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# Supporting Collaborative Inquiry for Geography and Teamwork Learning: The Techno-Pedagogical Design of My Groupwork Buddy for Geography

**Elizabeth KOH[a*], Yi-Huan TEE[a], Dhivya SURESH[a], Betsy NG[a], Helen HONG[ab], Tricia SEOW[a]**
[a]*National Institute of Education, Nanyang Technological University, Singapore*
[b]*Ministry of Education, Singapore*

**Abstract:** In computer-supported collaborative learning, many tools either focus on the cognitive or the social aspect but not both. With the increasing importance of nurturing students holistically encompassing academic and social skills, the later known commonly as 21st Century competencies, systems should therefore provide affordances that cater to these dual aspects. However, it is challenging and there are limited guidelines on designing such integrated tools. To fill this gap, this paper describes the development of a techno-pedagogical system, My Groupwork Buddy for Geography, for collaborative inquiry that intends to deepen students' knowledge and understanding of geographical topics as well as grow their teamwork. Two key design considerations are synthesized relating to the whole techno-pedagogical approach and the motivational needs of the student. The paper subsequently articulates these considerations in the design and implementation of two trial cycles of My Groupwork Buddy for Geography involving Secondary Three students' field-based geographical inquiry. Specifically, three techno-pedagogical design principles are elaborated on. In addition to theoretical contributions, this work discusses practical implications and offers guidance towards designing tools that build the dual complementary goals important for learners now and in the future.

**Keywords:** design, group inquiry, geography, teamwork, motivation

## 1. Introduction

In Geography, team collaboration is an essential part of the curriculum, as students have to work in teams as part of geographical inquiry. With the ubiquity of technology, students and teachers have adopted an assortment of tools to support them in this collaborative inquiry. However, each tool has specific affordances as well as limitations. In computer-supported collaborative learning, many tools either focus on cognitive awareness or social awareness but not both (Janssen & Bodemer, 2013). It is challenging and there are limited guidelines for tools to support both cognitive and social awareness. In the same vein, many tools for collaborative geographical inquiry emphasize the cognitive aspect, e.g., to build the geographical knowledge of the learner, and do not equally encourage the social aspect, e.g., the teamwork and collaboration of the learner. Moreover, with the current emphasis of future-ready learners who are competent in both academics and soft skills, it is therefore important that collaborative inquiry tools provide opportunities for learners to develop these dual competencies.

This paper describes the development of a techno-pedagogical system, My Groupwork Buddy for Geography that intends to deepen students' knowledge and understanding of geographical topics as well as growth in the 21st Century competency of teamwork. A design-based research approach is employed over two trials for Secondary Three (15-year-old) students in Singapore. The project also addresses students' psychological needs, which is often not as much mentioned in the literature in system design. A third contribution is that it theoretically and practically identifies and describes techno-pedagogical design principles for collaborative inquiry that meets the dual complementary goals of academic excellence and teamwork, related to cognitive and social awareness tools respectively.

The paper begins with a literature review of systems that support collaborative inquiry and design considerations. Next, it elaborates on key design principles of the system before closing with the benefits and constraints of the techno-pedagogical system design.

## 2. Literature Review

### *2.1 Systems that Support Collaborative Inquiry*

Collaborative inquiry is the process of investigating a certain question with a group of people and there are systems that support such inquiry in Geography as well as generic tools customized for group inquiry. For the first category, an example is nQuire (Sharples et al., 2015) designed to support the whole inquiry process, allow primary data collection, and allow teachers to orchestrate inquiries across multiple contexts such as classroom, field, and home (Scanlon, Anastopoulou, Kerawalla, & Mulholland, 2011). While this is a notable system, it did not focus much on the teamwork process.

Generic software has also been used to support collaborative inquiry in Geography such as learning management systems (LMSs). As noted by several studies (e.g., Scanlon et al., 2011), these generic software tools do not support the whole collaborative inquiry process and/or require additional scaffolds to more effectively and conductively support the process for students and teachers.

Lastly, group awareness tools can provide information about group members to support individual and collaborative learning (Janssen & Bodemer, 2013; Schnaubert, Heimbuch, Erkens, & Bodemer, 2019). They can be classified into cognitive group awareness tools (cGATs) or social group awareness tools (sGATs). Most cGATs enable comparison between the learner's own cognitive information with that of other group members while sGATs allow learners to compare their own behavior to that of others. While both are required for effective coordination, researchers have tended to focus singularly on either one (Janssen & Bodemer, 2013). Similarly, Schnaubert and colleagues (2019) highlight that cGATs are seldom used for other purposes although the versatility of cGATs has potential in guiding collaborative inquiry. They add that there are no existing guidelines or overarching framework to support educators in designing group awareness tools for their teaching needs.

### *2.2 Techno-Pedagogical Design Considerations*

In developing techno-pedagogical tools that support the collaborative inquiry of Geography that specifically foregrounds curriculum content and process as well as collaboration and teamwork aspects, the following design considerations are surfaced.

#### *2.2.1 Tools Need to Foreground and Support the Whole Collaborative Inquiry Process*

Scanlon et al. (2011) and Sharples et al. (2015) highlight the importance of systems that encompass the whole inquiry process, rather than piecemeal support of certain aspects only. In foregrounding the whole process, the curricular content as well as the collaborative aspects have to be made explicit. This explicitness helps emphasize to learners what is important of the process of their learning. This also refers to both the cognitive and social group awareness that are important for coordinating collaborative activities effectively (Janssen & Bodemer, 2013).

#### *2.2.2 Tools Must Support Learners' (Students) Psychological Needs*

This principle reiterates the importance of student-centeredness in ensuring that students' psychological needs are addressed. Drawing from self-determination theory (SDT), students have three basic psychological needs, namely autonomy, competence and relatedness (Deci & Ryan, 1985; Ng, Liu, & Wang, 2015). To facilitate students' psychological needs, teachers must create a need-supportive environment that fosters autonomous motivation such as identifying and fostering students' intrinsic motivation by offering options; fostering interest with respect to learning; providing rationale and informational feedback; as well as encouraging self-regulated learning (Reeve & Cheon, 2016).

Extensive studies in the SDT literature have provided the benefits associated with learners' need satisfaction and teacher's autonomy support. Although past studies were mainly focused on autonomy-supportive teaching in classrooms or face-to-face instruction, it is possible that technologies can be designed to meet these psychology needs of learners. According to a recent study on an online

pedagogical assessment, the findings suggest students experienced a sense of self-determination when engaging in online quizzes (Chemsi, Sadiq, Radid, & Talbi, 2020).

## 3. Study Context and My Groupwork Buddy for Geography Techno-Pedagogical Design

This project utilizes the design-based research approach over two trial cycles for Secondary Three students' field-based geographical inquiry. This form of fieldwork inquiry in teams is commonly known as geographical investigation (GI) in Singapore. A team of researchers, web developers, teachers, and education ministry officers were co-designers in the project and also sought students' voices throughout the trials. The following describes key techno-pedagogical design principles that were conceptualized and developed over the project, with an emphasis on the finalized design of Trial 2.

### *3.1 Collaborative Inquiry Model to Support the Whole Process*

In view of design consideration #1, to guide the collaborative inquiry in Geography and meet the dual complementary outcomes of deepening knowledge in geographical topics as well teamwork growth, the project designed a model that integrates the curriculum's geographical inquiry approach with a teamwork pedagogy, the Team and Self Diagnostic Learning (TSDL) pedagogical framework (Figure 1a). In essence, this integrated model combines the unique formative assessment approach of teamwork, which provides on-demand teamwork feedback, with an established geographical pedagogical framework, to encourage dual complementary outcomes. The model was also linearly visualized as a navigation pane on the system for easy referral and clickable guidance to parts of the system with respective online spaces for the activities (Figure 1b).

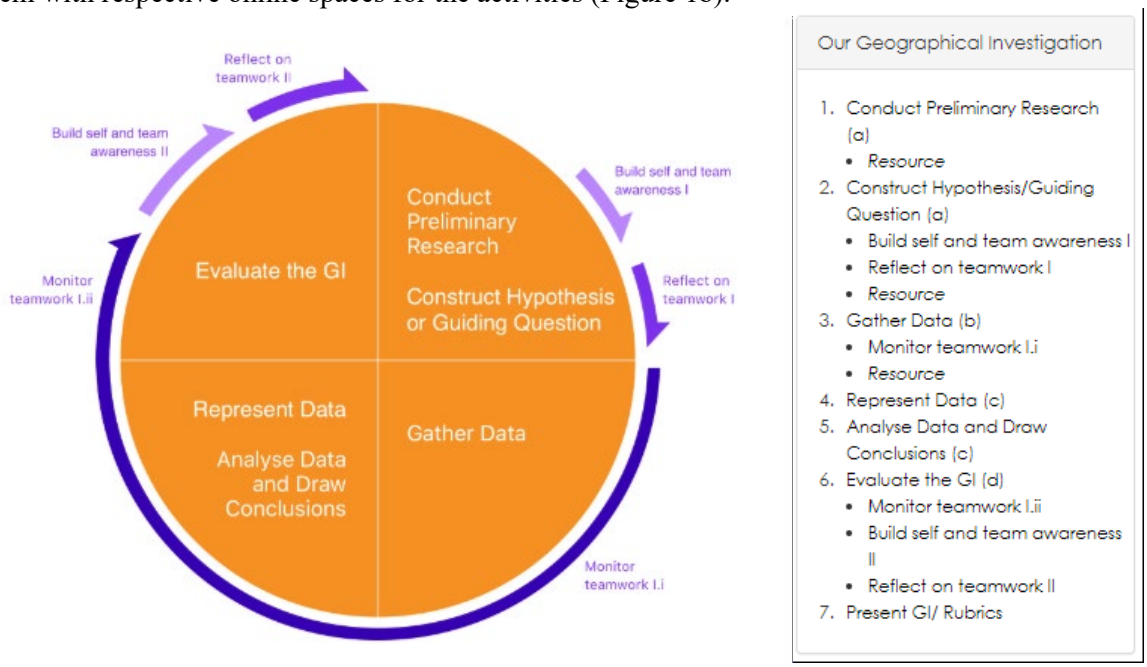


*Figure 1a.* Left; Collaborative inquiry model for geography learning and teamwork; GI - Geographical Investigation; *Figure 1b.* Right; Navigation pane of My Groupwork Buddy for Geography

The Geography curriculum in Singapore employs the geographical inquiry approach as its main pedagogy. Similar to inquiry-based learning, this approach comprises four key aspects, namely question-driven, evidence-based, reflection and knowledge construction. These aspects are represented in a cyclical inquiry process: *sparking curiosity*, *gathering data*, *exercising reasoning* and *reflective thinking*. On the other hand, TSDL is a digital formative assessment approach to teamwork (Koh, Hong, & Tan, 2018). Informed by pedagogies such as experiential learning and the learning analytics process model, TSDL relies on four staged mechanisms: 1) *team-based concrete experiences* that involves students engaging in collaborative activities to gain understandings of working with team members; 2) *self and team awareness building* through visualizing self and peer ratings of teamwork behaviors; 3)

*team and self reflection and sensemaking* where students reflect and set goals based on the insights from the visual analytic; and 4) *team and self growth and change* for students to monitor teamwork goals set.

The collaborative inquiry model for geography and teamwork learning integrates the four phases of the geographical inquiry process with two TSDL cycles. As seen from the first quadrant in Figure 1a, this is the phase, sparking curiosity, where students have to work in their team to conduct preliminary research as well as construct the guiding question. After this milestone of coming up with the guiding question and hypothesis as a team, students have gained enough concrete experiences (TSDL stage 1) and can proceed to TSDL stage 2, where they will build self and team awareness through self and peer ratings about aspects of their recent teamwork experience. This information is harnessed as a form of feedback for students via a visual representation, for students to reflect on. This provides students with a greater metacognitive awareness of the teamwork aspect, in addition to the taskwork aspect of the geographical inquiry process.

Following this, students will gather data and exercise reasoning (next two phases of geographical inquiry) with specific activities such as representing data. Students are reminded to monitor their teamwork progress through status checks (part of the last stage of TSDL). This makes it more visible for students and provides opportunities for them to regulate their individual and team learning behaviors. Finally, during reflective thinking where students evaluate about their geographical learning, the TSDL cycle can begin again, allowing them to consciously assess their teamwork.

### *3.2 Student Collaborative Space with Choices and Scaffolds*

In developing the tool, through having one electronic platform for GI, students can more easily engage in geographical tasks and team dialogue to construct joint understandings of subject content and teamwork, in line with consideration #1 (Janssen & Bodemer, 2013). Moreover, a collaborative space for students was implemented in Trial 2, via the collaborate function (Figure 2). This allows students to represent their joint understanding of their knowledge visibly in their team through the co-writing space, in addition to the team chat and team reflection space.

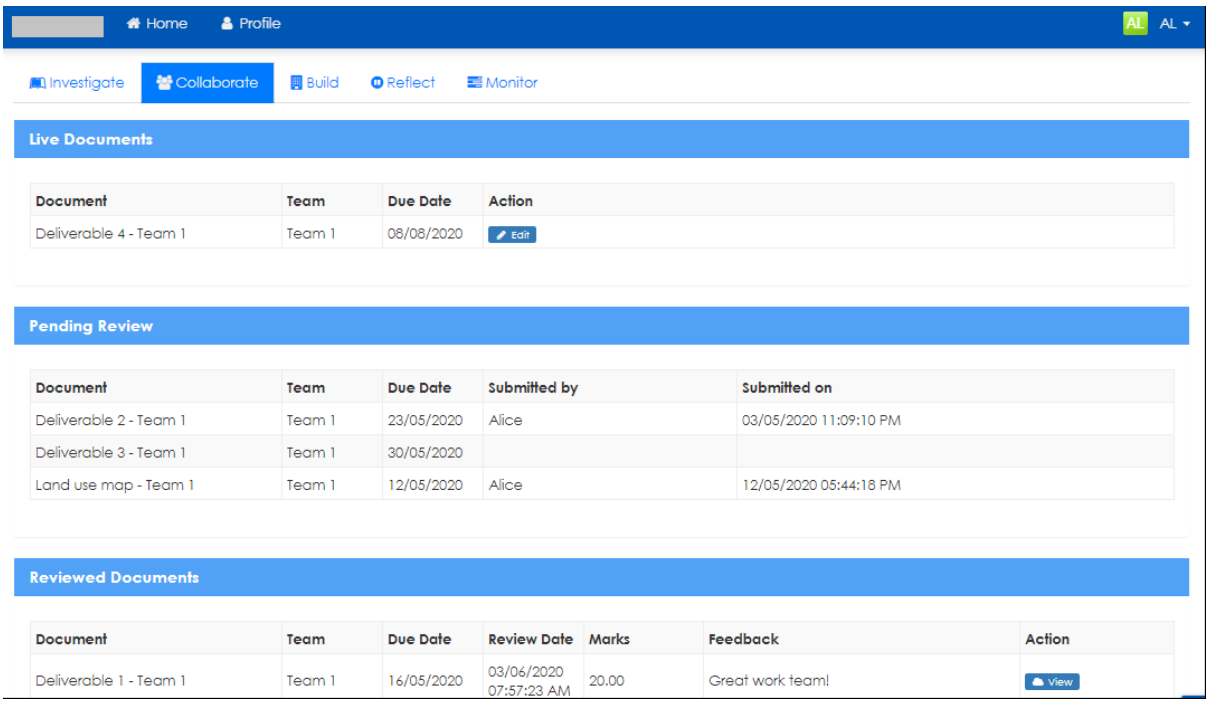


*Figure 2.* Collaborative documents of students organized by three sections.

Based on Trial 1 feedback from students, more explicit support for student's psychological needs through the system design was highlighted. Thus, in Trial 2's redesign, SDT motivating principles were more purposefully incorporated (consideration #2) such as take the students' perspective, offer activities to vitalize psychological needs (competence, autonomy, and relatedness), provide explanatory rationales and communicate using informational language (Reeve & Cheon, 2016).

Collaborative documents for each student team is organized in three sections (Figure 2). Live documents displays all the “active” documents for each team to work on via clicking "Edit". Figure 3 shows a sample working document. It starts off blank, providing flexibility in what students would like to create and edit, and also for teachers to insert guiding questions as scaffolds. On the right of the document, this online presence provides opportunities for students to interact with each other.

Teams had the choice of when to submit the document for review, before its due date. To help maintain learners’ motivation during the GI, instead of one large report that is due at the end, chunking was applied to break down the report into bite-sized deliverables with specific guiding questions that are due at certain timepoints. Also, scaffolds provided in the form of specific guiding questions for each smaller deliverable meant that explanatory rationales were provided at every step of the GI, so that students are clear about their deliverable. This helps to fulfil the motivating principle of offering students a clear standard to work towards, so as to fulfil one of their psychological needs, competence.

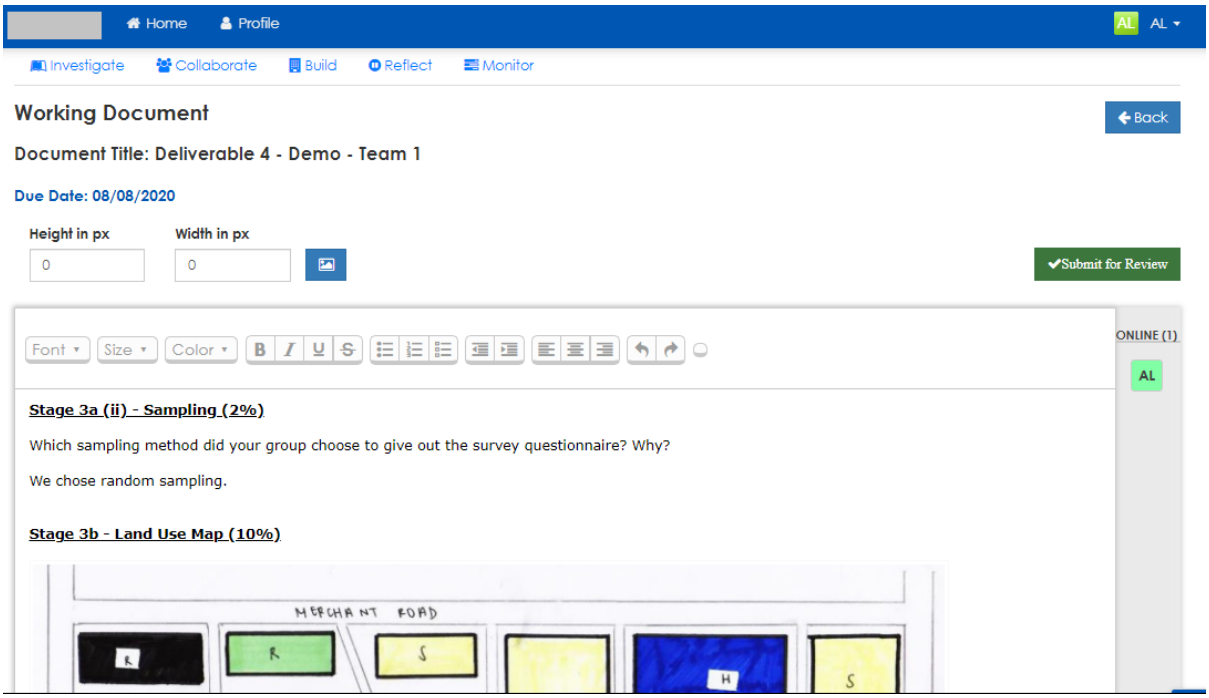


*Figure 3.* Collaborative writing space for students.

### *3.3 Collaborative Inquiry Content with Learning Prompts*

In line with design consideration #2, learning prompts for geographical and teamwork content were added in the forms of hints and tips. Geographical hints were indirect clues on the elements of the GI content (relating to declarative knowledge), to engage students in deeper thinking, whereas tips related to procedural knowledge, and were crafted to relieve students’ pain points at certain parts of the GI. An example tip is provided at GI Stage 2, Construct hypothesis/guiding question, “A little time spent here will save you a lot of time later”. Taking the student’s perspective, this tip highlights the importance of this step by explaining the rationale of time saved. For teamwork learning, teamwork tips were designed to be relatively generic to apply to most teamwork situations and relate to the dimension of teamwork that students wanted to improve on. Similar to the prompts for the geographical content, the tips employed motivating strategies such as taking students’ perspective and using informational language.

## 4. Discussion and Conclusion

To what extent can tools be designed to support both geographical as well as teamwork learning in collaborative inquiry? This paper has summarized two key design considerations relating to the whole techno-pedagogical approach and the needs of the student. Furthermore, these considerations were

developed in Trial 2 of the project. The collaborative inquiry model that integrated both the geographical inquiry approach as well as TSDL in its very alignment highlights how cognitive and social awareness tools can be combined in a single system, which is a contribution to the field. We are cognizant that the current collaborative inquiry model is depicted as linear in nature. Authentic collaborative inquiry could be more connected, iterative and intertwined (Scanlon et al., 2011). The relatively simplistic illustration was for easier understanding of the collaborative inquiry process, which already integrated the intricacies of two other frameworks. That said, during the implementation, teachers did elaborate to their students that iterative nature of collaborative inquiry.

Second, in designing the collaborative space for students, care was taken to provide flexibility and choice for them, balanced with structure and scaffolds for their guidance. Third, the content in the system relating to the outcomes of geographical knowledge and teamwork learning were enhanced with learning prompts intended to motivate their learning in these respective areas. Through these two designs, the system emphasized and explicitly addressed students' psychological needs. This incorporation of SDT-based motivational principles remains relatively novel and further work could validate the framework for examining motivational dynamics and experiences of learners.

Through the synthesis and design of My Groupwork Buddy for Geography, this paper has theoretically identified and practically developed three techno-pedagogical design principles for collaborative inquiry. This contributes to the academic literature in learning design and broadens much of extant literature on academic content towards an equal importance on softer skills such as teamwork. Additionally, this study extends the existing collaborative inquiry and SDT literature in the field of educational research. In all, providing guidance towards designing tools that build the dual complementary goals important for learners now and in the future.

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## References

Chemsi, G., Sadiq, M., Radid, M., & Talbi, M. (2020). Study of the self-determined motivation among students in the context of online pedagogical activities. *International Journal of Emerging Technologies in Learning, 15*(5), 17-29.

Deci, E. L., & Ryan, R. M. (1985). *Self-determination in human behavior*. New York, NY: Plenum Press.

Janssen, J., & Bodemer, D. (2013). Coordinated computer-supported collaborative learning: Awareness and awareness tools. *Educational Psychologist, 48*(1), 40-55.

Koh, E., Hong, H., & Tan, J. P. L. (2018). Formatively assessing teamwork in technology-enabled twenty-first century classrooms: exploratory findings of a teamwork awareness programme in Singapore. *Asia Pacific Journal of Education*, *38*(1), 129-144.

Ng, B., Liu, W. C., & Wang, C. (2015). A preliminary examination of teachers' and students' perspectives on autonomy-supportive instructional behaviors. *Qualitative Research in Education, 4*(2), 192-221.

Reeve, J., & Cheon, S. H. (2016). Teachers become more autonomy supportive after they believe it is easy to do. *Psychology of Sport and Exercise, 22*, 178-189.

Scanlon, E., Anastopoulou, S., Kerawalla, L., & Mulholland, P. (2011). How technology resources can be used to represent personal inquiry and support students' understanding of it across contexts. *Journal of Computer-assisted Learning, 27*, 516-529.

Schnaubert, L., Heimbuch, S., Erkens, M., & Bodemer, D. (2019). Cognitive group awareness tools: Versatile devices to guide learners towards discrepancies. In Chang, M. et al. (Eds.) (2019). *Proceedings of the 27th International Conference on Computers in Education* (p. 158-164). Taiwan: Asia-Pacific Society for Computers in Education.

Sharples, M., Scanlon, E., Ainsworth, S., Anastopoulou, S., Collins, T., Crook, C., … O'Malley, C. (2015). Personal inquiry: Orchestrating science investigations within and beyond the classroom. *Journal of the Learning Sciences, 24*(2), 308-341.