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**Formatively Assessing Teamwork in
Technology-Enabled Twenty-First Century
Classrooms: Exploratory Findings of a Teamwork
Awareness Programme in Singapore**

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Abstract

Teamwork, one of the core competencies for the twenty-first century learner, is a critical skill for work and learning. However, assessing teamwork is complex, in particular, developing a measure of teamwork that is domain-generic and applicable across a wide range of learners. This paper documents one such study that leverages technology to help provide a formative assessment of teamwork. It focuses on the self and peer ratings of a teamwork measure and a pedagogical method, which was trialled as a teamwork awareness programme in a mainstream Secondary School in Singapore. This teamwork awareness programme was incorporated into the school's Interdisciplinary Project Work curriculum. Findings of students' experiences of the programme are described. The teamwork competency dimension of 'team emotional support' was rated highest amongst students. Also, students' report gains in teamwork awareness, mixed engagement in reflective practices, and on the real-world relevancy of the programme. Discussions and implications of the findings follow.

Keywords:

- Teamwork
- Formative assessment
- Twenty-first century competency
- Project work
- Singapore

Introduction

Teamwork has been identified by many international frameworks, educational institutions and policy-makers as one of the core competencies for the twenty-first century learner (Ministry of Education, 2010; National Research Council, 2012; Rychen & Salganik, 2003). Moreover, it is valued as a critical skill for an effective worker (Baker, Horvarth, Campion, Offermann, & Salas, 2005; Cameron et al., 2009). In education, teamwork is typically a means for enhancing academic learning through collaborative learning and many educators have encouraged teamwork and learning achievement through various collaborative activities. However, teamwork processes are complex and students do not instinctively practice teamwork, or want to work in teams (Fransen, Kirschner, & Erkens, 2011; So, Tan, & Tay, 2012). Students have difficulties regulating themselves and others in teams (Järvelä & Hadwin, 2013; Järvelä et al., 2015). For instance, in Singapore, a survey of 767 Secondary Two students found that students had lower enjoyment and perceived lower value of teamwork over time (Liu, Wang, Tan, Koh, & Ee, 2009). Other research show that while using online collaboration technologies, students' often use divide-and-conquer strategies rather than collaboratively meaning-make in a team, (Tan et al., 2010). Still, there are studies that intentionally design for teamwork or foreground aspects of teamwork in collaborative activities (Näykki, Isohätälä, Järvelä, Pöysä-Tarhonen, & Häkkinen, 2017; O'Neill et al., 2017).

Another related challenge is the difficulty of measuring students' teamwork competency. This problem can be attributed to the various conceptual understandings of teamwork and also the practical aspects of measuring it. There are many teamwork models and conceptualizations in the literature (Salas, Rosen, Burke, & Goodwin, 2009; Valentine, Nembhard, & Edmondson, 2015). These stem from several academic fields including social psychology (e.g. Van den Bossche, Gijsselaers, Segers, & Kirschner, 2006), educational psychology (e.g. Loughry, Ohland, & Moore, 2007), and computer-supported collaborative learning (e.g. Näykki et al., 2017). Some teamwork measures are contextualized within an academic domain and not generalizable across academic subjects (e.g. Sancho-Thomas, Fuentes-Fernández, & Fernández-Manjón, 2009). On the other hand, there are domain-general measures of teamwork competency which can apply to various teams and tasks. For instance, Loughry et al. (2007) identify five dimensions of team member effectiveness: contributing to the team's work, interacting with teammates, keeping the team on track, expecting quality, and having relevant knowledge, skills, and abilities.

The practicality of measuring teamwork is challenged to a large extent by two issues: (1) fairness in awarding credit, and (2) monitoring teamwork of large numbers of teams. On the first issue, Pitt (2000) suggests that individual credit in teamwork is akin to a game and almost impossible to remain fair. Strijbos (2011) adds that there are no clear guidelines on assigning grade weightings to individuals in a team. On the second issue, monitoring and then assessing team behaviours of many teams is humanly difficult (Binkley et al., 2012; Koh, Wang, Tan, Liu, & Ee, 2009). Koh et al. (2009) found that teachers had little evidence of their students' thinking skills in group work apart from ad hoc observations.

To address some of these challenges, researchers have made use of self and peer assessment for a fairer measurement (Freeman & McKenzie, 2002; Phielix, Prins, & Kirschner, 2010). In addition, technology can also enable fairer assessment and the monitoring of large numbers of teams (Newhouse, 2011). Such technology-enabled assessment is in line with the move towards leveraging technology for twenty-first century classrooms (National Research Council, 2012; Spector et al., 2016; Tan et al., 2010).

Towards addressing some of the aforementioned issues, our research aims to develop a formative assessment of teamwork competency. We will elaborate on the formative assessment focusing on the measure and the pedagogical method that is, what is teamwork and how to formatively assess it. Moreover, this formative assessment was introduced as a teamwork awareness programme that was trialled in one mainstream Secondary School in Singapore. The aim of the programme was primarily to help students gain awareness of their teamwork competency. It was not designed as an intervention to improve their teamwork, rather we wanted to explore the feasibility of such a design and measure. The research question therefore is, what are the experiences of students in a teamwork awareness programme that formatively assessed teamwork?

The case study methodology is employed with qualitative findings from student focus group discussions, lesson observations and teacher interviews. The teamwork competency scores that resulted will also be described briefly.

Developing a formative assessment programme for teamwork

Measuring teamwork

Teamwork competency can be generally understood as a multi-dimensional construct that focuses on the process of members working in a team (Salas et al., 2009; Valentine et al., 2015). Past research has identified many dimensions of teamwork. For instance, the Organization for Economic Cooperation and Development (OECD)'s Definition and Selection of Competencies (DeSeCo) Project, three dimensions of interacting in heterogeneous groups are identified: (1) relating well with others, (2) cooperating and working in teams, and (3) managing and resolving conflicts (Rychen & Salganik, 2003). The Adult Literacy and Lifeskills Survey defines teamwork competency in terms of core team skills, knowledge, and attitudes associated with teamwork. They identify three primary skills: group decision-making, adaptability, and interpersonal relations, with an underlying skill, communication, that bridges the other three skills (Baker et al., 2005). In a review of the literature, Valentine et al (2015) summarized three

commonly measured teamwork dimensions: communication, coordination, and respect. Another study by Van der Haar, Segers, Jehn, and Van den Bossche (2014) looked at three dimensions of collaboration: questioning, requesting, and asserting in a collaborative problem-solving task.

Towards developing a measure of teamwork that is domain-generic and applicable across a wide range of learners (Salas, Burke, & Cannon-Bowers, 2000) for use in formative assessment, we conceptualized a six-dimensional measure of teamwork based on a broad review and synthesis of extant literature in the field. This measure was also pilot tested with two dozen teachers and students. This teamwork competency measure comprises (Koh, Hong, & Seah, 2014):

- coordination – organizing team activities to complete a task on time (Chang, Lin, Chen, & Ho, 2017; Kraut, Fussell, Lerch, & Espinosa, 2005; Stevens & Campion, 1994);
- mutual performance monitoring – tracking the performance of team members (Fransen, Weinberger, & Kirschner, 2013; Jehn & Shah, 1997);
- team decision-making – integrating information, selecting the best solution, and evaluating the consequences in a team (Bushe & Coetzer, 1995; Kankanhalli, Tan, & Wei, 2007; Van den Bossche et al., 2006);
- constructive conflict – dealing with differences in interpretation between team members through discussion and clarification (Kankanhalli et al., 2007; Van den Bossche et al., 2006; Van der Haar et al., 2014);
- team emotional support – supporting team members emotionally and psychologically (Bennett & Kane, 2014; Drach-Zahavy & Somech, 2002; Sargent & Sue-Chan, 2001); and,
- team commitment – identifying with and being involved in team goals (Bennett & Kane, 2014; Jehn & Shah, 1997).

Formative pedagogy

Several studies have encouraged the development of teamwork skills of students especially through formative pedagogy (National Research Council, 2012; Spector et al., 2016). For instance, Näykki et al. (2017) using a macro script with prompting questions that highlights the teams' socio-cognitive and socio-emotional monitoring processes formatively during collaborative learning. In another study, students' were provided with a visualization of peer assessment in the process of group work to help them be more aware of their collaborative behaviours (Phielix, Prins, Kirschner, Erkens, & Jaspers, 2011; Phielix et al., 2010). Other studies build in experiential teamwork learning with various group exercises and debrief students with feedback emphasizing teamwork principles during a course (O'Neill et al., 2017).

Similarly, the formative assessment of teamwork in this study was guided by the Team and Self Diagnostic Learning Framework (TSDL), which served as a pedagogical lens for the teamwork awareness programme (Koh, Shibani, Tan, & Hong, 2016). This framework is theoretically based on experiential learning (Kolb, 1984), collaborative learning (Vygotsky, 1978) and the learning analytics process model (Verbert, Duval, Klerkx, Govaerts, & Santos, 2013). Moreover, TSDL provides pedagogical support for socially shared regulation, the process where team members regulate their collective activity (Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013; Järvelä et al., 2015).

This paper elaborates on the stages of TSDL by outlining several learning principles that were employed in the development of the formative assessment. First, assessment should be made visible in a timely manner. Formative assessment focuses on assessing for learning, for the student to know where he is going, where he is right now, and how he is going to learn (Black & Wiliam, 2009). Therefore, formative assessment needs to provide feedback in a timely manner for students to know where they stand. Additionally, this feedback should make visible the measure of assessment as this helps the team become more aware of their behaviours (Bodemer & Dehler, 2011). In other words, teamwork assessment should make obvious the different dimensions of teamwork and be provided to the student at appropriate time points in the process of teamwork. This is similar to Järvelä and colleagues' (2015)

design principle of increasing learner awareness of their own learning process and those of their team members. This awareness helps students to regulate themselves, and co-regulate others in the team.

Second, student agency should be encouraged through the assessment. In particular, structured peer feedback on teamwork behaviours is a possible method. Although there are still issues with self and peer ratings such as under or over estimation (Panadero, Brown, & Strijbos, 2016), peer ratings for teamwork have been shown to be a viable method in some studies (Falchikov & Goldfinch, 2000; Phielix et al., 2010, 2011; Willey & Freeman, 2006). This is especially when peer ratings are accompanied by reflecting on students' own behaviours (Phielix et al., 2010, 2011), when the criteria is well understood (Falchikov & Goldfinch, 2000), or when it is a generalized rating (Panadero et al., 2016). Furthermore, peer ratings is useful for formative pedagogy and encourages student agency, for students to take ownership of their own teams. Also, such student agency is a form of activating students' externalization of their learning process for socially shared regulation in teams which is linked to team success (Järvelä et al., 2015).

Third, students should reflect on their assessment feedback and set future-oriented behaviours. Students need to make sense of their assessment and process it in a constructive manner. This principle of reflection emphasizes the need for students to understand the feedback from their assessment. Moreover, this sense making can be channelled for positive actions through focusing students on future-oriented behaviours, which is related to goal-setting (Wise, 2014) and externalization of regulatory goals (Järvelä et al., 2015). The strategy of reflection and future-oriented behaviours is an established pedagogy in many learning frameworks (Kolb, 1984; Wise, 2014) and has been shown to be effective in teamwork assessments (Phielix et al., 2011) and promoting collaboration success (Järvelä et al., 2016).

Research Design and Methodology

This exploratory study is part of a larger project that aimed to leverage on the affordances of Information and Communication Technologies (ICT) to assess and foster teamwork, as such it used a computer-mediated collaborative learning tool. While the study in its entirety employed mixed methods and collected multiple data sources, this paper focuses on the qualitative data to address the research question. The paper follows a concurrent nested design for mixed methods, with a more dominant qualitative aspect (Creswell, Plano Clark, Gutmann, & Hanson, 2003). Qualitative data collected included student focus group discussions (FGDs; sample questions are in Appendix A), video/audio recordings, fieldnotes, lesson observations and students' written reflection worksheets. Forty-five minute FGDs were conducted with 6 teams from different classes (all team members participated in the same FGD). Teams were selected by their teachers, typically a convenient sample. Feedback was also obtained from teacher interviews. Quantitative data collected included a post-task survey (for the teamwork ratings). For the quantitative data, this was analysed mainly using descriptive statistics. Three researchers examined the qualitative data collected. The data was split up, and each researcher thematically coded the data, discussing the codes that emerged with each other and ensuring that agreement was reached in developing the larger themes following practices of consensual qualitative research (Hill, Thompson, & Williams, 1997).

Teamwork awareness programme

The teamwork awareness programme was designed and carried out over two sessions during the Interdisciplinary Project Work (IPW) timetabled time of Secondary Two students in a mainstream school in Singapore. The two sessions are as follows:

- 1). Session 1: Collaborative activity (around 90 min in duration) using computers/laptops
- 2). Session 2: Feedback and Reflection (around 45 min in duration) in the classroom

Session 1 consisted of a briefing, a collaborative activity and post-task survey. A researcher led the session. Students were first introduced to the objectives of the project, what their involvement entailed and the learning activities they would be participating in. Students in a class were randomly grouped into teams of three or four members. Students were provided with a seating arrangement such that

they were at least two seats away from another member of the same team, to reduce physical communication between the team members. Students used an online chat system “TeamChats” for the collaborative activity (Figure 1). Part of the rationale was to provide students with some real world experience where team members may not be situated within the same office, and also in line with the school’s e-learning readiness practices where in the event of a school closure, students can carry on their learning out of school.

The collaborative activity consisted two tasks: an icebreaker task for students to get to know their team members and to use the TeamChats system, followed by a dilemma task with no fixed answer (Appendix B displays the dilemma task). Instructions were given by a human-controlled Chat Admin who typed standardized instruction messages in the chat. Students had to solve the dilemma task in their groups in 30 min. After the completion of task, they performed the post-task survey where they had to rate themselves and their peers.

Session 2 was conducted a week after the first activity, due to IPW lessons carried out a week apart. This session aimed to encourage students to reflect and learn more about their teamwork behaviours. A researcher facilitated the session with occasional co-facilitation by the class teacher(s). Students sat in their teams and were given a hardcopy visualization of their teamwork ratings (Figure 2 is an example). This assessment is termed a teamwork competency micro-profile as it is a “micro” status of their teamwork competency based on Session 1’s collaborative activity. It is not a personality profile. The micro-profile consisted of the six individual teamwork dimensions (reported in the Instrument section).

Also, an “overall similarity rating” score was calculated. The calculation is: [(Self - Peers) for each dimension]/Number of dimensions. A negative value indicates that the student rated himself lower than his peers (team members). A positive value indicates that the student rated himself higher than his peers.

In addition, students were provided with a hardcopy reflection worksheet. This worksheet had four questions which were adapted from Phielix et al. (2011). For individual reflection, students were asked to reflect on: (1) What differences do you see between the rating that you received from your peers and your self-rating? (2) Why do or do you not agree with your peers concerning your rating?

For team reflection, students reflected in their groups on: (1) What does the group think about its functioning in general? Discuss and formulate a conclusion shared by all the group members. (2) Set specific goals (who, what, when) to improve group performance.

Facilitators helped the students know more about teamwork by sharing with them the different dimensions of teamwork competency with examples. They also illustrated good practices of teamwork

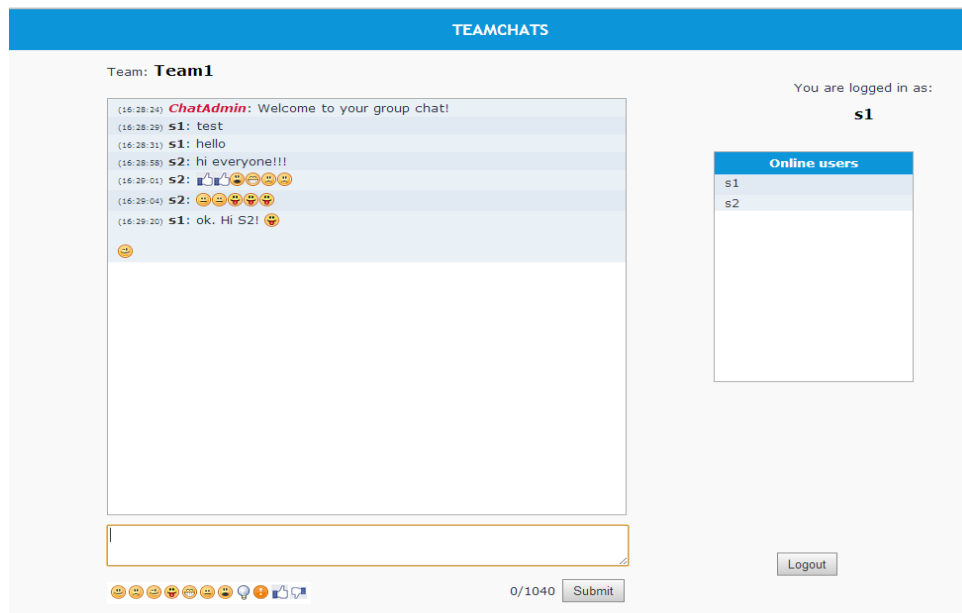
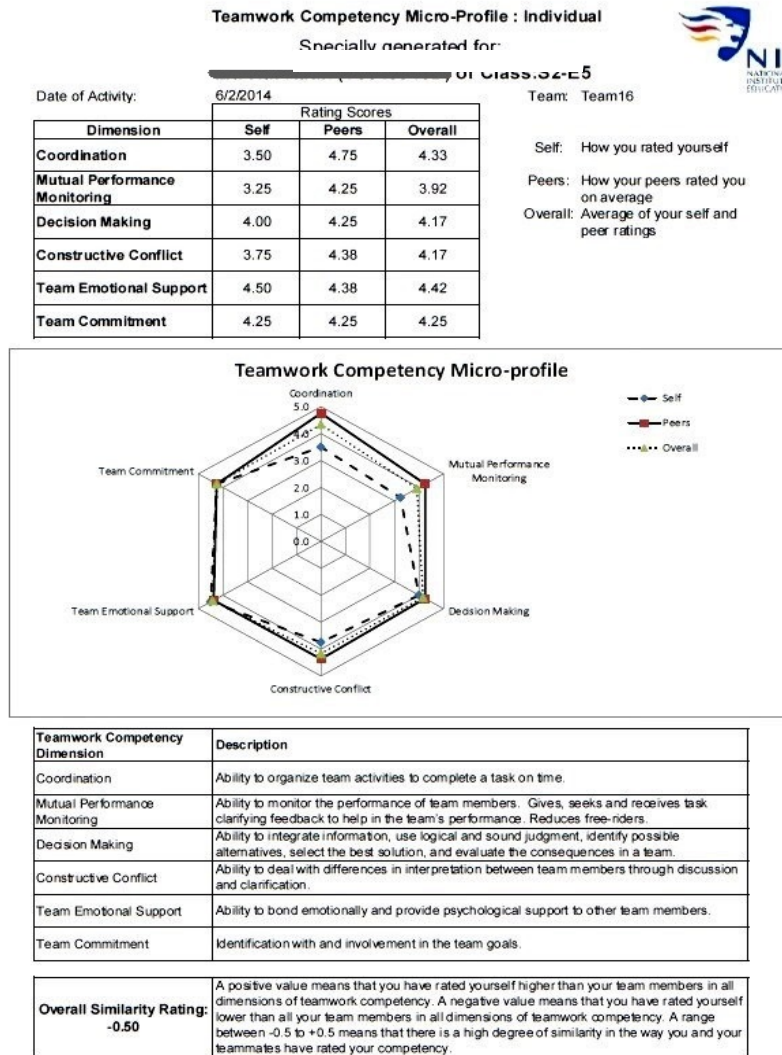


Figure 1. Screenshot of the online chat system “TeamChats”



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Figure 2. Sample micro-profile

behaviours. The facilitators guided the students to reflect on the activity and the micro-profile both individually and as a team. Students were given feedback time to share and reflect on their experience. The facilitators were guided by a lesson plan that detailed the facilitation protocols, sequences of activities and intentions of the lesson.

The teamwork awareness programme was carried out over four months from January to April 2014. Due to the capacity of the technical system developed, computer availability and the manpower constraints, the activity was carried out one to two classes at a time.

Participants

Participants comprised a total of 281 Secondary Two (14-year old) students (161 males; 120 females) who undertook IPW as part of their express and normal academic curriculum. However, due to absentees in Session 1, the final number of participants was 272. Students who did not attend Session 1 but were present for Session 2 sat with their planned teams for the reflection activity. Although they were not able to fully benefit, they were able to learn from the other classmates' teamwork experiences and behaviours to plan what they could do in future team-based tasks.

Instrument

A new teamwork competency instrument with items adapted from various literature (e.g., Bushe & Coetzer, 1995; Kankanhalli et al., 2007; Van den Bossche et al., 2006) was developed. There were 24 items, four each for the six dimensions. Items were created for both self and peers. Sample items include: Coordination – “X provided information to team members on time”; Mutual Performance Monitoring – “X thought of ways to improve how we worked together”; and, Team Emotional Support – “X appreciated everyone in the team”. For self-ratings, X was “I”, while for peer ratings, X was replaced by the team member’s name. Responses were on a Likert scale from 1 to 5 where “5” indicates “Strongly Agree”, “3” was “Neutral” and “1” was “Strongly Disagree”. An exploratory factor analysis was conducted for the self-ratings and revealed a six-factor solution with a cumulative variance accounting for 78.87% of the total variance. Reliability scores for the dimensions were found to be acceptable, ranging from 0.72 to 0.88 (Koh & Hong, 2017).

Results and Findings

To understand students’ experiences in the teamwork programme, we first examine how students’ perceive their own and their peers’ teamwork behaviours using the formative assessment instrument. Subsequently, we present the students’ experiences from the qualitative analysis.

Student ratings of teamwork dimensions

Due to the need to provide feedback quickly after the activity, the research utilized descriptive statistics to calculate the student ratings of the self and peer teamwork competency dimensions for the teamwork assessment. Although a blunt analysis, this served as a useful heuristic to understanding students’ teamwork competencies, for which teaching implications can be drawn from. It was also reified when upon disclosing these scores with the teachers, they were in unison about the dimensions, especially team emotional support. In addition, without seeing the students’ names, teachers could guess accurately which students had a large gap in their overall similarity scores. This suggests that based on the teacher’s gauge of their students, having taught them for at least a year, the descriptive teamwork assessment scores had substantial face validity. The mean scores of self and peer ratings, and an overall mean (self and peer ratings) are shown in Table 1.

These self and peer ratings were quite similar for each dimension. On average, out of the six Teamwork Dimensions, student overall means were highest on Team Emotional Support, $M = 3.87$, $SD = 0.62$. Team Commitment was second highest, $M = 3.77$, $SD = 0.54$. These may suggest that students generally were supportive towards team members, and well bonded. They had a sense of belonging towards their own team and desired to complete a task as a team.

Team Decision-Making and Coordination were ranked in the middle among the six dimensions. This suggests that students were aware and had some know-how about these two aspects of teamwork. These have the overall means of 3.66 and 3.67 respectively, and students are neutral or agree in their perception of performing these behaviours.

Mutual Performance Monitoring was the lowest rated dimension, although the overall mean was 3.43, which suggests that students moderately agreed that they displayed this dimension of teamwork.

Table 1 Mean and Standard Deviation of Teamwork Competency Dimensions

Teamwork Competency Dimension	Self Mean	S.D.	Peer Mean	S.D.	Overall Mean	S.D.
Coordination	3.57	0.75	3.7	0.72	3.66	0.6
Mutual Performance Monitoring	3.26	0.78	3.49	0.71	3.43	0.56
Team Decision-Making	3.58	0.78	3.7	0.74	3.67	0.62
Constructive Conflict	3.47	0.83	3.64	0.71	3.59	0.59
Team Emotional Support	3.93	0.81	3.84	0.68	3.87	0.62
Team Commitment	3.75	0.73	3.77	0.61	3.77	0.54

Students felt that they did not actively monitor their team members as compared to the other teamwork dimensions. Also, it seems that students were less concerned about the quality of their work and wanted a quick solution. This could point to a need for more intervention on this particular teamwork dimension.

Constructive Conflict was the second lowest dimension among the six dimensions. Students were less sure of how to address differences in opinions and manage conflicts within the team in a constructive manner that adds to the team's end product. Students rated themselves and their peers as less able to clarify ideas and handle differences of opinion. This is possibly due to not knowing how to deal with such differences or being uncomfortable doing so.

The overall similarity score mean was in the negative direction but close to zero. The negative direction shows that students have rated themselves generally lower as compared to how their peers have rated them. As there could be students who under- or over-rated themselves, further statistical tests are needed to make greater sense of this score. For the overall similarity score range, most students fall between -1 and 1. However, there are students who fall in the extremes at both directions. There were four such students which indicated that these students perceive themselves very differently from their peers. These students may need further guidance and the respective teachers were informed.

A further validation of the self-ratings for each teamwork dimension using factor analysis is in progress. Initial findings show that the validated self-ratings have similar results as the descriptive statistics of the raw rating scores. Moreover, self-rated teamwork dimensions were all statistically significant and positively correlated with each other.

In sum, students' ratings show that team emotional support and team commitment were the more dominant team behaviours that they experienced.

Students' gaining teamwork awareness

Our findings indicated that generally students were positive and gained a better understanding about teamwork as evidenced from the students' written reflection worksheets. All worksheets indicated some form of teamwork awareness from being able to compare their teamwork dimension ratings with their peers, to recognizing the key areas that allowed their team to work together well or not so well. For instance, Student 121 wrote in the reflection worksheet:

We co-ordinated very well, and supported and aided one another in contributing ideas. Teamwork is really important and moral support is also a very important factor in being able to function more smoothly in group work.

This suggests that the programme helped students understand their team better in terms of the teamwork dimensions. Another student, student 801, shared in the focus group discussion that

[I was able to] find out what others think about me. I was able to find out what I can do more.

The peer ratings seemed to have particularly helped students gain a better awareness of their own teamwork competency, especially when they agreed with their peers. This was exemplified in their written reflections:

[For] mutual performance monitoring, I gave myself a lot of the score but my team members gave it lower than what I expected. I agree [with this rating, as] I did not provide as much information and made some nonsense comments. Student 347.

I agree with my peers concerning my rating as I have tried my best to work together as a team to complete the task given on time and give feedback to help in the team's performance. Student 403.

Several students also wanted to go through the programme again and work with different team members as it was "useful to experience how other people work in a group together".

These suggest that through the programme, students did gain some understanding about teamwork. It also highlights the value of the formative pedagogy in this programme, providing timely feedback for students to reflect on their teamwork processes, interactions, strengths and areas for development.

Relevance of teamwork activity to the real-world

Another theme that surfaced was the real-world relevance of the teamwork activity and teamwork process. For students, this was highlighted through the topic of the task, where some students said that they were not that interested in this topic and preferred scenarios that had more “life lessons” or be related to current affairs. Also, as the project randomly grouped students into teams of three and four, and did not allow student self-selection, this was remarked by teachers as being similar to real-world circumstances, where one does not get a chance to select their colleagues or team members in an organization. This random grouping resulted in mixed reactions from students. Many of the students found themselves in teams with classmates that they had never worked with before. Some students were unhappy about this initially, but they got used to this and completed their team activity. Still, there were others who enjoyed the opportunity to collaborate with students they normally would not group with.

Another real-world relevance of the programme was in terms of the real-world application of teamwork. Students were asked to reflect on how they could function in another team in the future. Many students gave very specific steps that they could apply in their next team activity. For instance, Student 124 wrote:

If I am in another team in the future, I can share my ideas and hear everyone's opinion. Instead of being headstrong, we should be positive as there might be an answer better than mine.

The twenty-first century competency of teamwork is highly relevant to the real-world and through the authentic learning experience of the programme, the skills of working better in teams is foregrounded.

Accuracy of assessment

The formative assessment that relies on self and peer ratings, without any expert or teacher ratings, is one which might possibly be biased. This was highlighted by several students in the FGDs and reflection sheets, especially when they disagreed with how their team members rated them. Some students felt that certain team members may not have rated them honestly. Similarly, teachers also felt that certain students might not have rated their team members accurately. Still, while there were students who questioned the accuracy of the assessment, most students generally agreed with their self and peer ratings. Also, the terming of the teamwork assessment as a “micro-profile” reflecting a state of the student ratings signifies the temporal nature of this teamwork rating, and that it can grow and change. While this mitigates possible concerns, calibrating the rating of students is an area that can be further examined. Perhaps students should be taught how to rate others through more practice with peer assessment and peer feedback to support each other's learning. Likewise student agency can be further encouraged through the assessment, in particular, structured peer feedback on teamwork behaviours, as students take on greater ownership of their learning and development.

Mixed engagement in reflections

We found that students did not engage as actively with the reflection activity in Session 2 as compared to Session 1. Students in the FGD shared that they found Session 2 difficult. Student 904 shared that he found the reflection questions straightforward but explained that it was “hard to think of something”, to “write something down” when he “did not have any opinion of it”. Another student, student 901, stated that students need to know the purpose of the reflection and suggested having more examples to help them reflect, and also to structure it in a format likened to that of a classroom discussion.

This difficulty is also revealed through the responses in the student reflection worksheet. Some students were vague or did not answer the questions about how their group was functioning or what goals they would set. For instance, in response to the goal-setting question, Student 905 wrote “be more supportive and have more teamwork”. There were others too that felt that they did not need to change and could function as what they had functioned. Still, most students were able to sense-make and write specific goals to improve future team performance, for example:

I would make sure everyone is doing what they are supposed to do and do it on time. Student 701.

I will be committing more to the team and be more active. I will be giving suggestions to the members to improve the answer and participate in the discussion more. Student 902.

We would put all our differences aside and work together as a team. Student 903.

These statements do suggest that while students did struggle with reflecting, on the whole, they still managed to achieve some level of meta-cognitive understanding and describe their future teamwork goals.

Feedback from teachers similarly highlighted the struggle students have with reflecting on their teamwork competency. However, teachers recognized the importance of Session 2 and highlighted that more time was needed for students to reflect and make greater sense of the micro-profile.

As for Session 2, it's good for the students to know and express themselves according to their profile... It's useful for students to know themselves, and it sets them to think about how to work in a group. Teacher A

Teacher C felt that there could be “more room for discussion” to allow all groups “a chance to present” to “know what students are thinking”. She was concerned that the micro-profile could be “too remote” and suggested allocating more time for reflections over a series of lessons to give teachers time to analyse students’ micro-profile, in order to provide more “specific advice to students”, so that students “can work better in their teams”. Similarly, another teacher commented that students might “know the number [the survey scores in their micro-profile] but they need more time to digest the significance so that it can be useful”.

These voices from students and teachers highlight the challenge and the importance of scaffolding such reflective activity for teamwork into the curriculum.

Discussion and Implications

The findings have revealed varied experiences of students’ in the teamwork awareness programme that formatively assessed teamwork competency of Secondary Two students. Results firstly reveal that in terms of students’ teamwork dimensions, mutual performance monitoring seems to be among the least found teamwork behaviour among students. Constructive conflict was also either in the middle or bottom rank of the dimensions. This could be interpreted as student participants were weaker at mutual performance monitoring and constructive conflict in team-based learning tasks. In turn, these are teamwork dimensions that the school can target more specifically with various interventions. As for teamwork strengths, team emotional support is generally higher. Still, this needs to be continually encouraged in teams. These findings point to the teamwork formative assessment tool’s potential in surfacing possible strengths and weaknesses of students’ teamwork competency which can help guide teachers in providing more specific support and scaffolding for their students on team-based tasks.

In essence, the formative assessment has made visible a relatively abstract twenty-first century concept of teamwork, and opened up opportunities for further exploration of teamwork competency by students and teachers. For instance, teachers can facilitate a discussion of students’ teamwork behaviours during a subsequent class to raise further awareness of team struggles and strategies to overcoming those challenges. This would be especially important for issues related to mutual performance monitoring (e.g., social loafing) and constructive conflict (e.g., too little disagreements, too many disruptive disagreements, students not building on each other’s ideas). Nurturing teamwork competency in students will equip them to better handle the demands of group activities in school and their future teamwork, thus allowing higher student agency to take on greater ownership of their own learning.

In addition, the study has used a formative assessment measure that employed self and peer ratings. One of the concerns of using self and peer ratings, although efficient and cost-effective, is social desirability bias (National Research Council, 2012). This is when respondents portray an overly positive account as compared to their actual behaviour or perceptions. In this project, this possible bias is reduced through having more than one peer to rate a team member. Also, in the instructions given, students were informed to rate their peers honestly and accurately. That said, we acknowledge that there

are still limitations to self and peer ratings and this can be improved by increasing students' expertise (Panadero et al., 2016). This measure additionally needs further validation and multiple methods; this is being developed in ongoing work. Nevertheless, the formative assessment is able to provide just-in-time information about the students' teamwork competency. Also as highlighted earlier, students' were able to gain awareness of their teamwork competency, which is the main goal of the programme. The micro-profile connotes a temporary state, and encourages students to improve their teamwork competency in future teamwork.

Another related issue is that in this particular scenario, grades were not given. The education system in Singapore has been noted by some as exhibiting a relatively strong performative assessment culture (Hogan et al., 2013). To this end, if grades were awarded, students' might respond in a different manner as a result of performativity. For instance, students' might inflate their self ratings in hope of receiving a higher grade. However, recent policy shifts towards more holistic and balanced assessment has signalled mindset changes (Leong & Tan, 2014). Moreover, internationally, there is an increasingly recognition of skills and competencies, and school grades are one part of the larger equation. It was heartening to note that several of the students in the programme identified that teamwork was important as a life skill, for working in a team smoothly and grades were not part of the picture (e.g., Student 121 above). With such mindsets and cultural shifts, it is all the more important to encourage more of such programmes and formative assessments in schools, to provide opportunities for students' to develop their twenty-first century competencies and continuously create a broader approach to assessment.

Our findings have also touched on larger learning practices notably reflective practices, as students are given the opportunity to recall their past teamwork actions, and make sense of their micro-profile and peer feedback coupled with focusing on future-oriented behaviours. This study found that students need more time to engage in reflection. This was similarly identified by their teachers – that it is important for students to reflect but yet difficult for them to do so. Our study also finds that students are not used to engaging in reflections regularly and need more scaffolding especially in giving feedback to peers and responding to such feedback. These meta-cognitive and dialogical skills to reflect and learn from self and group reflections cannot be assumed. Moreover, these reflective practices do not pertain only to reflecting on teamwork competency, but to the larger practice of reflection, for all types of content, both content mastery and twenty-first century competencies.

These imply that at the school level, to support students' reflective practices, greater guidance can be provided such as teaching and structuring exploratory talk (Mercer, Wegerif, & Dawes, 1999) and/or giving time and space for deep thinking and collective sense making (Tan, Koh, Jonathan, & Yang, 2017). Similarly, teachers can be encouraged to do the same, and cultivate reflective practices and demonstrate them in the classroom. As such, at the policy level, structuring and planning the curriculum for greater opportunities for reflective inquiry, equipping students with the skills for exploratory talk and dialogue, as well as meta-cognitive strategies for deep thinking would be crucial.

Engaging in reflective practices also require authentic reasons for doing so. Our study also found that the collaborative activity has to be designed with elements of authenticity based on real-world problems. This is much aligned to work the education ministry in Singapore is advocating through its Applied Learning Programme. Authentic learning would therefore include working in teams with people whom we do not necessarily know or have a choice over. The random assignment of students into teams in this project has created that opportunity to work with different people – a feature which future iterations of this project implementation hopes to continue.

As part of enhancing authenticity of such programmes, we foresee the need to co-develop and co-design more projects with teachers to cater to different situated collaborative learning contexts. Future work will also be dedicated to the application and refinement of the TSDL framework for other contexts and participants, both learners and teachers alike.

Lastly, just as we cannot assume that students know how to work in teams, give feedback and engage in self and group reflection, similarly, we cannot assume that teachers are ready to facilitate twenty-first century competency development, in this case, teamwork competency. We received varied responses from teachers suggesting varying levels of teacher readiness. The most positive response was from a

teacher who decided to co-facilitate with the researchers. The teacher took the initiative to give appropriate instructions, facilitate team discussion and call on students to share in class. On the other hand, there were a few teachers who were uninterested in the programme and preferred if the researchers ran the programme. Professional development either through formal channels (i.e., courses, professional learning communities) or informal channels (i.e., staffroom discussions) will be useful towards shifting teachers' mindsets and/or providing in-depth understanding of teamwork competencies, facilitation skills for guiding students in peer feedback and reflection. Teachers have powerful tacit knowledge of their students as they interact with them daily. To this end, we propose more co-designing of curriculum involving both researchers and teachers as the way towards enhancing the success of such programmes.

The findings of the study are not without its limitations. We recognize the subjectivity of our study, and reduced these by adhering to respective protocols such as lesson plans and FGD protocols for the data collection. Also, several researchers were involved in the data analysis process to encourage multiple perspectives. Still, the findings may be more peculiar to this particular site and may not apply to other dissimilar contexts.

Conclusion

In this study, students' experiences of a teamwork competency programme that formatively assessed teamwork was explored in a mainstream Secondary School's IPW curriculum in Singapore. This programme was enabled by ICT, and created a micro-profile of teamwork competency based on self and peer teamwork dimension ratings.

The teamwork awareness programme has contributed to students' awareness of their personal teamwork competency. As highlighted in the qualitative findings, students' generally agreed with the micro-profile and many were able to make sense of their teamwork competency through the reflection activity. In that sense, the assessment measure made visible the strengths and weaknesses of students' teamwork competency. Teachers' also largely concurred with the micro-profile and were found to be a crucial partner in facilitating the programme. Moreover, based on the micro-profile scores, relevant interventions can then be designed and implemented. Therefore, the programme served to generate awareness and provide target areas for future intervention support.

Our findings also revealed broader contextual issues that include real-world relevance and reflective practices. As with many educational programme, the context matters. This study has revealed micro and macro aspects to generate insight on developing and implementing formative assessments in Singapore classrooms.

This study has also developed a formative pedagogy and a micro-profile of teamwork competency using self and peer ratings. This allows relatively immediate feedback to the students and teachers on students' teamwork competencies. The instrument is domain-generic and could be applied to other collaborative learning contexts too.

In all, this research has leveraged ICT to provide an assessment measure and method to examine teamwork in Singapore schools. It has also described learning principles to encourage the awareness of students' teamwork competency. Findings from the study were discussed alongside their implications for teamwork. These reveal the experiences of the programme and include: students' ratings of teamwork dimensions, gains in teamwork awareness, engagement in reflective practices, and real-world relevance. Teamwork competency is crucial for the twenty-first century and this project goes towards building the research and practice of teamwork in technology-enabled twenty-first century classrooms.

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Appendix A

Sample focus group discussion questions

1. When you first heard from your teachers (or from the facilitators) that you will be participating in this project, how do you feel?
2. How do you find the dilemma task?
3. Do you find that you have enough time to complete the task?
4. What were your goals in doing this task? What do you think are the goals of this task?
5. What do you think is the most important skills, knowledge and attitude needed to complete this task well?
 - a. Do you find that you have sufficient skills to complete the task?
 - b. Do you find that you have adequate knowledge to complete the task?
6. Do you engage in group work, collaborative problem-solving tasks in class?
 - a. How often do you do that?
 - b. When do you do that? E.g. In which subject areas?
7. Do you agree with the micro-profile? Why?
8. What information is useful to you in the micro-profile?
9. What would you change in this micro-profile? How would you make it better?
10. How do you feel about this activity / project overall?

Appendix B

Dilemma task

Using Teamchats, discuss the following scenario with your team members. Decide on the course of action your team should take. You have 30 minutes to do so. You may use Internet resources to help you.

The little city town of Knotsville was a dream hospice for many of the senior citizens of Singapore.

Built in the middle luxurious green forest of Mandai, it was like a little oasis, a paradise for the old folks. Like other satellite towns in Singapore, Knotsville was self-contained, having all the basic amenities. There was a hypermarket, a movie theatre, and the streets were litter with all manner of shops. Quite an offering, you may wonder, for a bunch of elderly. But, despite being built for the elderly, Knotsville is indeed a popular and lively place, which their children and grandchildren of many of the elderly would visit ever so often. And when it was not so lively, the place was a peaceful haven of green overlooking the serene waters of Seletar reservoir.

Of late, however, the residents began noticing changes. The water smelled different. Some would find fishes floating on the surface, dead. Some of the residents seem to be falling ill too. Off in a distance, plumes of black smoke could be seen furiously rushing skywards.

Knotsville has been adopted by your school as part of the Community Involvement Programme and it was during one of the visits that your class came to know of this developing situation. Being the Green Environment programme ambassadors for your school, it was immediately clear to you and your friends that there was a connection between the black smoke and the emerging situation in Knotsville.

Furthermore, you know about the source of the black smoke; your dad runs the precious metal refining factory just over the horizon.

If you establish the cause of the situation in Knotsville is the factory, your dad would lose his job. On the other hand, the folks at Knotsville deserve to live out their days in a safe environment. Some could not move away even if they wanted to.

Just then, the sound of an approaching ambulance caught your attention. Looking at where it stopped, you see the paramedics rushing to an elderly woman lying on the ground; you realize it is Mrs Lim, your old neighbour and favourite nanny...

Task:

Identify the problem. What will be the best possible solution to solve the problem?

Remember to give only one solution in your team as your final answer. You may start discussing with your team now!