

DEVELOPING AND ASSESSING TEAMWORK WITH ENHANCED TEAM-BASED LEARNING APPROACH

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ABSTRACT

Singapore Polytechnic (SP), Civil Engineering course reformed its curriculum according to the CDIO principles since 2004. Teamwork is an essential interpersonal skill in the CDIO syllabus to be integrated as an important learning outcome into the engineering curriculum. This important interpersonal skill is usually developed and assessed through project-based learning (PBL) approach. The author combined the approach of PBL and Team-based Learning (TBL) which is an active learning instructional strategy that engage learners as an individual or a group in thinking and problem-solving activities. TBL is an approach substantiated with four essential elements recommended by Michaelsen (2008) to ensure a successful implementation with highly reliable learning outcomes. It is an approach making opportunities in a blended learning environment with group work central to both exposure and enhancement of learner's ability to apply the course content to their project work. This paper describes the infusion of team-based learning essential elements into the classroom and a mini-project in a blended learning environment to develop and assess teamwork skills. Learning activities are designed for students to apply their course content knowledge that they have learnt in the course. The paper then presents summaries of results for both quantitative and qualitative students' feedback as well as identifies the implications for enhancing practice in teamwork development and assessment.

KEYWORDS

Team-based learning, project-based learning, blended learning, teamwork, assessment, journaling, peer assessment, Standard: 2,3,8, 11.

INTRODUCTION

Skills to work in a team and as a team have become an important part of the working culture and many companies now look at these skills when evaluating a person for employment. Hence, it is important that students learn to work in a team environment so that they will have these skills when they enter the work force. Hence, it is important that students learn to work in a team environment so that they will have these skills when they enter the work force. From a literature review on teamwork skills (Richard Y. Chang(1994), Stephen C. Armstrong(2008), Maginn, Michael D.(2004)), it is gathered that in general, teamwork skills require to form an effective team include communication and active listening, resolving conflict, team diversity and team motivation. These skills are usually termed as teamwork in any group work project. Jessie Ee, et al. (2004, p.49) advocated the importance of a new approach in curriculum where the focus of instruction is shifted to encouraging strategic and motivated students, rather than delivering specific domain content. Developing teamwork skills has to go beyond the traditional

instruction and into a new approach such as team-based learning (TBL) for students to learn and practice and for lecturers to facilitate teamwork skills. The primary learning objective in TBL, resonated with Jessie E, et al. (2004) point on new approach in curriculum, is to go beyond covering content and focus on ensuring students have the opportunity to practice using course concepts to solve problems in small group learning with emphasis on both individual and group accountability (Michaelsen, et al., 2009).

However, monitoring and assessing teamwork is often not clear and sometime neglected. Assessment of teamwork is a tedious and difficult task and would be inaccurate and unfair if monitoring of teamwork can only be done during the classroom contact time. Monitoring is usually not possible outside the classroom. With the provision of technology, in particular, tools in Blackboard (BB) to trace the evidence of the team's communication and progressive work done outside the classroom contact time as well as Learning Activity Management System (LAMS) to administer self & peer assessment. This provision is important to create a blended learning environment which combines face-to-face instruction to achieve an independent and collaborative learning as well as a fair system of assessing teamwork.

A MINI PROJECT FOR STEEL STRUCTURE ANALYSIS, DESIGN & DETAILING OF A SINGLE STOREY BUILDING

Structural Steel Design & CAD is a core module offered in semester 2 of year 3 in the Diploma in Civil Engineering with Business (DCEB) which has been the final year capstone project integrated into the DCEB curriculum since it first adopted the CDIO approach.

The tasks of the mini project for students consist of load calculation, design of steel structural members to EuroCode, and 3D modelling and detailing of a real-world single storey frame building with minor modifications to better suit for students' learning of the module.

The module had been delivered in a traditional way supported partially by project-based learning approach until AY18/19. Team Based Learning (TBL) method has been introduced to this module in order to improve the students' performance in a holistic way, and hence the delivering of this module to students has been changed significantly ever since.

The min project was also re-developed in order to fit the key principles and practices of TBL.

TEAMWORK DEVELOPMENT

Team Based Learning

According to Michaelsen & Sweet (2008), the success of TBL lies in the following 4 essential elements of TBL successfully implemented:

- **Groups** - groups must be properly formed and managed,
- **Accountability** - students must be accountable for the quality of their individual and group work,
- **Feedback** - students must receive frequent and timely feedback, and
- **Assignment Design** - group assignments must promote both learning and team development.

Figure 1 represents our adapted TBL instructional activity with a mini-project (project-based learning) to enhance the assignment design element with real world context.

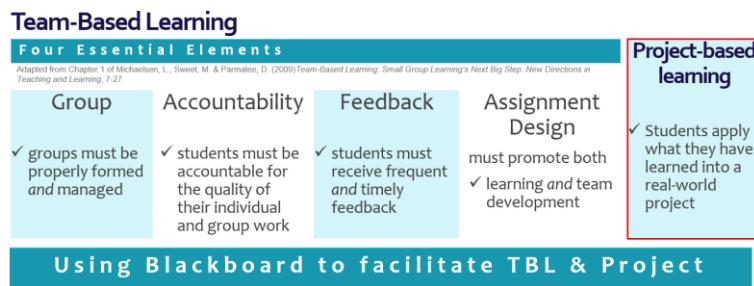


Figure 1. TBL Essential Elements adapted from Michaelson (2009)

TBL is designed to provide students with both conceptual and procedural knowledge (Michaelsen, 2009). Our approach to develop teamwork skills is to adopt blended learning which requires students to learn both in face-to-face (F2F) and out of the classroom with team-based learning as the primary enabling element and requires student to self-regulate in a guided environment with the help of technology. Self-regulated learners apply flexible approaches to problem-solving that are adaptive, persistent, self-controlled, strategic, and goal-oriented. Scott G Paris (2004, p58) recommended the following three ways to develop self-regulated learner which resonates with our self-directed learning (SDL) holistic implementation blueprint underpinned by SP SDL Model (2018) and Gibbons' model (2002).

- setting appropriate goals that are attainable yet challenging;
- managing time and resources through effective planning and monitoring;
- reviewing one's own learning, revising the approach, or even starting anew.

Majority of the class time is used for team assignments and focus on using course content to solve problems in a real-world project. Primary role of lecturer has shifted from delivering content to designing and managing the overall instructional process. Student's role shifts from being passive recipients of information to one of accepting responsibility for the initial exposure to the course content so that they will be prepared for the in-class teamwork and later for the mini-project. Susan A. Ambrose et al. (2010) indicated in her book on "How Learning Works" that research suggests when students are provided with a structure for organizing new information, they would learn more and better. The methodology adopted here is to pace the project specification requirement to align with the course content and to have a permanent or same group of teams working on their individual and group learning in the classroom and in their mini-project work. Figure 2 outlines how time in a one lesson (3 hrs) of TBL is organized in the context of Structural Steel Design & CAD final year module.

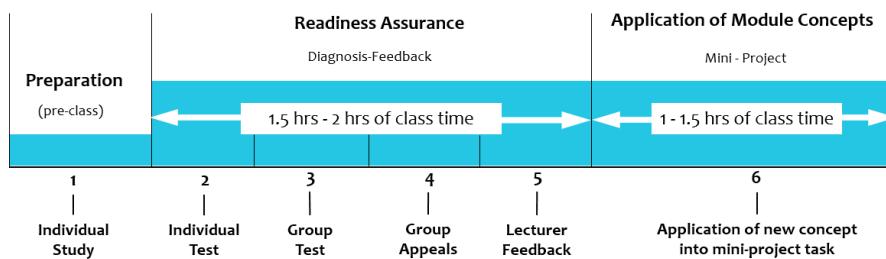


Figure 2. A Contextualised TBL Lesson

Students are strategically organised into permanent groups for the entire semester. Module content are designed and organised in topic to be in sync with the mini-project tasks as illustrated in a final year module - Structural Steel Design & CAD which is described in the later section. Before every lesson, students must study the scheduled topic because each lesson begins with the Readiness Assurance Test (RAT). This RAT consists of a short multiple-choice quiz (MCQ) or short questions depend on the topic. This is to test the key ideas of the topic which require students to first complete as individuals, and then they take the exact same test again as a team, coming to consensus on team answers. At the end of RAT, students receive immediate feedback on the team test and follow up with a time for lecturer to clarify any misconceptions arising from the test results. This can be done efficiently with the use of technology (BB - Item Analysis) * which allow lecturers to quickly see which questions might need revision and clarification with students. After the RAT is completed, the remaining time is spent on mini-project that require them to practice applying the module content. To encourage students to remain reflective throughout the project, they are required to write journal and record it as a blog in the Black Board e-learning portal. The blogs are only visible or private to the individual student or team and the facilitator.

*[*Item Analysis is a tool in BB that measure the effectiveness of MCQ.]*

Establish the Team

As the saying goes, a good beginning is of great importance to the success of any task. TBL requires the lecturer to form a diverse group with different learning ability as well as demographic characteristic such as gender and ethnicity to form an effective team. In this pilot run, diverse groupings are formed by the lecturer from the start with different learning ability by taking their overall grading in the course and two individual modules that contributes important prior knowledge as well as characteristic such as gender, class group and ethnicity.

Susan A. Ambrose et al. (2010) indicated in her book on "How Learning Works" that research has suggested when students are provided with a structure for organizing new information, they learn more and better. Although students have learned teamwork skill in another module, they would learn more and better during their application in the mini project if there is a structured methodology for them to follow. From a literature review in search for a structure, the steps to establish the team were adapted from Stephen C. Armstrong (2008). These steps are infused into the mini project as tasks that cover four activities that the team must complete in the classroom to make sure each group can function as effectively as possible both as a learning team and as a project team. The four activities are listed below:

Activity 1: Confirm Team Membership

The purpose of this activity is to form a diverse team with a mix of learning abilities based on their GPA and demographic characteristics like gender and ethnicity (this is done by the lecturer before the term starts). This is also to get the team to assign role according to their strengths. They are also encouraged to rotate their roles to experience different role in a team.

Activity 2: Common Understanding

The purpose of this activity is to make sure everyone in the team has a common understanding of what the TBL is and what this project is about, why they are here, and what the team will work on.

Activity 3: Agree on Team Rules and Operating Values

The purpose of this activity is to avoid some common predictable conflicts. Rules and operating values such as meeting start times, duration, locations, rules for late or missed meetings, etc. that the team must agree to.

Activity 4: Agree on Plan and Schedule

The purpose of this activity is to force the team to think through the steps required in activity 1 and develop an agreed plan and schedule against which to measure progress with the required deliverables and deadline constraints.

Students are expected to document their work done in these activities and post to BB-Group so that the team can refer to them anytime and anywhere. With the use of technology, monitoring of teamwork has become possible with evidence of work done, minutes of meeting and discussion notes that the team has posted to BB-Group.

Teamwork Assessment

The new approach in curriculum which has the focus of instruction shifted to encourage strategic and motivated students, rather than delivering curricula or managing classroom behaviour (Jessie Ee, et al., 2004) will result in a change in teamwork assessment. Both assessment and instruction need to be synchronized. Dochy (2001) referred to assessment as not only measuring knowledge gained but also student involvement, their application of that knowledge, integration in learning environment and knowledge construction in real life situations.

The assessment on the mini-project is based on the group work done in and out of the class each week and the journal blog in the e-learning portal in BB. Rubrics are used in assessing the students' performance in the mini project. While rubric may address the assessment on technical content and attributes by the lecturer with evidence of work done in the e-learning portal, a more complete assessment is necessary on teamwork outside the classroom.

Self & Peer Assessment

Teamwork and its dialogue session outside the classroom can be further assessed by self & peer assessment. Peer assessment involves using peers' comments in assessing the quality of assignments [Roberts, 2006]. Generally, there are two forms of techniques of self and peer assessment in teamwork. Technique 1 is for teamwork weightage that does not contribute much to the project/activity final marks. Technique 2 is where teamwork is very much emphasized and contributes a high weightage to the project final marks. Technique 2 is adopted here for the self and peer evaluation. Five categories of assessing teamwork effectiveness were taken from www.CATME.org (a free website) for the self & peer evaluation. The five categories are:

1. contributing to the team's work;
2. Interacting with teammates;
3. Keeping the team on track;
4. Expecting quality;
5. Having relevant KSAs (knowledge, skills and abilities).

We believed that these 5 teamwork competencies are the essentials to build teamwork skills that include communication and active listening, resolving conflict, team diversity and team motivation.

Self and peer assessment were usually done at end of the project. This acts as a summative assessment instead of a formative assessment for learning. In order to do a formative assessment for learning, self-assessment is conducted at the mid of the semester for learners to do self-reflection on their contributions, giving them time to catch up with their contribution and to do improvement as well as for lecturers to adjust instructional strategy when necessary. At the end of semester, learners will then do the peer assessment.

Self & peer assessment is administered through two different tools because of administration challenges and benefit in each tool. Self-assessment is administered through BB at mid semester and self & peer-assessment is administered through LAMS at end of semester. BB has the flexibility to deploy self-assessment independent of peer assessment. LAMS though has no such flexibility, but it has a good mechanism to calculate an adjustment factor (SPA factor) to convert group marks into an individual mark for a project. A SPA factor of > 1 indicates a student's contribution was rated above the average contribution of the team. A SPA factor of < 1 indicates student's contribution rated below the average contribution of the team.

STUDENT FEEDBACK AND DISCUSSION

A survey was conducted at the end of the learning experience to gauge the effectiveness and relevancy of TBL and self & peer assessment. Feedback survey of students at three instances were carried out:

- a) From 2 groups of students who have experienced the new approach of teaching (TBL) in an elective module and the formative self & peer assessment administered through BB with no SPA factor considered (25+26 students and 50 responded) in AY19-20 term 1 and 2 respectively.
- b) from 2 groups of students who have experienced the new approach of teaching (TBL) in the core module as described in this paper and the formative self & peer assessment administered through BB with no SPA factor considered (17+17 students and 28 responded) in AY19-20 semester 2.
- c) from another 1 group of students who have experienced the new approach of teaching (TBL) fully online in an elective module and the formative self-assessment administered through BB and summative self & peer assessment administered through LAMS (24 students and 21 responded) at end of AY20-21 term 1.

They were asked to respond to questionnaires with rating of 1(not true) to 5(very true). Quantitative and qualitative responses were collated and tabulated in Table 3a – Learning Experience, Table 1b – Self & Peer Assessment and Table 1c – Using Technology to manage and monitor Learning and Project.

Table 1. Percentage of Responses > rating 4

a) Learning Experience

Question	Case				
	AY19-20 Sem 1 Elective (a)		AY19-20 Sem 2 Core (b)	Average of (a) and (b)	AY20-21 Elective
	(25 students)	(25 students)	(25 students)		(c) (21 students)
	Term 1	Term 2	Term 1 & 2		Term 1
Formative Self & Peer Assessment	BB	BB	BB	BB & LAMS	
a) It gives me a chance to reflect on my contributions early so that I can make improvements.	68%	88%	72%	76%	81%
b) It gives me more time to assess my team members based on their contribution they have input.	68%	88%	72%	76%	62%
c) It is a more fair and meaningful peer assessment	44%	88%	52%	62%	72%

b) Formative Self & Peer Assessment

Question	Case			
	AY19-20 Sem 1 Elective (a) (25 students)	AY19-20 Sem 2 Core (a) (25 students)	AY20-21 Elective (b) (21 students)	AY20-21 Elective (c) (21 students)
Learning Experience:				
a) It has given me more time or opportunities to learn and work as a group	60%	84%	76%	77%
b) It has helped me to be more aware of my learning progress (e.g. using BB - my Grade and feedback to your readiness test either in the classroom or via BB)	60%	88%	76%	81%
c) It has helped me to improve my learning, either because of the help from my group or because I am able to help	56%	84%	76%	67%
d) It has helped me by giving me opportunities to connect the knowledge I have learnt and applied it in my project	60%	84%	92%	77%
e) It has actively engaged me into focus learning weekly leading me to be a self-directed learner (SDL)(Note: a SDL plans, monitor & manage their own learning and extended their learning into other areas)	60%	76%	72%	67%

c) Percentage of Responses > rating 4 (Using Technology)

Question	Case	
	AY19-20 Sem 2 Core	AY20-21 Elective
	(b) (25 students)	(c) (21 students)
	Term 1 & 2	Term 1
Using Technology to manage and monitoring learning and project	BB	BB
a) It provides a platform to record reflection, discussion and work done by the team	76%	72%
b) It provides a platform to manage and monitor team progress	80%	57%
c) It provides a platform of work evidence done by each member and as a result teamwork assessment is fair.	68%	67%
d) It provides a platform and opportunity for us to feedback on each other work in the team.	56%	72%

Learning experience

Students' reflections on their learning experience in the new teaching approach were positive and encouraging. These reflections, together with the above percentage rating have indicated that students recognized the benefits of the enhanced TBL with the project-based learning integrated and to learn as both a learning and project team.

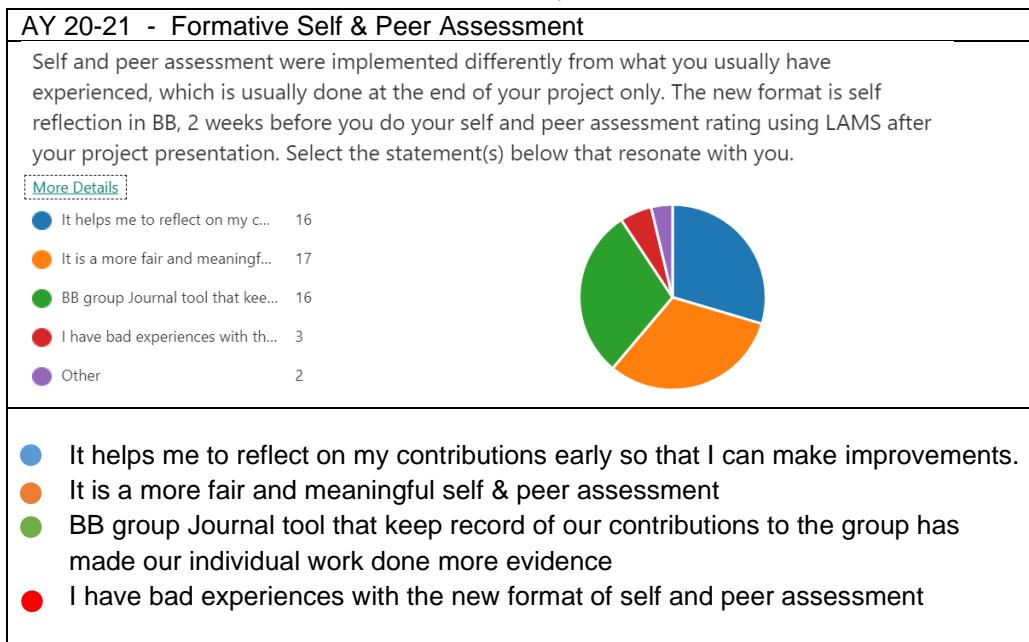
The improved percentage rating in the 2nd attempt in AY19-20 has indicated that lecturers' familiarity with the new teaching approach is a key consideration to improve students' learning experience. When the same teaching approach is ported to a different context module in AY 19-20, result has indicated an improved percentage rating at the opportunity to connect knowledge into project work (92%). Although the percentage rating for the 1st attempt in AY19-

20 term 1, had been on the lower side but their reflections on 1 thing they like most in this learning experience were encouraging. Things that they don't like were mostly either problem on the submission logistic or workload and some due to personal motivation challenges.

Formative Self & Peer Assessment

The percentage rating using BB as the administering tool were averaged (Table 1b) and compared to the case using BB & LAMS. The higher percentage rating in the AY20-21 term 1 has shown an improvement on the process by using both BB and LAMS to administer self & peer assessment. These results together with students' reflections as well as feedback from a mid-semester home based learning (HBL) survey tabulated in Table 2, indicated that students have benefited from this formative assessment. However, a lower percentage rating of 62% (Table 1b) has highlighted a possible need to further improve the process of peer assessment.

Table 2. Mid-semester HBL Survey on Self & Peer Assessment



Using Information and Communication Technology (ICT) to Manage and Monitoring Learning and Project Work

Assessment for learning in teamwork is now possible with more accuracy and efficiency with technology that allow lecturers to gain insight on their students' learning progress as a group and at the same time to allow students to do collaborative learning. However, the percentage rating in Table 2 have indicated that most students do not see the benefit of using technology to manage and monitor their learning and project progress.

Conversely, there were some qualitative students' reflections have shown otherwise. We believe if given repeated opportunities to students to practice using ICT to manage and monitor their learning and project over a period of time from year 1 to year 3 of their study in the course, they will then see the benefit and develop a habit of mind. As quoted by Aristotle, "We are what we repeatedly do. **Excellence**, then, is not an act, but a **habit**."

CONCLUSION

Teamwork skill is an essential part of any successful collaboration projects both in the context in the industry and in a school setting. Thus, it must be a part of the school training experience. With the advancement of technology that facilitate participatory information sharing and collaboration on the World Wide Web, TBL has assisted and improved the way lecturers develop, assess and monitor teamwork, as well as change the way students learn.

This new approach involves instructional shift from a traditional classroom to a blended learning classroom that needs learners to do pre-class reading and form learning team as well as changes in the assessment of teamwork. The pre-class learning is similar to the flipped learning which is also another blended learning format in which online work on key underpinning knowledge completed before more application-orientated work is facilitated in the face-to-face context (Bergmann & Sam's, 2012). TBL essential elements, especially the readiness test component can be seen as one of the approaches for facilitation to enhance students learning in the face-to-face context.

As we are switching to online instructions in an attempt to slow the rapidly evolving COVID19 pandemic, many are scrambling to convert F2F classes to online classes – a process that take some thoughts and often takes weeks or months of preparation and now has to be done in a matter of days. Not only has this sudden turn-around forced us to scramble but changing delivery methods has left many of us wondering how we are going to provide a seamless learning experience to our students. Those who are already using the Information and Communication Technology (ICT) to manage and monitor learning and especially project work have benefited as they continued seamlessly to facilitate learning and project work using the ICT. An ICT initiative to manage and monitor project work that the main author has been trying to instil into both teaching staff and students for many years is now made possible for 100% adoption by a pandemic without much resistance. They now see the necessity and urgency to use ICT.

In conclusion, this paper represents the work of a few iteration of an action research in finding new approaches to develop teamwork and its assessment. Future investigations will further improve and validate the development of teamwork skills and its assessment in addition to TBL as well as self and peer assessment in assessing teamwork.

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BIOGRAPHICAL INFORMATION

Soo-Ng Geok Ling passion for teaching and technology can be traced back to my early-professional days with her first job in supporting the transforming construction industry to use IT solutions in engineering projects. The reason? She likes getting people excited about how technology can help them to be efficient. She is now a senior lecturer in the School of Architecture and the Built Environment at the Singapore Polytechnic. She is committed to education through improving students' learning and mentor teaching staff through effective professional development.

Dr Tao Nengfu is a specialist in School of Architecture and the Built Environment, Singapore Polytechnic. His current scholarly interests are Computer Science, Structural Engineering, Soil Dynamics and Earthquake Engineering.

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