

INSTITUTIONAL TEAMWORK SKILLS DEVELOPMENT AND MEASUREMENT AT SINGAPORE POLYTECHNIC

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ABSTRACT

Teamwork or collaboration is recognised by many governments and international agencies as an essential life skill and competency in the workplace. Employers almost always rank teamwork among the top competencies expected of college graduates. In Singapore, SkillsFuture Singapore (a government agency driving skills equipping at the national level) identifies it as a core skill, and it is reflected in the MOE (Ministry of Education) framework for 21st Century Competences. At the Singapore Polytechnic (SP), collaboration skill is one of our graduate attributes. To hone collaboration skill, many educational institutions incorporate collaborative exercises and teamwork projects as learning experiences for students. While such learning activities increase the opportunities for team interaction, putting students in a group does not necessarily lead to the development of teamwork skills. To effectively develop teamwork skill, teamwork learning activities need to be carefully designed and integrated throughout the course. Empirical studies have shown that teamwork skills improved after students were systematically given explicit teamwork instruction, opportunities to practise teamwork skills and formative feedback on their teamwork skills across their curriculum. This paper describes how teamwork skills development and measurement is holistically and systematically supported and developed in SP. The journey starts with an educational innovation project by an academic staff which led to a small-scale pilot project in AY20/21 before scaling to an institution-wide roll-out to all students joining SP in the AY23/24. The goal of this teamwork project is twofold: firstly, to develop teamwork skills systematically over a three-year diploma course, and secondly, to obtain psychometrically reliable and valid teamwork scores to inform the development of teamwork skills in SP students, leading to the award of a Teamwork Metric at graduation. The metric enables the quantification and evaluation of collaborative performance, providing a critical foundation for assessing and improving teamwork skills within an educational setting.

KEYWORDS

Teamwork, Interpersonal Skill Development, Interpersonal Skill Assessment, Peer Feedback, Standards: 2, 3, 11

INTRODUCTION

Numerous innovative approaches to cultivating teamwork skills have emerged, with dedicated efforts focused on class activities or modules (Ling & Tao, 2021; Ng & Tan, 2021). While individual learning activities within classes or modules are valuable, it is crucial to recognize that mastering teamwork skills goes beyond a single module. Research suggests that explicit instructions, practice opportunities and formative feedback enhance teamwork skills. Zou and Ko (2012) showed that teamwork skills improved after the Hong Kong University of Science and Technology students were systematically given explicit teamwork instructions, opportunities to practise and formative feedback across their three-year curriculum. Other researchers echo the usefulness of multiple learning experiences and longitudinal measurements over the program rather than within single modules (Siciliano, 1999; Donia, Mach, O'Neill, & Brutus, 2022; Farland & Beck, 2019). This adds another layer of challenge to the academic administration system as it must track teamwork skills development across different modules and course-level aggregated teamwork skill measurement. This challenge is compounded when the teamwork award is meant for the entire population of students across the whole institution. To address the challenge, the academic administration system must, at the very least, be able to track the teamwork skills development across different modules to produce a course-level aggregated teamwork skills measurement.

LITERATURE REVIEW

While a substantial body of implementation studies addresses the scaling of educational innovations (Wyss & Robinson, 2021; List, Suskind, & Supplee, 2021; Robinson, Wyss, & Hannahan, 2021), there is a paucity of research specifically targeting the scale-up implementation of teamwork skills development at the institutional level. Despite the importance of scaling as observed by Mickelsson, Kronlid, & Lotz-Sisitka (2019), they noted that views on scaling educational activities were often vague. Others suggested that the concept of scaling is under-researched, particularly in education and learning fields (Mickelsson, 2018) and highlighted the lack of theoretical frameworks underpinning it (Harwell, 2012; Fischer, et al., 2015).

SP's institutional implementation of the development and measurement of teamwork skills in all courses adds to the knowledge of how to scale, especially in teamwork skills development. The implementation process will be elaborated using the innovation-learning-scaling up process developed by Linn, Hartmann, Kharas, Kohl and Massler, 2010, as illustrated in Figure 1. In the beginning, the impact of our new educational innovation experiences was limited and slow. To achieve greater impact, the project had to be scaled up. Through capacity development and learning from the pilot project, an institutional scale-up plan was developed and implemented.

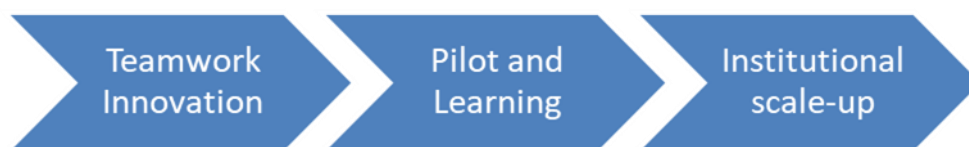


Figure 1. From innovation to pilot to institutional scale-up

SINGAPORE POLYTECHNIC (SP) INSTITUTIONAL CONTEXT

In this paper, teamwork is viewed as an individual skills-set that students deploy, to contribute to the success of groups or teams they are a part of (Hughes & Jones, 2011). Collaboration is an SP graduate attribute. The other five are: competency & versatility; creativity, innovation & enterprise; ethics & responsible citizenry; self-directedness & personal effectiveness; and global mind-set. These attributes lie at the heart of our SP Education Model. In this paper, teamwork and collaboration are used interchangeably.

TEAMWORK EDUCATIONAL INNOVATION PROJECT

The seed for the Teamwork Project (TWP) was planted by an academic staff, whose interactions with two visiting academics kick-started his personal learning journey and practices in fostering communication and collaboration among students in his course. He experimented with forming diverse teams, held students accountable for their own growth in teamwork skills through self and peer assessment and deployed team-based learning pedagogy in his classes. When he started, he used Excel spreadsheets to manually compile his students' self and peer assessment feedback. The institution's timely acquisition of Learning Activity Management System (LAMS) allowed the staff to leverage on the system to automate the rollout of the self and peer assessment (SPA) teamwork survey to fellow colleagues teaching the same course, online. The SPA survey comprises the five quantitative and two qualitative CATME (Comprehensive Assessment of Team Member Effectiveness) questions. The CATME instrument was developed by Ohland, et al., (2012) for use in colleges to measure teamwork skills and is derived from literature on teamwork effectiveness. The five quantitative questions in this self and peer evaluation instrument are: (1) Contributing to the team's work, (2) Interacting with teammates, (3) Keeping the team on track, (4) Expecting quality, and (5) Having relevant knowledge, skills and abilities (KSAs).

The staff began sharing his learning experiences informally, at various institutional platforms such as Excellence in Education & Teaching Convention (EETC) and the Pedagogy Committee. This encouraged colleagues in other schools to experiment with the SPA teamwork measure in their own classes. In 2017, the SPA teamwork measure came to the attention of senior management at SP when the staff had the opportunity to share on "Team-based Learning Made Easy" with visitors to the institution. The accompanying delegation from SP included the PCEO (Principal & Chief Executive Officer). Interest was expressed in tracking students' teamwork skills development over the three years at SP.

PILOT AND LEARNING

At the request of SP's PCEO, a modest institutional pilot of the SPA teamwork measure to one three-year diploma course in every school (the "one-school-one-course" pilot) in the institution began in AY 2020/2021 with the Year 1 cohort. The teamwork data of students in these courses were collected over their three-year diploma course. The head of the then Academic Quality unit (AQ) was tasked to oversee its implementation. What began organically as one staff's personal project gaining traction with pockets of colleagues in different schools who continued using the teamwork measure after trying and finding it useful and easy to use, took a more

coordinated direction, with the AQ Head working with appointed staff in each school to track the implementation of the teamwork measure in each school's designated course.

In the "one-school-one-course" pilot phase, the focus was on the systematic measurement of teamwork skills for one class of students from one course in each school over their three years of study (or six semesters), with one teamwork measurement taken in each semester. The initial set of teamwork measurement data was collected and analyzed to assess its validity and reliability. Continual effort was made to gather a comprehensive dataset of six teamwork measures for the student cohort. All schools were invited to participate in this teamwork pilot project before the 2020 Academic Year (AY20/21). Eight courses responded to this pilot invitation.

Teamwork Measurement Implementation

In this pilot, students conduct self-assessments (SA), and peer assessments (PA) of team members. In addition to administering the survey, LAMS has also been programmed by the vendor to compute the SPA (Performance factor) and SAPA (Self-Assessment to Peer Assessment) factors using the self and peer assessment data collected. LAMS also sends feedback reports to students after each SPA exercise. In addition, the lecturer downloads class reports from LAMS for developmental feedback to students and for grading teamwork contributions.

As the measurement of students' self-assessment and peer assessment of teamwork skills is planned once a semester over their three years of study, this works out to six teamwork measurements for each student. Figure 2 gives an example of the teamwork data measurement for students enrolled in the Diploma in Civil Engineering (DCE). The course team from DCE began by identifying six modules with substantial teamwork learning activities across the three-year course for the AY20/21 cohort of students. As illustrated in Figure 2, students carry out their teamwork assessments in BE8131 and BE8136 modules in Year 1; BE8231 and BE8234 in Year 2; and BE8307 and BE8335 in Year 3.

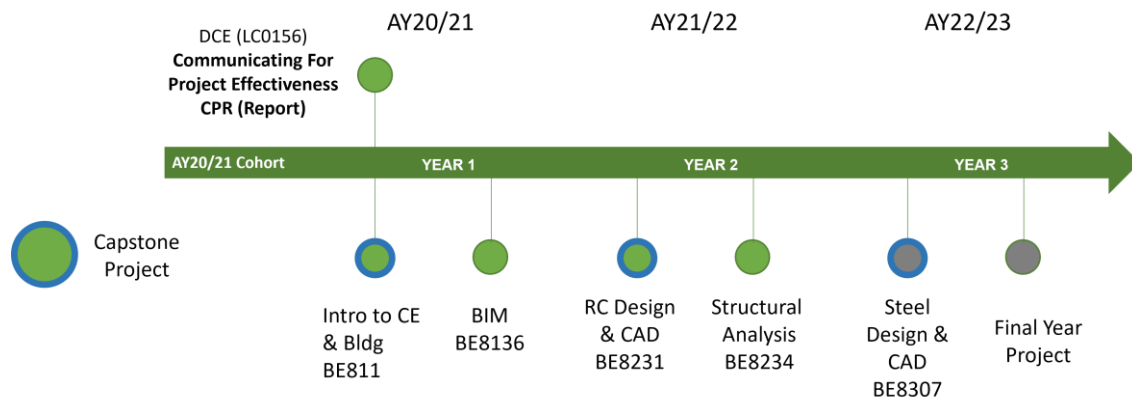


Figure 2. Teamwork measurement implementation

As it was made known to everyone involved at the start of the pilot phase that the final goal is to extend the teamwork measurement to all students, it was important that the pilot phase ascertained the usefulness of the teamwork measure assessment for participating students, prepare the ground, and gleaned the necessary input to develop the scale-up plan. The pilot

phase thus provided the space to learn through experimentation. The following sections discuss what we learnt about the usefulness of the teamwork measurement and instrument, the data collected to develop the scale-up plan, and which also affirmed SP's readiness to scale up.

Usefulness of Teamwork Measurement Exercise and Instrument

Staff and Students' Survey on the SPA Teamwork Measure

In AY22/23 Semester 1, 16 staff teaching 40 SIP (Sustainable Innovation Project) module classes (comprising 836 students) piloted the teamwork measure in their classes over a semester while 26 staff and 46 classes (comprising 570 students) did so in the following semester, AY22/23, Semester 2. In both semesters, the teamwork measure was carried out in Week 6 (as a mid-semester or "formative" assessment) and in Week 17 (as an end-semester or "summative" assessment) in the 45-hour, 15-week, semester-long module.

At the end of each semester, a separate online survey was carried out with staff and students, to understand how they felt about using the teamwork measure as a lecturer and as a student. 13 out of 16 staff who took part in the AY22/23, Semester 1 pilot took part in the survey (a response rate of 81%). 5 out of the 11 new staff users (those who were not part of the pilot in Semester 1) took part in the Semester 2 survey (a response rate of 46% among the new users). Key findings from the staff survey for Semester 1 and 2 are shown in Table 1:

Table 1. Key Findings from Staff Survey at End of AY22/23, Semester 1 and 2

No	Survey Questions	Strongly Agree/Agree ratings over a 5-point scale	
		AY22/23, Semester 1	AY22/23, Semester 2
1	Important to have two SPA touchpoints (formative and summative)	92%	100%
2	SPA supports my observations about students' teamwork skills	100%	83.4%
3	SPA gives additional insights about students' teamwork skills	92%	100%
4	SPA is useful for giving feedback to teammates on their contributions	92%	100%
5	SPA is useful in identifying 'free riders'	85%	67%
6	SPA is useful for students to evaluate their own contributions	100%	83%
7	I want to continue using SPA	100%	100%

Staff feedback for the two semesters show a positive view of the teamwork measure as a useful tool for corroborating, and augmenting, their observations about students' teamwork skills and teamwork contribution, and in the value of the tool in allowing students to give feedback to one another and for self-evaluation. Most importantly, all express a wish to continue using SPA.

Table 2 shows key findings from the same end-of-semester survey conducted with students who took part in the teamwork measure pilot in Semester 1 and 2.

Table 2. Key Findings from Student Survey at End of AY22/23, Semester 1 and 2

		AY22/23, Semester 1	AY22/23, Semester 2
	Quantitative Feedback Received	(300 respondents out of a possible 836; response rate: 36%)	(222 respondents out of a possible 570; response rate: 39%)
No	Survey Questions	Strongly Agree/Agree	Strongly Agree/Agree
1	Used SPA before	78%	73%
2	Find SPA easy to use	98%	95%
3	Useful for giving feedback to <u>teammates</u> on their contribution to the SIP project	92%	87%
4	Useful for evaluating their <u>own</u> contribution to the SIP project	79%	78%
5	Useful in identifying 'free riders'	85%	87%
6	Know how to interpret the SPA data they receive	87%	84%
7	Find the Mid-Semester or formative SPA exercise helpful in identifying areas for improvement	90%	84%

The key finding (Table 2, results for survey questions 3, 4 and 5) is that students in the SIP-SPA pilot found SPA a useful tool for giving feedback to teammates and for receiving feedback from teammates on their contribution to the team. This is corroborated by most qualitative comments given on how SPA allowed them to give honest (because it is anonymous) feedback to teammates and lecturer, and how it tells them what they can improve on and how they did as a team member.

Even more striking is the emphasis students gave on SPA as a feedback tool for self-improvement (“I learn to improve based on feedback I receive from my teammates”, “able to identify which areas I am strong in through positive feedback given”, “It helps me reflect on my contribution”, “Knowing what my teammates think about my performance allows me to work more on my areas of improvement”), as opposed to SPA being a tool for giving feedback to teammates on how *they* can do better.

Student feedback from both semesters suggest they find the SPA teamwork measure “convenient and simple to use” that it is an “easy platform to give feedback on” and that they would like to “keep using it in the future” if not “make it compulsory”. This is emphatic endorsement from students on the use of SPA in SIP.

Feedback from Companies

SP also piloted the use of the SPA teamwork measure with 10 internship companies at the start of AY22/23, Semester 1. At the end of the internship program, an online survey was conducted with Supervisors and SP interns, to understand their internship-SPA experience.

We analyzed internship-SPA results, reviewed interns' SP-SPA records (where applicable, as not all interns had done SPA before in SP), and spoke with their lecturer in-charge and a company supervisor. Key findings are: internship-SPA results were consistent with SP-SPA results, and this suggests that the SPA teamwork measure could be a useful teamwork developmental tool while students are still in school; the SPA teamwork measure is especially useful at the workplace where team members have worked with each other for a period and can give meaningful feedback to one another; and the SPA teamwork measure has the potential to provide rich data for personal and team growth, and for staff development and appraisal at the workplace.

The positive and rich teamwork learning experiences from the internship-SPA pilot with companies adopting the self- and peer-assessment model was important validation for the use of the SPA teamwork measure in SP and for making it available to other modules. The favourable survey feedback from students, staff and industry provided a strong signal for scaling up the teamwork measurement to the entire student population.

Institutional Scale-up Plan

Finding the Route to Scale

During the one-school-one-course pilot phase, another institutional initiative, the compulsory, Common Core Curriculum (CCC), was also being rolled out. CCC aims to equip students for a rapidly evolving and unpredictable world. The opportunity to synergise the teamwork measurement initiative with CCC arose when it became apparent that three CCC modules; Collaboration in the Digital Age (CDA), Data Fluency (DF) and Social Innovation Project (SIP) involve learning in teams and would be keen to include the SPA teamwork measurement. The inclusion of these three CCC modules provided a high level of confidence that the teamwork measure institutional scale-up plan would be achievable as all students will carry out teamwork measurements in three CCC modules (indicated by orange coloured outline) and in at least three domain modules (indicated by black coloured outline), as shown in Figure 3.

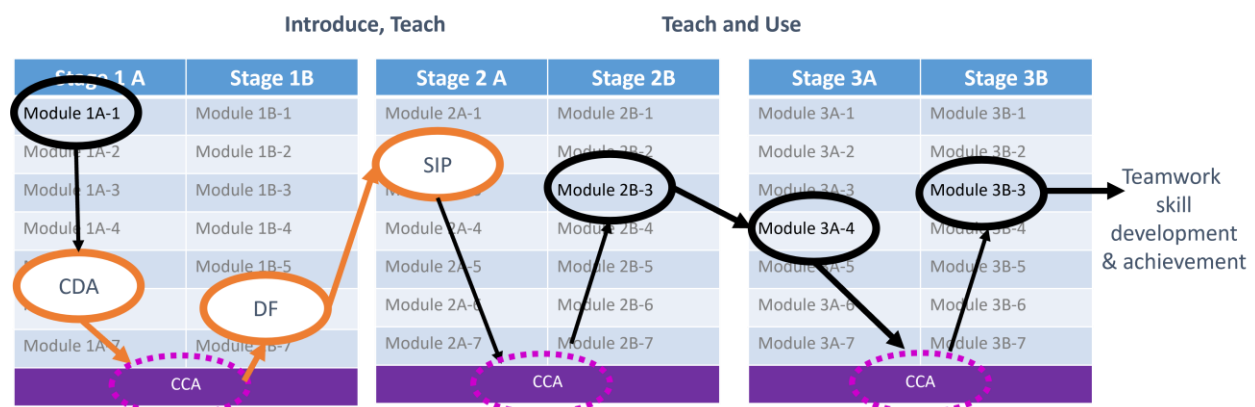


Figure 3. Route to institutional scale up by tapping on 3 CCC modules (CDA, DF and SIP)

Designing an Integrated Curriculum to Develop Teamwork Skills of Students Across Every 3-Year Diploma Course

What is more important, with the inclusion of the Common Core Curriculum (CCC), is that all students will be on-boarded in a consistent and systematic way, through CDA (which aims to develop collaboration skills). In addition to the three CCC modules, the other domain modules are selected based on their suitability. Project modules and those employing relevant pedagogical approaches like team-based learning and problem-based learning are modules included in this scale-up plan. Through this institutional scale up model, a curriculum that facilitates the development and monitoring of teamwork skills throughout the three-year course was realized.

To confirm the exact number and specific modules to be included in the teamwork measurement scale-up implementation plan, the project team met with cluster teams consisting of school directors, as well as course teams. This collaborative effort resulted in the identification of at least six suitable modules for inclusion in every three-year course. In the scale-up phase, students will be introduced to the SPA teamwork measure and taught teamwork skills in the CDA module. They will then use and practise teamwork skills in SIP and other domain modules.

Implementing a Consistent and Rigorous Teamwork Skill Measurement Across the 3-Year Course

In the institutional scale up, all students who join SP in AY23/24 and after, will be awarded a teamwork metric at the end of their three-year course. This makes it crucial that the teamwork assessments are consistently carried out throughout the institution. To facilitate a robust and consistent practice in the institutional roll-out, the following tools and practices were put in place: (1) a common teamwork measurement instrument was used. A common CATME instrument with the same five quantitative questions and teamwork assessment is conducted on the same LAMS survey system; (2) consistent on-boarding and teamwork skills development (introduce-teach-use) for all students through CDA, DF and SIP (compulsory CCC modules). Similarly, a consistent on-boarding through standardised training was also implemented for staff. All teaching staff who will be carrying out the SPA teamwork measurement in their module(s) are trained through the same workshop offered at institutional level and this consists of a half-day training that includes an overview of the importance of teamwork, and technical functions and features of the SPA teamwork tool from the students' and staff's perspective; and (3) a consistent and rigorous way of conducting teamwork measurement that comprises both "formative" and "summative" teamwork assessments. The exception is when it is a small module of 15 hours or when the module runs only in a particular term instead of over the entire semester. In addition, best practices for peer evaluation including the recommended flow for conducting SPA, are taught to staff.

Readiness to Scale

To foster widespread participation in this institutional scale-up plan, it was crucial to instil confidence in staff and management by showing proof of the level of readiness. The level of readiness is demonstrated through the reliability and validity of measurement data, commitment of key stakeholders, capacity development and IT readiness.

Validity and Reliability Test of Measurement Data

A quality teamwork measurement adds credibility and provides greater confidence when we use them. Two general criteria for evaluating psychometric measurements are reliability and validity (Jhangiani, Chiang, & Price, 2015). Significant correlations were obtained in the inter-rater and test-retest reliability of the teamwork measurements obtained from the pilot phase (Pee & Chue, 2022).

Commitment of Key Stakeholders

To generate interest and commitment for the teamwork scale-up, multiple levels of engagements were conducted from May to August 2022. A total of 10 meetings were held with various stakeholders, including (1) School POCs (Points of Contact), (2) Principal Management Team, and (3) Senior Directors and Directors. The meetings served several purposes: progress updates for schools and institution, negotiations to reach common ground, securing buy-in, surfacing challenges encountered, encouraging participation and addressing requests for assistance. Two explicit outcomes were achieved from these engagements; the commitment to participate and the identification of modules in every course that would be included in the scale-up plan.

Staff Capability and IT Readiness

The one-school-one-course pilot phase contributed to the development of staff and institutional capacity to effectively measure teamwork skills in each school, ensuring the availability of necessary resources and expertise to assess and enhance collaborative abilities within the educational environment. Additional training was offered to new staff joining the scale-up, conducted by an institutional SPA training team. Similarly, the ease-of-use of the SPA measurement on LAMS and the development of teamwork dashboards on LAMS, all serve to ensure staff and IT readiness, in support of the institutional roll-out.

INSTITUTIONAL SCALE-UP

An institutional scale-up plan proposal including supporting data on (1) the usefulness of the teamwork measurement exercise and instrument; (2) a workable plan and (3) the readiness of staff and adequacy of resources was presented to PMT in 2022. The scale-up plan was supported and the greenlight was given for implementation in AY23/24 with the Year 1 cohort.

SP's Institutional rollout of the SPA teamwork measure innovation took time, a decade to be precise, from about 2013 to 2023, starting with one staff, before scaling-up to include the entire institution. It went through many phases, beginning with independent users of the teamwork measure sharing and exchanging information on an informal basis, before progressing to the one-school-one-course phase, and finally the campus-wide deployment of the teamwork measure phase. During the scale-up phase, further enhancements were made to the LAMS system to provide teamwork dashboards for lecturers and students so that they could monitor the students' or their own teamwork progress over time. As part of scaling-up, the institution is presently refining the computation of the Teamwork Metric to recognise the teamwork skill achievement, may be awarded to the AY23/24 cohort when they graduate in 2026.

CONCLUSION

This paper presents a systemic account of the institution-wide scale-up framework for developing and measuring teamwork skills with the goal of sharing lessons learnt with educators who need to undertake similar projects and on this scale. Moving forward, data will be gathered to show the impact of the institutional roll-out of the teamwork measure in nurturing and tracking the achievement of an SP graduate attribute - collaboration skills in students in a systematic way, over three-years.

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