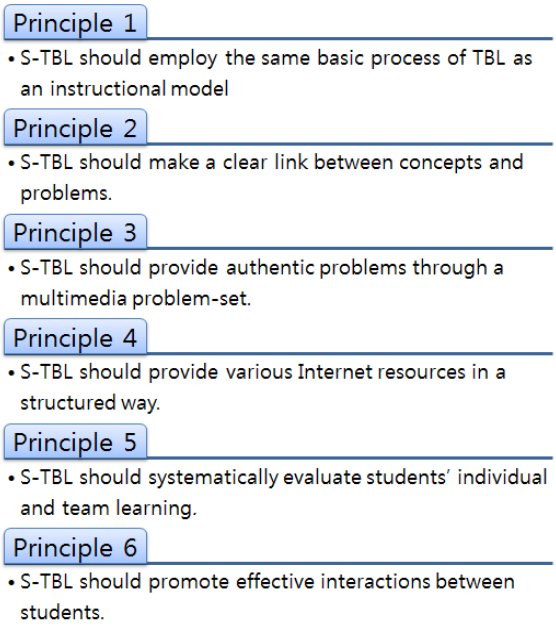
Team-Based Learning (TBL) is an instructional model that is based on procedures for developing high-performance learning teams that can enhance the quality of student learning in various fields. The educational effectiveness of TBL has been studies in various fields with diverse students[3][4][5][8][10][11][14]. The conventional TBL model is composed of the following four stages(see Fig. 1): Lesson Planning, Pre-Class Preparation, Readiness Assurance Process and Application Exercises[12][13].




(Figure 1) Team Based Learning procedures

## 3. Design Principles for a S-TBL Model

For this paper, we have 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(see Fig. 2). These six design principles will be able to guide us in developing a S-TBL model that can be effectively implemented in the classroom.




(Figure 2) Six principles of S-TBL

### 3.1 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[12][13]. 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 will 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 and up-to-date resources that are of a wider variety. Using smart devices, instructors can provide more immediate and individualized feedback. Interactive communication tools can foster inter- and intra-team communication and collaboration. In addition, we believe S-TBL should be used in regular schools and classrooms, where necessary smart technologies and devices are available, rather than implementing an entirely online learning environment. Thus, we see TBL as a primary instructional model with smart technologies supplying the 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.

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

Traditional textbooks often include general concept-based knowledge and principles. Textbook content is static and limited in nature. Textbook-based instruction (often in the form of lectures) is 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 ill-structured and authentic 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. In order to solve authentic problems at the Application Exercises stage, students should build understandings and acquire necessary concepts and knowledge through the Pre-Class Preparation and Readiness Assurance Process. The links between concepts and real-life problems can be made both by the instructor's guidance 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.

### 3.3 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, ill-structured and found in real-life situations. S-TBL should present these complicated and ill-structured authentic problems through multimedia, such as movies, animation, 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 support for solving the problems.

### 3.4 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, where learners are given a high level of control and responsibility for topics they explore, TBL sets boundaries for topics and themes that 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.

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

One of the most promising features of S-TBL is

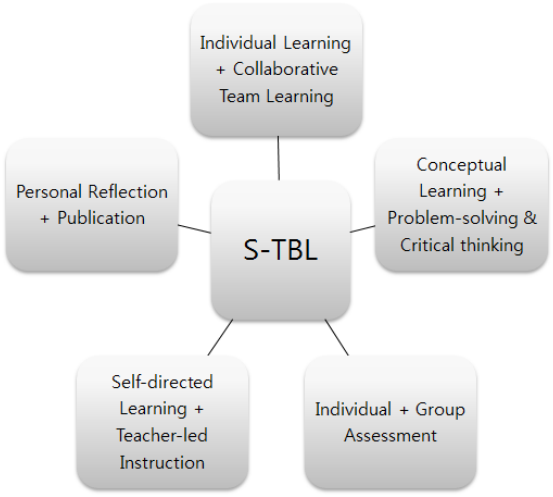
the possibility of collecting students' learning activities and achievement records throughout the whole learning process, and in turn, evaluating performance based on various evaluation criteria. Evaluation in the traditional TBL includes the readiness assurance process for conceptual understanding; 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 (an evaluation between teams), which becomes another learning opportunity. Despite the merits of those multiple evaluation processes of TBL, they take too much time in evaluation. S-TBL has the potential to save time evaluating by collecting related learning activities and achievement records (both individual and team) online and analyzing the records and providing evaluation results in real-time. An immediate and ongoing evaluation system on S-TBL will provide both instructors and students with on-time feedback.

### 3.6 Principle 6. S-TBL should promote effective interaction between students.

The Pre-Class Preparation stage in the conventional TBL is quite restricted to individualized learning regarding homework assignments. Thus, interaction between students rarely occurs 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 interaction. 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 performance and accomplishments in this student-directed learning stage, interaction 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.

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

Referring to the six design principles discussed in the previous section, we have 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 by adding features and increasing the potential for more effective learning.




(Figure 3) Integrating features of S-TBL

### 4.1 S-TBL Lesson Planning stage

Overall, S-TBL will follow the basic processes and stages of TBL. At the Lesson Planning stage, instructors make a plan for S-TBL lessons. To make an S-TBL lesson plan, instructors must first decide which subject area, grade level, and time of the 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 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 a learner's familiarity and proficiency of smart technologies may vary, tutors or facilitators can be arranged to provide necessary personal support during the class or during a pre-workshop. In addition, it is critical to check availability and conditions of smart technology facilities, devices, software, and content beforehand. Instructors should have enough proficiency in operating smart technology devices and applications for use as both a learning and a teaching tool.

Moreover, it is important to develop a Learning Management System (LMS) that is linked to the S-TBL model. LMS should provide features and functions, allowing the recording of individual learners' educational 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 and sounds. Learners can find information or resources by searching through the database. LMS also collects all learning activities and artifacts throughout the whole process and can analyze the activities and achievements. Instructors' feedback, peer-evaluation, and a self-evaluation system are also available on S-TBL LMS.

### 4.2 S-TBL Pre-Class Preparation stage

At the Pre-Class Preparation stage, learners will access the 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 or her 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.

### 4.3 S-TBL Readiness Assurance Process stage

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 levels and other characteristics. Instructors save information regarding team formation in LMS and then LMS automatically presents 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 a number of individual learning achievement records. Both the 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 interaction among team members is 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 each 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 both an individual's and the team's performance. The instructor then checks each team's answers immediately and can judge which concepts learners are having difficulty understanding. Therefore, the instructor can more easily provide customized and immediate feedback. In turn, learners can clarify and strengthen their conceptual understanding.

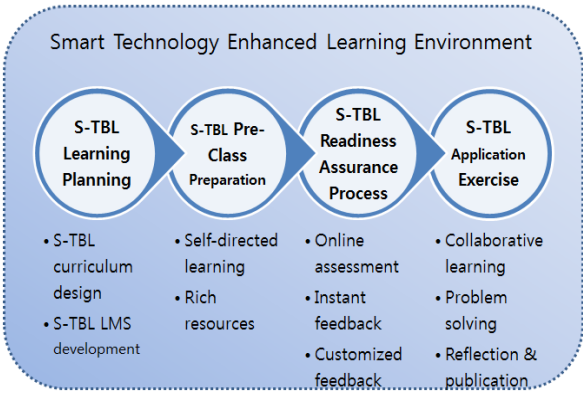
### 4.4 S-TBL Application Exercise stage

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 by 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.

A team evaluation consists of a few points. The team's solutions/artifacts are to be critiqued for accuracy and completeness. Students are also asked

to complete both a self-evaluation and a peer-evaluation. Self-evaluations help each student reflect upon 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 participation 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.




(Figure 4) S-TBL procedures

## 5. Conclusion and Suggestion

This paper proposed a new learning model called the S-TBL, which is based on the conventional TBL model, with the adding-on of 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 in fostering 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 classroom, a verification process of the proposed 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 and improve the conceptual model to be a more practical working model. Also, future research should evaluate the 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 the current status of Internet and smart technologies in schools is also critical. 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 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, instructor media literacy and instructional design expertise should be strengthened to prepare for smart technology-enhanced learning environments. Concerning technological innovations in schools, often teachers are regarded as critical change agents, who can bring visible and lasting success in technology-rich learning and teaching experiences[15]. Some teachers are tech-savvy and willing to accept changes, whereas many more teachers are reluctant. 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 the usability of the S-TBL model in the field.

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