NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE
Centre for Research and Development in Learning

CRADLE HIGHLIGHTS

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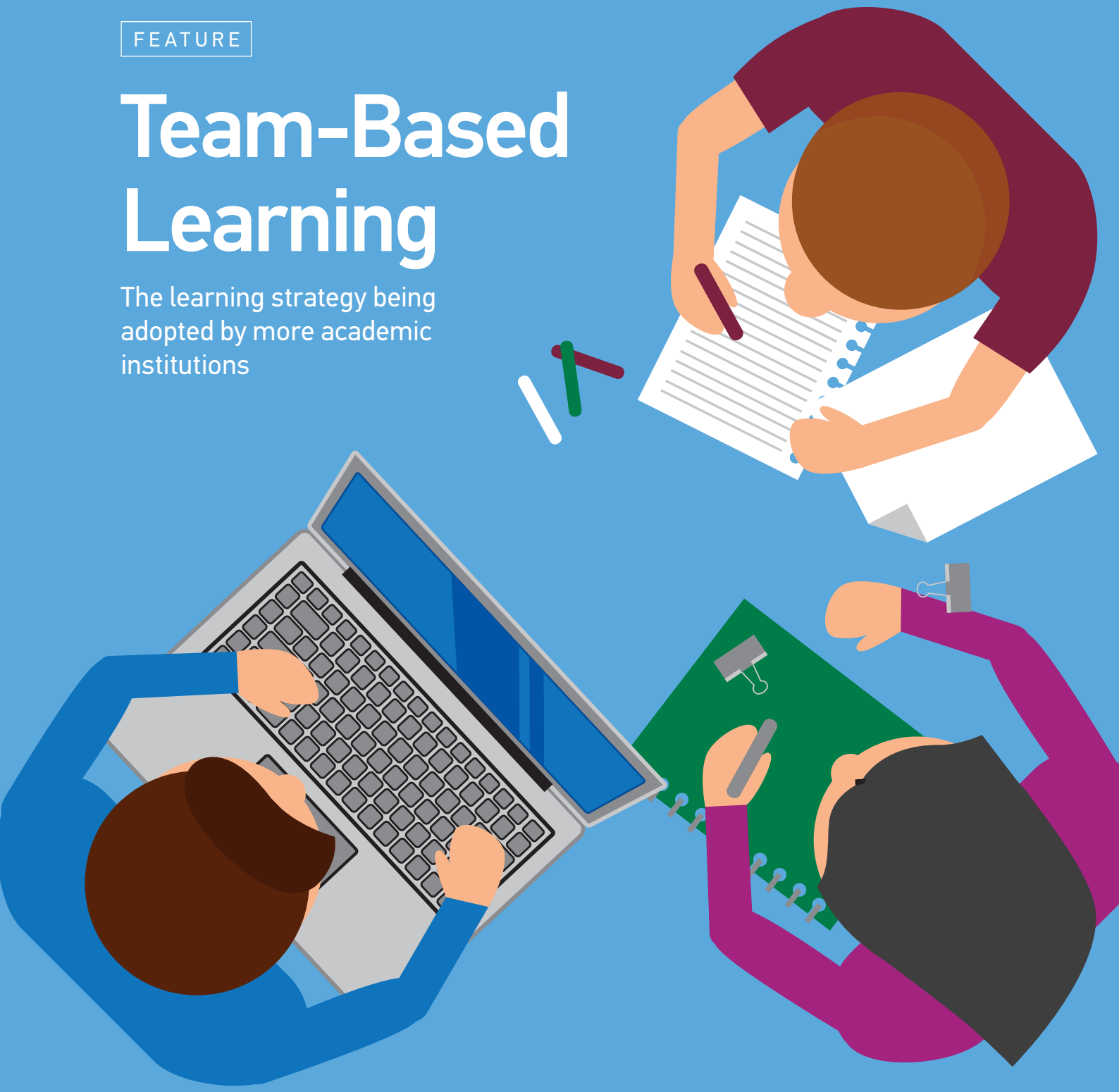
in this issue

FEATURE

Team-Based Learning

The learning strategy being adopted by more academic institutions



From the Editorial Desk

It is with great pleasure that we bring you this inaugural issue of CRADLE@NTU's newsletter, CRADLE Highlights.

Since its inception in 2014, the Centre for Research and Development in Learning (CRADLE@NTU) has been focused on fulfilling the vision upon which it was set up - a research hub founded to conduct research and development related to teaching and learning within tertiary institutions and the context of adult continuing education. Our goal is to coordinate, facilitate, and support researchers from various disciplines in conducting impactful translational research on the University's pedagogical strategies. Through interdisciplinary research, we hope to develop into a transdisciplinary Science of Learning research hub.

As a driver of change in NTU's education system, we focus on the innovation and enhancement of the university's learning initiatives in the foreseeable future. Young as we may seem, CRADLE@NTU has launched numerous learning-focused research ventures, including the evaluation of technology-enhanced learning; the development of effective biliteracy among learners; and the development of learning analytics to examine students' learning processes and outcomes.

Our founding director, the late Professor Lee Sing Kong once said, "NTU has high hopes that the students would effectively contribute to knowledge creation and industry practice in a highly globalised economy." He strongly believed that through CRADLE@NTU's research efforts, evidence-based learning interventions that will help university professors hone 21st-century skills int their students can be developed.

CRADLE Highlights is an e-newsletter that documents our centre's key research efforts. Our debut issue is devoted to Team-Based Learning – a nearly four-decade old learning pedagogy pioneered by American educator, Larry Michaelsen, which focuses on the development of students' self-directed learning and group accountability. We hope you enjoy reading about its adoption within international institutions and in Singapore.

As with all other endeavours driven by purpose, CRADLE@NTU seeks your long-term partnership in making tertiary and life-long learning a fun and transformative one.

The Editorial Team,

CRADLE Highlights

About CRADLE Highlights

The current e-publication marks the inaugural issue of CRADLE Highlights, which will be circulated among NTU's teaching and research staff, to promote breakthrough pedagogical approaches and impact learning within the university and beyond.

Its e-pages will feature innovative learning pedagogies of global interest, teaching tips, teaching anecdotes, and research updates on learning-purposed topics including intercultural exchanges; data analytics; utilisation of campus learning spaces; system-driven retrieval of students' performance data; interdisciplinary reasoning and communication; and the application of brain imaging techniques and neuroscientific evidence to the design of teaching strategies. ■

Dr Larry Michaelsen

Team-Based Learning:

In Retrospect

History has records of education being a highly motivated individual endeavour. According to Compton, Kamei, and Cook (2016), this individualistic learning style continued to the beginning of 20th century schooling, when American reformist Abraham Flexner questioned the for-profit motivations and lack of accountability in Western education systems. His critiques marshalled more pronounced strategies to streamline teaching techniques, which remained dependent on the one-way relay of lectures that produced a generation of passive learners for another 50 years from 1910 to 1960.

Post this period, Larry Michaelsen's Team-based Learning (TBL), one of the most prominent,and longevous learning strategies from the late 20th-century, provided the basis for the development of breakthrough teaching techniques. Given its minimal resource demands, the seeds of TBL were scattered in US medical campuses across nine different states, where the more noticeable academic outcomes were felt by the bottom 20% of each cohort.

TBL depended on self-managed teams that distributed teaching and learning functions evenly among students. Michaelsen's 1970's Socratic approach involved facilitating problem-solving discussions that engaged a large class of about 120 students, where each student as motivated to prepare for each class activity. This method helped promote group accountability and collective understanding of how to apply classroom learning, and transforming students from being competitive players to collaborative team players.

Today, the approach is the pedagogy of choice in a few NTU schools, with targeted aims of promoting critical and creative thinking, communication skills, leadership, and discipline knowledge competency among Singapore's future industry professionals. ■

TBL

In Theory & Practice

Team-based learning's American roots have taken place in various global institutions situated in Australia, Europe, Asia, and the Middle East. Today, it is the pedagogical approach of choice in Singapore's top medical schools. It is also one of the key initiatives in NTU's 2020 education strategy, which will impact the University's five key research thrusts, namely, Sustainable Earth, Global Asia, Secure Community, Healthy Society and Future Learning.

Theoretical underpinnings of TBL

According to Hrynchak and Batty (2012), TBL is a direct application of constructivist learning, which regards knowing as a process involving collective thoughts and personal experiences. Much like proponents of the TBL, constructivists acknowledge

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that learning should be learner-centred, where there are opportunities for learners to engage in solving real-life problems, instead of being handed fact-based knowledge by instructors. Learners also enhance their learning experience through dialogue and interaction with co-learners. All these elements are consistent with TBL, which allows students to take ownership of their learning experiences in teams with maximal diversity. ■

> "TBL is a direct application of constructivist learning, which regards knowing as a process involving collective thoughts and personal experiences."

Advantages of TBL

Hunt and colleagues (2003) remarked that TBL can be readily adopted even with low-cost resources and high faculty-student ratio. No intensive capital for refurbishments of school resources and spaces is required, but significant outcomes can be expected from the development of self-managing and cohesive teams that call for minimal supervision from content experts.

Beyond logistics and administrative ease of adoption, this approach promotes teamwork, problem-solving; knowledge retention; communication; collaborative learning; leadership; disciplinary knowledge competence; and individual and group accountability, the key collective skills required in industry practice.

These outcomes are possible through the presence of four elements: 1) self-managing groups; 2) individual and group accountability; 3) frequent and timely feedback; and 4) group assignments that promote the application of classroom concepts. The approach is carried out in a three-stage process:

1. Pre-class preparation through individual study
2. Readiness assessment tests taken individually (individual readiness assessment – iRA) and in collaboration with other team members (team readiness assessment – tRA)
3. Group exercises where students answer problem sets, do reports or write appeals for their group answers

Local Adoption

In NTU, the adoption has been heavily technology-driven since it was first practiced by the Lee Kong Chian School of Medicine (LKCSoM) in 2013 – a grand leap from decades-old manual hand out of course materials, and administration of quizzes with pen and paper (refer to LKCSoM's TBL Booklet for details). Today, the TBL approach is widely practiced in Nanyang Business School, School of Humanities and Social Sciences, and the Renaissance Engineering Programme (REP).

The University is actively investing in electronic and physical resources to help facilitate collaborative learning. In LKCSoM, each student s provided a school-issued iPad pre-installed with in-house and purpose-built learning applications hat house pre-recorded learning materials, which students can access anytime, anywhere. Both TBL individual and group quizzes are administered through iLAMS, a re-engineered system of open access software designed for collaborative activities.

The LKCSoM e-Learning ecosystem is neatly integrated with and supported by the University-wide IT initiatives such as the $S75 million investment for Technology-Enhanced Learning (TEL) and Flipped Classroom Pedagogy. Offline, NTU hosts a list of physical facilities that promote collective learning. The Hive, a $S45 million learning hub situated in NTU's South Spine, and the Arc, NTU's latest learning hub located in the North Spine were designed to provide more social learning spaces. Other "team-based" spaces such as interactive seminar rooms and learning studios are now staples in campus structures. ■

EVIDENCE-BASED LEARNING OUTCOMES

Studies found positive effects of TBL on students' discipline competencies and academic performance.

Michaelsen and Sweet (2011) observed diversity and plurality of well-informed opinions among team members in TBL environment.

Koles and associates (2010) demonstrated the significant contribution of TBL to the achievement of higher exam scores by both top performing and academically challenged students.

McInerney and Dee Fink (2003) reported that students who engaged in group projects performed better in exams than those who did not.

Carmichael (2009) found TBL students having better scores on first three semestral exams, more As and Bs, and fewer Ds and Fs for final marks than students in lecture-style courses.

Vogler and Robinson (2016) observed students, who had the chance to collaborate with their teams during the first half of the semester, performed at least one score higher on eight or more difficult exam items compared to students who did not.

Thomas and Bowen (2011) reported significantly higher exam scores for the TBL portion of courses examined.

Haberyan (2007) observed students enrolled in TBL structured industrial / organizational psychology course scored higher in post-test versus pre-test.

Chung and colleagues (2009) found that students' performance in group readiness assurance test (GRAT) was significantly higher than their performance in individual RAT for a TBL-taught medical ethics course.

Kuhne-Eversmann and fellow researchers (2008) reported that joint decisions on paper cases drove students' post-test mean scores up by 23.1% from their pre-test scores.

Note: References on Page 7.

CRADLE@NTU

At the frontline of local TBL academic research

CRADLE@NTU is currently at the frontline of a number of academic research projects. Initiated in Singapore's local tertiary landscape, these projects assess the impact of the TBL pedagogy on students' formation of soft skills, and learning outcomes derived from engagement in e-Learning ecosystems. CRADLE's research efforts aim to contribute to the TBL literature pool, which has been dominated by a Western scholarship from the traditional fields of medicine and healthcare.

Patterns of TBL engagement behaviour

The centre's first instalment in the extensive TBL study is an applied research initiative titled, "Developing a Computational Modelling Framework of Student Engagement in NTU's Team-Based Learning Ecosystem." The project is funded by NTU's start-up grant led by a project team consisting of Dr Hong Huaqing of CRADLE@NTU, Associate Professor Andy Khong of the School of Electrical and Electronic Engineering, and Mr Paul Gagnon of the LKCSoM e-Learning and IT services department.

The project focuses on developing a computational modelling framework of student engagement in NTU's self-directed learning (SDL) and TBL environments, where LKCSoM's TBL ecosystem acted as a starting point. The ecosystem, designed to integrate seamlessly with, as well as support, the delivery of a mobile, self-directed, and paperless curriculum experience, s built upon an e-Learning framework known as the TERASA (Technology Enabled Resources, Activities, Support and Assessment; Gagnon et al., 2017).

Empirical data from the computational modelling framework provides dynamic reports relaed to emergent student online engagement behaviour and patterns, identify salient variables related to the effectiveness of the learning ecosystem, and eventually assist in predicting students' learning outcomes and behaviours.

The project is particularly interested in the following three aspects of students' online engagement: i) the total time students spent on tasks; ii) students' continuity or sustained time spent for each task; and iii) the emergent correlations between time on task and student performance on formative assessments over the course of each teaching block within, and throughout students' academic years. Results of the current analysis may impact our

understanding of the level of students' engagement in SDL and TBL, and inform the design of potentially universal e-learning ecosystems.

This study comes on the heels of the university's launch of the Technology-Enabled Learning (TEL) initiative, where at least half of existing course modules will be migrated online and enhanced with interactive features. This move is a game-changer in the industry; through TBL and SDL, course information can now be transmitted online in multimedia while promoting students' initiative and resourcefulness in taking ownership of their education.

TBL as a tool in the formation of soft skills

Another topicCRADLE is currently conceptualizing focuses on examining the impact of TBL on students' achievement, leadership, communication, and teamwork abilities across differential disciplines. The project in preparation is CRADLE@NTU's collaboration with NTU's Teaching, Learning, and Pedagogy Division (TLPD), Lee Kong Chian School of Medicine (LKCSoM), Nanyang Business School (NBS), National Institute of Education (NIE), and School of Physical and Mathematical Sciences (SPMS).

Although there are existing studies investigating the impact of TBL on examination performance (e.g., Fatmi et al., 2013; Sisk, 2011; Dwanson, et al., 2017), assessments of students' teamwork, communication skills, and leadership abilities are limited to self-reports or observation studies. We believe it is pertinent to conduct a systematic exploration of TBL's impact on the development of students' leadership identities and communication skills across multiple disciplines within Singapore's higher education landscape.

Through the adoption of the TBL pedagogy in select schools, this project will investigate ways in which the university can promote critical 21st-century skills that ill empower students to become effective contributors in a global, knowledge-based economy. The project aims to investigate how learning attitudes, behaviour, academic performances, and interactions within student-teams change over the course of TBL-styled programmes, and the relationship among these changes. The project will also attempt to investigate the diverse effectiveness of TBL across disciplines and learning spaces.

A pedagogical objective of TBL s to impart life competencies in addition to a fostering of academic achievement, both of which are necessary for addressing a human capital performance gap in most industries.

This project will involve students from our collaborators, LKCSoM, REP, SPMS, and NIE, an examination of the students' profiles, and observations of changes in their attitudes, behaviours, discipline knowledge, and team-interaction patterns over the course of their programme. These measures will be triangulated with data from logged online activities, face-to-face class interactions, and participation in focus group discussions.

We believe this study as the potential to go beyond a documentation of TBL's effectiveness in boosting students' academic performance; we expect evidence of TBL's role in encouraging the development of soft skills to have far-reaching effects on furthering TBL's implementation, scholarship, and application. ■

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Testimonials from NTU TBL practitioners

"I have implemented TBL in my course for more than 3 years now. I have found TBL to be highly effective in three areas: student preparation, collaborative learning, and quality of class discussion. With TBL, students are better prepared and hence, their readiness to learn is strongly evident at the start of each session. TBL really provides an enabling context for students to learn collaboratively. With TBL, the application exercises facilitate quality class discussion where students go beyond content to real world applications."

Associate Professor Tan Joo Seng
Deputy Director, Renaissance Engineering Programme,
Associate Professor Division of Strategy, Management and Organisation
College of Business (Nanyang Business School)

"I have conducted one REP course using the TBL mode. I find that it's quite effective as almost all students come puctual and prepared, I am able to carry out the iRAT and tRAT tests smoothly. Also, most students like the application exercise session and it involves more difficult questions. They have opportunities to ask questions and clarify their doubts."

Associate Professor Teh Kah Chan
Assistant Chair (Academic), School of Electrical & Electronic Engineering
Fellow, Renaissance Engineering Programme

"I have been using TBL for a few years now. It is an important first step in encouraging active learning. Peer assessment is one issue that requires some adjustment."

Associate Professor Christopher Shearwood
Fellow, Renaissance Engineering Programme
Associate Professor, School of Mechanical & Aerospace Engineering

"Getting the students to work together in groups helps them a lot with their studies; it enhances engagement and also boosts their soft skills. And it is more fun."

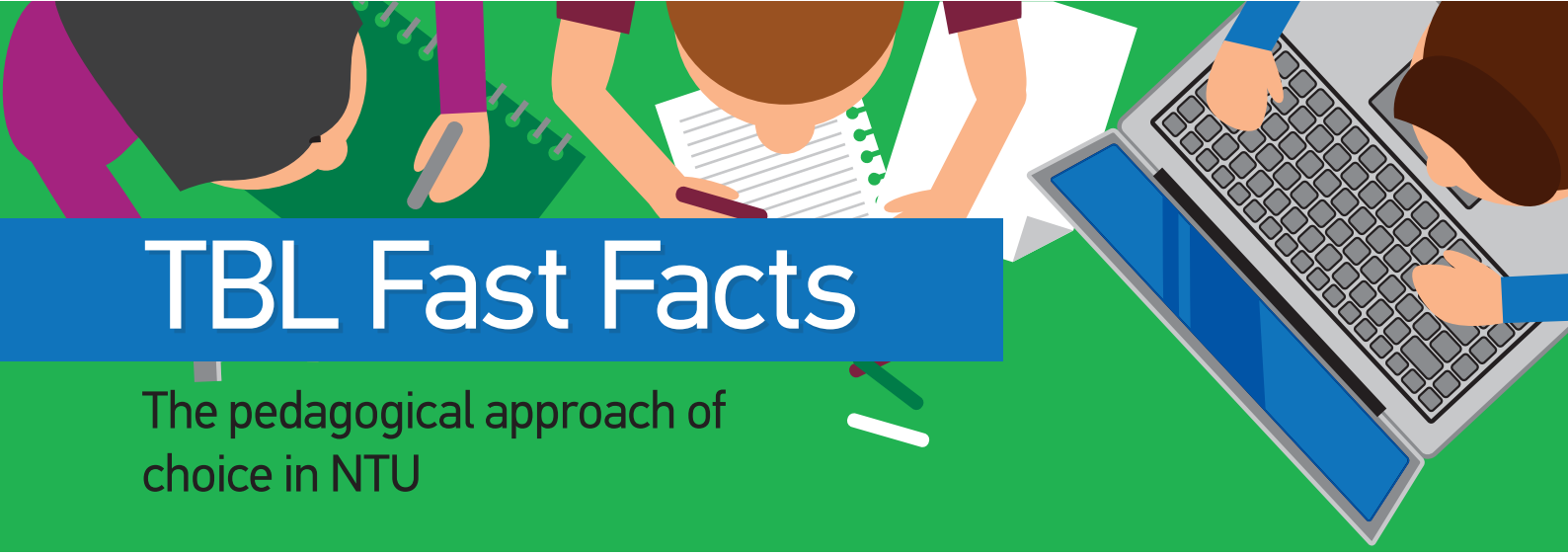
Associate Professor Roderick Wayland Bates
Associate Chair (Faculty), School of Physical & Mathematical Sciences
Division of Chemistry & Biological Chemistry, School of Physical & Mathematical Sciences

"I first implemented Team-Based Learning (TBL) approach for the course, RE1002-ELECTRONICS &INFORMATION ENG I in Semester 2 of AY2015-2016. The second round of the TBL course in AY2016-2017 Semester 1 has concluded. For the course I am teaching, the weekly 3-hr TBL class requires students to prepare before the class. They need to watch a number of online videos, read through the uploaded lecture notes, and work out the solution for a list of application exercises. The TBL class begins with an individual readiness assessment test called iRat, followed by group test called team readiness assessment test, tRat, and lastly, class discussion on the various application exercises."

Associate Professor Goh Wang Ling
Fellow, Renaissance Engineering Programme
School of Electrical and Electronic Engineering

"I have implemented TBL in RE8005 Financial Management course in the Renaissance Engineering Programme. The TBL pedagogy allows students to focus on the application of concepts and tools to solve problems in a collaborative manner. Students learn to work in teams and also take responsibility to learn the concepts in the pre-reading materials. These are important life skills that students should have in the real world."

Associate Professor Ho Kim Wai
Associate Professor of Banking and Finance
Nanyang Business School



TBL Fast Facts

The pedagogical approach of choice in NTU

Globally adopted

Adopted in at least 10 countries.

Length of togetherness

Teams ideally stay for at least 6 months to strengthen trust and cohesiveness among members.

Team membership

Teams composed of 5 to 7 members for optimal effects.

Promotes

Individual readiness, group accountability, and practical application of theories.

"Collaboration allows teachers to capture each other's fund of collective intelligence."

- Mike Schmoker

CRADLE Highlights

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