

Designing a web tool to support teamwork awareness and reflection: Evaluation of two trial cycles

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Abstract: Teamwork is an important 21st century competency to be nurtured in students. In this study, we describe the first two trial cycles of a web tool “My Groupwork Buddy” that is designed to support teamwork awareness and reflection in collaborative inquiry tasks. The tool is developed using a design-based approach and was based on the Team and Self Diagnostic Learning pedagogical framework. The system was trialled with 35 Secondary School students in a blended learning environment. Qualitative feedback from student focus group discussions and questionnaires were analysed from each trial. Design changes that focused students on specific reflection questions and goals helped to improve the quality of student responses of their teamwork. Further refinement of the tool and activity designs is in progress to better support teamwork awareness and reflection to build the teamwork competency of 21st century learners.

Keywords: Teamwork, collaboration, design-based research, web tool

1. Introduction

Teamwork and collaboration are important skills needed for the 21st century learner (Pellegrino & Hilton, 2013; Voogt et al., 2013). Moreover, ICT tools can be harnessed to help nurture students’ teamwork in collaborative inquiry tasks (Soller et al., 2005). Using design-based research, a web application “My Groupwork Buddy” (MGB) was co-designed by researchers and teachers to support Secondary school students’ teamwork awareness and reflection in collaborative inquiry tasks. This paper reports on the first two trial cycles of the project. ICT was harnessed as a metacognitive and reflective tool (Soller et al., 2005). It was a reflective mirror of teamwork processes as it provided data on certain teamwork processes. As it provided normative data through self and peer ratings, it was also a metacognitive tool, which allow for a more triangulated and fairer measurement (Freeman & McKenzie, 2002), for students to reflect and grow their teamwork competency.

The paper is structured as follows: First, we share the methodology and the pedagogical model of the study. Next, the research context followed by the technical details of implementation is explained. The two trial cycles will be subsequently described in terms of the design and implementation; these will then be evaluated before ending with a brief discussion and future work.

2. Methodology

Design-based research was the overarching methodology in this project as it allows rapid prototyping and refinement of systems, learning designs and principles in authentic learning settings (Barab, 2004; Brown, 1992). It also emphasizes co-designing with stakeholders (Barab, 2004). The tool, MGB was co-designed with a team of researchers and educators, with support from a web developer. MGB was developed to facilitate the growth of students’ teamwork competency based on the Team and Self Diagnostic Learning (TSDL) Pedagogical Framework (Koh et al., 2016).

TSDL is rooted in experiential learning, socio-constructivism and the learning analytics process model (Kolb, 1984; Duffy & Jonassen, 1992; Verbert et al., 2013). The framework comprises four stages: (1) concrete experience through involving students in the experience of collaborative activities, (2) building students’ awareness of their teamwork competencies, (3) engaging students in

reflection and goal-setting, which helps to (4) engender growth and change in students' teamwork competency. In this study, we focused on four teamwork competency dimensions (See Koh et al., 2016 for further details on TSDL as well as the teamwork competency dimensions).

Multiple forms of data were collected and for this paper, we mainly draw on qualitative data collected for the evaluation e.g., student feedback questionnaires and focus group discussions.

3. Research Context

This project is an intervention for 14-year-old students to nurture their teamwork competency and for teachers to develop their pedagogical practice in collaborative inquiry tasks. It is planned for 2 years and this paper reports on the first two trial cycles of the project in the first 6 months (2 school terms). A mixed-gender school participated in the project with the course, Design and Technology. In this course, students collaborate in teams to create a physical prototype of a useful device for a welfare organization (e.g., a home for the elderly or destitute). Two classes taught by the same teacher (a total of 35 students, 10 teams) participated in the project. Students were grouped by the teacher into teams of 3 or 4. Most of the tasks and assignments for the course involved group activities in a blended learning environment. Students had 70 minutes for the course each week during the 2 school terms.

4. Techno-pedagogical Design

The development of the MGB web tool is underpinned by the TSDL framework. It is designed as a Single-Page Application (SPA) website which allows dynamic updating and contains several features. The base MGB system allows login and lesson content management for students and teachers to access necessary information. To support students' concrete teamwork experiences, MGB provides a collaborative platform via a real-time team chat. Students are able to chat with other members of the same team. The teacher can also broadcast messages to all teams in a class through the chat.

Being a SPA, students are able to navigate through the different pages while using the chat, without being interrupted by a page reload. Remote Procedure Calls (RPC) are used to call functions on the server asynchronously to load new content from the server. MGB is written in Haxe programming language (<http://haxe.org/>), making it easy to implement RPC for communications between client and server. The Haxe compiler is a source-to-source transpiler that will compile codes to JavaScript on the client side, and to PHP on the server side. It requires a function to be written only once in Haxe for use in both client and server side. The chat is implemented using a JavaScript library called Firebase (<https://www.firebase.com/>) that can synchronize objects between multiple clients.

To enable students' teamwork awareness building, a self and peer rating feature is embedded in the system and the results are visualised on a radar chart to students on the MGB dashboard, on a page we term the *Teamwork Competency Micro-profile*. This makes visible the students' teamwork competency strengths and weaknesses based on the four teamwork competency dimensions mentioned earlier. Visualisations are developed using a JavaScript library called Chart.js (<http://www.chartjs.org/>). A MySQL database is used to store system and student data. Several other features are developed in the second iteration which we will elaborate on in the subsequent sections.

5. First Iteration

5.1 Design and Implementation

In the first trial cycle, My Groupwork Buddy was used for 3 weeks. MGB was a web-based system containing features required for login, lesson content management, team chat, teamwork competency self and peer ratings and the dashboard for the teamwork competency micro-profile (Figure 1).

For *stage 1* of TSDL where students participate in concrete team experiences, students collaboratively researched on a welfare organization to obtain information (e.g., needs, profile of residents) and produce a collaborative research report. The MGB user interface was designed to facilitate students' collaborative research activities. With reference to the right-hand side of Figure 1, students were introduced to the team chat system on MGB by the teacher through a series of questions relating to their collaborative research task e.g. probing questions about evaluating the credibility of online sources. Other than face-to-face communication, the MGB team chat allowed students to

converse and share web links with their team members for discussion. Course materials uploaded by the teacher were located in the lesson content pages on MGB accessible from the left navigation panel (Figure 1), containing lesson information and useful online resources such as web links and videos. As seen in Figure 1, the lesson pages and team chat are positioned right next to each other to help guide students' discussion on the team chat. Students were allowed to use other communication media to complete their collaborative research report e.g. Google Docs, WhatsApp. In all, these were the concrete team experiences that formed the first part of the TSDL framework.

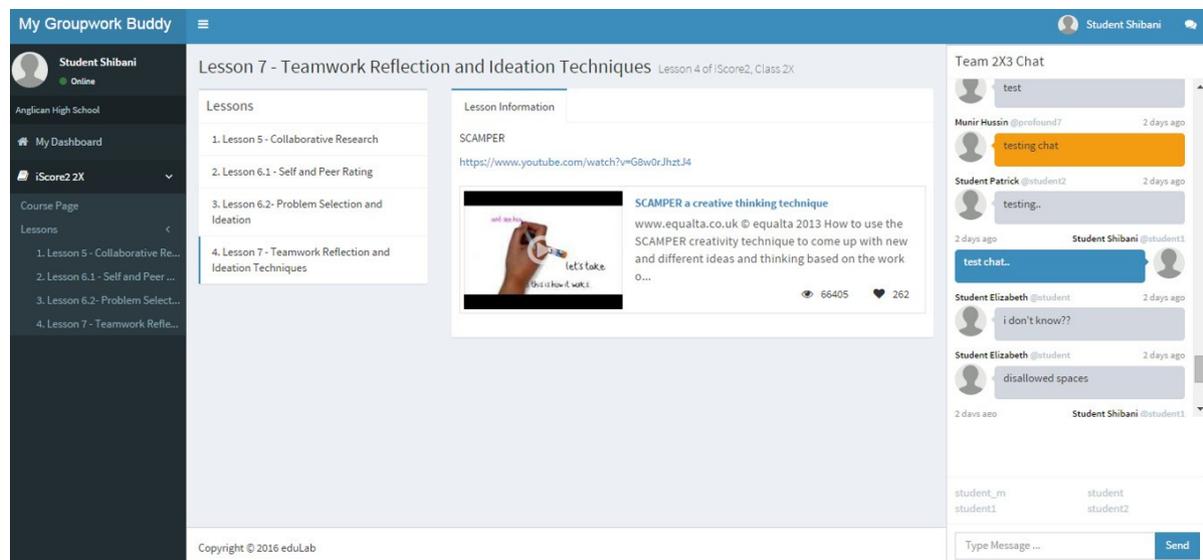


Figure 1. Screenshot of MGB lesson content pages and team chat



Figure 2. Screenshot of MGB personal teamwork competency micro-profile in trial 1

In TSDL *stage 2*, students rated themselves and their team members on their teamwork behaviours on an online self and peer rating survey on MGB. After all students in a team finished the self and peer ratings, teamwork competency scores were computed based on the ratings. Students clicked on My Dashboard during the lesson in the following week to view their personal teamwork competency micro-profile. The micro-profile included a graph and a table of their own teamwork competency scores based on self, peer and overall ratings in the form of a radar chart (Figure 2). Peer scores were the average of team members' ratings and the overall similarity score indicates the average difference in ratings between self and peer. Definitions for the teamwork dimensions were also displayed. This rating and micro-profile

visualisation activity helped the students to build self and team awareness, which is the second stage of TSDL.

The subsequent TSDL *stage 3* is the self and team reflection and sense making. In this stage, students viewed their teamwork competency micro-profile and reflected individually and as a team. The different teamwork dimensions were explained to students with examples provided. Students then reflected on their personal micro-profile using the following reflection questions adapted from Phielix et al. (2011): (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 you agree with your peers concerning your rating? This time

given to them helped them interpret their personal micro-profile and analyse their perceived strengths and weaknesses. Following their self-reflection, students went to their teams and had a team reflection guided by two questions (“What does the group think about its functioning in general?”, “Set specific goals to improve group performance”). This team reflection stressed how the group performed and how the team can set goals for improving future teamwork performance. For this iteration, reflection activities were carried out using pen and paper. These reflection and goal-setting activities aimed to help students grow their teamwork competency, as the final TSDL *stage 4*.

5.2 Evaluation

In general, students found MGB easy to use and useful. However, a few students were not sure about the micro-profile or did not quite understand the teamwork competency dimensions and how it could be interpreted or relate to themselves. Some students said that they informed their team members of how to rate them or tended to give better ratings to friends. These students felt that since they did not rate properly, the micro-profile might be inaccurate. Students also wanted MGB to be customizable to their preferences in terms of fonts and colours, have other collaborative functions on MGB similar to that of Google Docs, and even play games on MGB.

For TSDL *stage 3*, students were reluctant to reflect, sharing that it required them to think harder or that they had nothing to say. Also, some students shared that after the activity, nothing changed in their teamwork behaviours. Some teams discussed about their functioning in general, not linking to the perspectives of the given teamwork dimensions. Students felt that the long reflection questions can be fragmented to smaller levels and simplified.

6. Second Iteration

6.1 Design and Implementation

In view of student feedback, the time we had, and the design team’s discussion, five key changes were made to MGB. First, for the self and team awareness stage, a team micro-profile was added containing the teamwork competency scores of all team members based on peer ratings in addition to the personal micro-profile (Figure 3). This intended to make clearer the perceived strengths and weaknesses of each member.

Second, the reflection and sense-making activity was digitized from the paper version. This allowed the whole activity to be fully in online format.

Third, the personal and team reflections and the overall similarity score were re-designed to focus on four specific dimensions (See example of personal reflections in Figure 4). This aimed to encourage deeper and more meaningful reflections on their specific strengths and areas for improvement. A handout consisting of descriptions and project-specific examples of each teamwork competency dimension was also provided to all students.

Fourth, the team reflection interface was developed to create a shared reflection space that was accessible to all team members. Only the last entered text is saved as the team reflection.

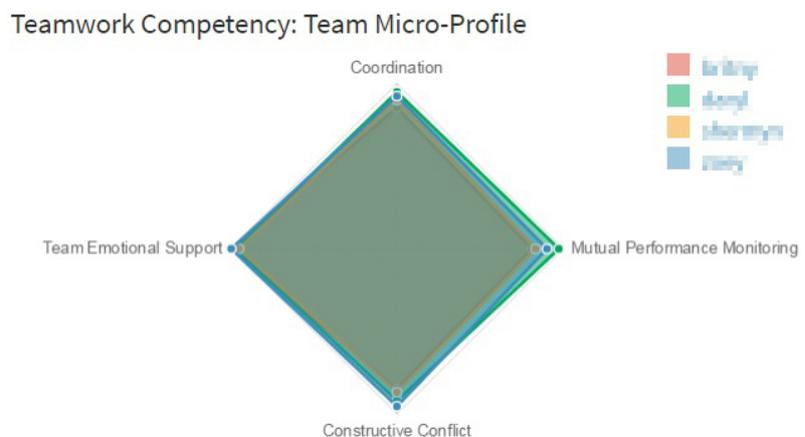


Figure 3. Screenshot of MGB team micro-profile in trial 2.

Personal/Individual Reflections

What differences do you see between the rating that you received from your peers and your self rating?

Coordination	I rated myself higher than the rating from my peers. Maybe due to the fact that I did not ensure that there was a smooth exchange of information and task because of late work.
Mutual Performance Monitoring	I rated myself higher than the rating from my peers. Maybe due to the fact that I did not review my group members' work.
Constructive Conflict	I rated myself higher than the rating of my peers. I'm too generous to myself.
Team Emotional Support	I rated myself higher than the rating of my peers. I do not show much care or value to my group members.

Figure 4. Part of the personal reflections on MGB in trial 2.

Fifth, a separate goal-setting page was set-up (previously combined with team reflection). This was designed to help students set personal and specific goals, with clear start and end dates, to improve future teamwork processes (Figure 5).

For the second trial cycle, MGB lasted 3 weeks employing the TSDL framework. *Stage 1* was expanded to become a set of group tasks (e.g., model-making, drawing orthographic projects, scheduling plans for prototype production), rather than a single group task (trial 1). In *stages 2 and 3*, students performed ratings and reflection activities in the same session using immediate visualisations and feedback, instead of waiting a week between stages (trial 1).

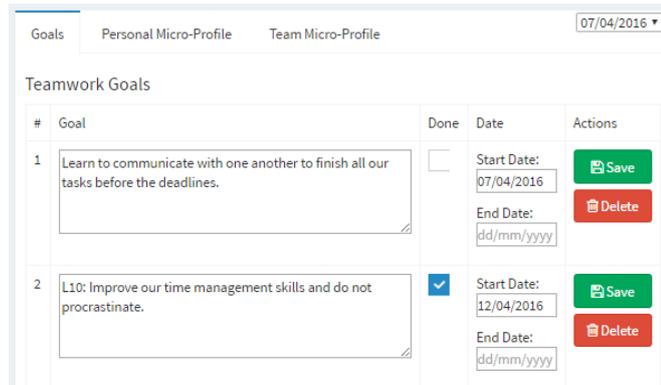


Figure 5. Goal-setting as part of the reflections in Trial 2.

6.2 Evaluation

While rating team members during the TSDL *stage 2*, some students did not feel comfortable comparing team members with one another. Instead, they preferred to compare the team members with their own performances. Some students felt that ratings are not accurate due to usage of numbers (e.g., students did not want to rate their peers too high or too low) and preferred to use words for providing feedback rather than giving scores. In the micro-profile, most students found the similarity score for each teamwork competency dimension useful because they can specifically see which teamwork competency dimension they are competent or lacking in.

In TSDL *stage 3*, the focus on each teamwork dimension helped the students reflect more specifically compared to the broad questions they answered in trial 1. Students could demonstrate their knowledge and application of teamwork behaviours better. Feedback for the handout on the teamwork competency dimensions was also positive. Most of the students found it helpful for their understanding of the teamwork competency dimensions. There was evidence that students internalized the definitions of the dimensions by attempting to assimilate the teamwork dimensions descriptions in their written reflections. This led to better quality reflections that were more specific to the teamwork competency dimensions. Still, there were some students who copied or lifted descriptions from the handout given to them and did minimal reflecting.

Trial 2 had more structured goals than trial 1. The goal-setting tab implemented in MGB was well received as it was seen as an easy way to monitor the progress on goals and add new goals. Students felt that the goals tab will remind them of their goals and motivate them to achieve their goals since it is the first tab they see when they sign in. Some students had more specific goals related to the teamwork dimensions in trial 2 compared to the generic goals set earlier (See Table 1).

7. Discussion and Concluding Remarks

The trial 2 evaluation reveals that the quality of reflections using MGB has improved. Students also set more specific goals relating to the teamwork dimensions for future team activities. Such future-oriented goals set by students is linked to improving team behaviours in other research (Phielix et al., 2011) and goal-setting is an important area that this project intends to head towards to help grow students' teamwork competency. However, there were a few students who continued to be non-engaged and had minimal reflection and goal-setting. This suggests that the design of MGB with the activities should be further revised in order to engage all learners in the process of personal and team reflections. Further calibration between students' interpretation and the pedagogical scaffolding is needed to encourage students to be engaged in such metacognitive activities.

Another issue uncovered is how best to visualise self and peer rating information to students. The decision to show analytical visualisations of peer comparisons and/or time-based self-comparisons though seemingly matter-of-fact could have greater impact than imagined. This is a similar issue identified in Tan et al. (2016), and is an area that requires more research. Also, a key

concern is that MGB is infrequently used by students as they prefer using other tools. Possible solutions to this include enhancing the functionality of MGB to include more collaborative editing tools and ensuring mobile compatibility. Besides MGB design changes, the evaluation reveals the need to draw out design principles from TSDL that will help enhance teamwork competency.

In this study, a web-based tool, MGB, was designed and revised in two trial cycles to support the nurturing of teamwork competency through the TSDL framework. Further refinement of the tool and activity designs is in progress and will be implemented in future iterations. Through the pedagogical use and constant refinement of the tool, pedagogy and practice, we hope to better support teamwork awareness and reflection to build the teamwork competency of 21st century learners.

Table 1: Comparison of goals set in iteration 1 and 2.

Student	Iteration 1 Goals	Iteration 2 Goals
A	I think that we will put in our best to help the elderly in healthcare and respect each other's views.	I want to be able to communicate better with my team so that we can complete tasks efficiently with everybody's help and effort put in so that we can complete our project.
B	We can be more interactive and discuss more and be more attentive.	Term 3 goals: work harder and be more efficient in everything that we do so that we can finish everything faster. Also we should coordinate more to get things done faster.

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