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Location-based Collaborative Learning at a Geography Trail: Examining the Relationship among Task Design, Facilitation and Discourse Types

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Abstract: In this paper, we examine the characteristics of a discourse that show evidences of collective knowledge construction and investigate the impact of task design and facilitation on in situ small group collaborative learning. To examine discourse types, all audio-recorded verbal data of the three groups of secondary students is transcribed, coded and analysed with respect to two key dimensions in the knowledge construction process, namely, *the epistemic* and *the social*. Tasks were categorized largely into *performative* and *knowledge-generative*. Analysis showed that different epistemic activities and the nature of facilitation have a definitive bearing on group discursive moves and more importantly, the presence of a real world context could generate intense knowledge co-construction even for mundane performative tasks. In conclusion, we propose that a three-prong approach (FAT) – Facilitation, Activities in-situ, and Technology – should be considered to support meaningful collaborative learning practices in mobile learning.

Introduction

Rapid advancement in information and communications technology has revolutionised the teaching and learning landscape; creating new and exciting possibilities for learning beyond the four walls of the classroom, and thereby, inevitably changing the role of both the learner and the teacher. Seamless learning across context and space is now made possible with the affordances of mobile computing and web applications. Interaction with the real world environment has also given learning, new shades of meaning and intent. In the field of computer-supported collaborative learning (CSCL), whilst there is extensive research and literature on leveraging emerging mobile devices and Web 2.0 technologies to enhance the learning experience in the real-world setting and/ or learning on the move (e.g., Squire & Klopfer, 2007), there remains little empirical research on other equally significant configurations of mobile learning: that is the *design configuration* of mobile learning environments and the execution path to bring about the desired learning outcomes. Another common pitfall is the focus on the unending possibilities of mobile devices and innovative software applications over the rich affordances of the physical environment in the context of enhancing mobile learning.

To examine the design configurations and the affordances of real-world contexts for promoting meaningful collaborative learning experiences, this paper articulates the in situ learning experience of three groups of Secondary One students (ages 12-13) on a geography mobile learning trail. Specifically, we are interested in investigating the intricate relationship among task-design, facilitation and the discourse types in situated small group collaborative learning. This study analyses the content, process and pattern of students' interactional discourse in the knowledge construction process. We believe that a focus on process rather than outcome is pertinent to understanding the design configurations necessary for effective in situ collaborative learning.

Theoretical Frameworks

The anatomy of location-based collaborative learning primarily composes of two main constructs: *context-oriented* and *a collective enterprise*. More importantly, these two constructs should not be conceived as separate entities operating in their own paradigms; rather they are closely interwoven in the process of knowledge construction to bring about the desired learning outcomes. Educational researchers argue that students learn best when they are able to learn skills and theories in the context of real world, then construct their knowledge of a subject to be applied (Gay, Stefanone, Grace-Martin, & Hembrooke, 2001). This accords with the works of Brown, Collins and Duguid (1989) on situated cognition where they postulated that "knowledge is situated" and expounded on the necessity of cognitive apprenticeship and collaborative learning" where collective undertaking of authentic problem solving would give rise to new knowledge and insights. They attributed such a learning outcome to group dynamics and synergy. And interestingly, in theorising mobile learning, Sharples, Taylor and Vavoula (2005) reiterated that what essentially differentiates mobile learning from other types of learning is that "It is the learner that is mobile, rather than the technology" and they contended that a fundamental concern in understanding the essence of mobile learning is "to understand how people artfully engage with their surroundings to create impromptu sites of learning". Further, they highlighted the prerequisites of successful learning, point towards a social-constructivist approach on learning, where learning

is conceived of "as an active process of building knowledge and skills through practice within a supportive community". Therefore, a working pedagogical framework for location-based collaborative learning should satisfy these two conditions: context- oriented and a collective enterprise.

One approach to support situated learning experiences in school is through the form of field trips (e.g., excursion, outdoor learning, etc). Previous research on field trip reveals that the educational effectiveness of a field trip is controlled by its structure, learning materials and the interaction with the environment (Orion & Hofstein 1994). Field trip visits often result in the students experiencing many phenomena and ideas that are new to them, where the individual is situated and ultimately have a strong influence on the ways in which knowledge is constructed (Anderson, Lucas et al. 2000). In the field trip, the environments cannot be pre-specified, therefore learning in the field trip including re-conceptualisation is created through the activity of learning. Knowledge is dynamically constructed by learners interacting with their surroundings (Sharples, Corlett, & Westmancott, 2002). This unique feature of location-based learning during field trips is expounded in Brown et al.'s (1989) concept of learning and cognition, where they posit that "situations might be said to co-produce knowledge through activity", hence learning and cognition are fundamentally situated.

Next, a social-constructivist approach also epitomizes the significance of collective co-construction of knowledge underpinning the nature of the learning process. Here, learners not only construct meaning on their own, but also with others to apply knowledge in real world context (Pena-Shaff & Nicholls 2004). Collaborative learning is thus, conceived of as active participation and interaction both with the environment and with others to negotiate meaning (Jonassen, Davison, Collins, Campbell, & Bannan Haag, 1995). Hence, the sense of place was emphasized in location-based learning since space not only refers to geographical locations, but also cognitive, psychologically affected space where social interactions place an important role (Gruenewald, 2003). And on the notion of technology-mediated mobile learning, mobile devices are mediating tools that allow people to capitalise on the situation in terms of the immediate physical space, while encouraging social communication and archiving in ways that enhance the learning context.

Methodology

Research Setting and Design Consideration

Premised upon a social constructivist framework on distributed cognitions (Salomon, 1993) and situated learning (Brown et al. 1989), the geography trail at Sentosa island in Singapore serves as a real world platform to acquaint students with situated collaborative learning; generating, sharing and affirming findings and solutions in problem-solving and inquiry-oriented activities. For the implementation of location-based geography trail, three main activity stations, named Yellow, Red, and Green, were identified along Sentosa's coastal areas spanning from Siloso beach to Palawan beach. To promote independent group decision-making, all instructions and procedures for activities were hosted on a web-based platform (see Figure 1), and facilitators, who are trained university students, were also present at all the activity stations. Facilitation was a built-in measure to assist students in their collaborative undertaking by providing them with task-oriented questions and necessary prompts that build on students' contributions to charter the course of their discussion. Each group was carrying Macbooks as mobile devices, and given a password to log onto the system and a set of coordinates to locate the stations with the help of Google maps. They were also able to upload their findings and collected artifacts onto these web pages created for each station.

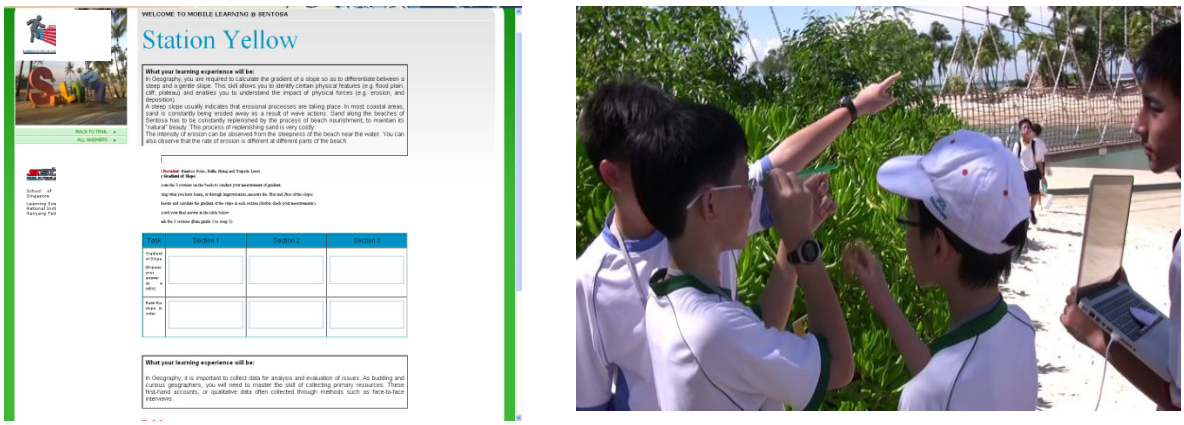

Figure 1. Web Platform (Left) and Students Measuring Height of Observation Tower Using Trigonometry (Right).

Table 1 presents an overview of the type of tasks designed for the mobile learning trail. The tasks were co-designed by the research team and collaborating teachers. Two key considerations drive the design and

execution of the learning activities. Firstly, the learning activities should provide students with an authentic platform to apply their acquired geography skills and knowledge in a real world setting. Secondly, the activities ought to set the stage for in-situ collaborative learning, meaning collaborative meaning-making among students in the course of interaction with and within context. Hence, the on-site activities seek to maximize the presence of a *real world* platform, engaging students in meaningful knowledge creation and production where "the process of learning is informed by sense of place" (Lim & Barton, 2006, p.107). For instance, some of the key earning activities include measuring of gradient, identification of physical features in relation to the impact of physical forces of erosion and disposition, and the collection of qualitative data via face-to-face interviews with tourists.

In examining task design and implementation, we are particularly interested in the nature of task types in terms of its structuredness. In this study, well-structured tasks form *performative tasks* where learning paths to complete a task is rather fixed and procedural, leaving relatively little room for negotiation, judgment and conflict among group members. Measuring and calculating gradients of slopes (Task 1) is an example of well-structured tasks, as students can apply learned procedural skills to solve the task. On the other hand, we refer ill-structured tasks to *knowledge generative tasks* where the course of learning focuses on generating, communicating and co-constructing ideas. Design thinking task at the Green station (Task 7) falls into this category of knowledge generative tasks since the nature of tasks does not lead to one single answer or learning path; instead students need to propose workable solutions in the consideration of multiple dimensions. The nature of tasks can combine both performance and knowledge generation as the case of Task 2 where students need to generate interview questions and perform an interview with tourists.

Table 1: Overview of task design and characteristics.

Station	Task type	Description of tasks	Desired learning outcomes
Station Yellow	Performative	*Task 1:* Measure and calculate the gradient of the slope at 3 different sections of the beach and rank the slope from the gentlest to the steepest.	To understand the impact of physical forces such as erosion and deposition on the steepness of the beach.
	Performative and Knowledge generative	*Task 2:* Interview tourists to find out why they picked Sentosa as a holiday destination and what they think can be improved for Sentosa as a tourist attraction.	To collect qualitative data through primary resources such as face-to-face interviews for analysis and evaluation of issues.
Station Red	Performative	*Task 3:* Capture a picture along the coastal area and annotate five physical features: beach, island, observation towers, sea & suspension bridge.	To capture photo images and label its features as part of the process of data collection.
	Performative	*Task 4:* Calculate tower height using trigonometry	To estimate the height of both physical and human features & to relate the actual features seen on ground to the representation on topographical maps.
	Performative	*Task 5:* Identify, capture a picture of the ridge and annotate the physical feature.	To differentiate between physical features.
	Performative and Knowledge generative	*Task 6* Identify important industries near Sentosa and state their significance for the Sentosa establishment	To ask geographic questions, acquire and analyse geographic information
Station Green	Knowledge generative	*Task 7:* Design thinking with a focus on the beachfront area of the Sentosa island in terms of its attractions, accessibility and amenities. Identify a problem area and propose solutions, following the four fundamental steps of design thinking – brainstorm, share, categorise and solutioning.	To analyse, synthesize and evaluate real-life situations, in a systematic manner.

Participants

In this study, we employed a naturalistic case study method (Stake, 1995) to unpack the relationships among task design, discourse types, and facilitation. The location-based Geography trail was implemented at one Secondary school in Singapore in March 2010. To examine more closely how students co-construct ideas for each task type, our study focused on three groups of four Secondary One students each. The collaborating teachers initially expressed some concerns about gender and ability issues over technology-enhanced learning experiences that required complex problem solving skills. Hence, the selection of groups was randomly made in consideration of gender and academic ability (determined via a standard geography test). The three selected groups include two mixed-ability groups: Group 1 with all-girls and Group 2 with all-boys and one high-ability mixed gender group- Group 3.

Data Collection and Analysis

The conversation and interaction of group members for all activities on the learning trail were video- and audio-recorded and transcribed for analysis (73 pages in total). To analyse the students' interactions and knowledge construction process, all verbal data of the students was transcribed and analysed with respect to two key dimensions in the knowledge construction process, namely, *the epistemic* and *the social*. We adapted Pena-Shaff's framework (2009) for analyzing discourse where she subsumed the eight categories on knowledge construction proposed by Pena-Shaff and Nicholls (2004) into the epistemic and social dimensions surfaced in Weinberger and Fischer (2006). We found that while the frameworks were originally used to analyze online discourse, the coding categories are general enough to be applied in face-to-face discourse. Further, the frameworks were premised upon a social constructivism theoretical framework consistent with our theoretical stance on collective knowledge creation. Fischer et al. (2002 in Weinberger & Fischer, 2006) define the *epistemic dimension* as the on-task discourse where participants undertake knowledge construction tasks, and emphasis is given to the *content of the contributio*ns of the participants. Of equal significance in the analysis of collaborative learning discourse is Weinberger and Fischer's (2006) proposition of the *social dimension* where they posit that the social modes of co-construction describes how learners response to and/ or build on the contributions of fellow participants in the course of solving a task. Table 2 features the revised coding category system for Knowledge Construction.

Table 2: Coding category system for knowledge construction.

Dimensions	Code Category and Description
Epistemic Dimension *Construction of Problem Space* (retell rather than interpret)	*Elementary Clarification (ECL):* Observing or studying a problem identifying its elements, and observing their linkages in order to come to a basic understanding
Epistemic Dimension *Construction of Problem and Conceptual Space and Relationships between both* (main task in problem-oriented learning environments)	*Question (QS):* Establishing relations between the problem and the conceptual space *Reply (RP)* *In-depth Clarification (ICL):* Analyzing and understanding a problem which sheds light on the values, beliefs, and assumptions which underlie the statement of the problem
Epistemic Dimension *Construction of Relations between Problem and Conceptual Space*	*Interpretation (IN)*
Some Epistemic Dimension	*Evaluation/Judgment (EV/JD)*
Statements not conductive to knowledge construction	Clarification without grounds; inappropriate use of theory/concepts, arguments with no ground, remarks on organization matters (*non-KC)*
Non-epistemic activities	Social comments not related to discussions (*non-EP)*
Social Dimension	*Externalisation (EX):* Discussions typically start with externalization/ Explain what they know *Elicitation (EL):* Receiving information from the learning partners learning partners as a resource *Quick consensus building (QCB)* *Integrated-oriented consensus building (ICB)* *Conflict-oriented consensus building (CCB)*

Coding Schema and Unit of Analysis

The group interactional discourse of completed tasks for all three experiment groups at the various activity stations was selected for analysis in this study. The number of tasks varies from station to station, ranging from minimum two tasks to maximum four tasks. As such, the corpus of transcribed verbal data at the different activity stations was segmentised first according to the different tasks at each station, and thereafter, according to semantic features such as topics, discussion threads and ideas. Chi (1997) argues that it is more meaningful

using semantic boundaries to determine the unit of analysis since an idea may require a few sentences to put across; moreover, similar idea could be surfaced several times by team members who are more vocal. We found this particularly true of face-to-face collaboration where tracking the development of the interactions to trace evidences of collective knowledge construction is necessary. Hence, each segmentised unit of analysis in our study, depending on the discussion thread and topic, could contain a single or several categories. To achieve consistency and reliability, two more rounds of re-coding for all three participant groups were carried out by the first author. A second coder was also deployed, and an inter-rater reliability of 0.712 (Kappa coefficient) was achieved. In general, a Kappa value of 0.7 above is acceptable.

Findings and Discussion

A Comparison of the Occurrences of Discourse Types

The frequency of occurrences of statements for all task-discourse according to the category system is presented in Table 3 for all groups at all three activity stations. As mentioned earlier, only the conversational discourse of completed tasks is coded, thus for the tasks at yellow station, only findings of Group 1 and Group 3 are reflected and for tasks at red station, Group 3 completed only the first task out of the four tasks assigned. All the groups managed to complete the task at the green station.

Table 3: Frequency of occurrences of discourse types according to task-type for all three groups.

Task Structure	Performative									Performative + Knowledge Generative				Knowledge Generative		
	well-structured															ill-structured
	Task 3			Task 5		Task 4		Task 1		Task 2		Task 6		Task 7		
Groups	G1	G2	G3	G1	G2	G1	G2	G1	G3	G1	G3	G1	G2	G1	G2	G3
Epistemic dimension																
ECL	2	0	0	2	1	1	2	4	4	0	0	0	0	0	2	0
QS	1	1	0	1	1	0	3	0	2	1	1	1	2	3	5	1
RP	3	2	4	0	1	4	5	4	5	1	3	3	5	3	3	3
ICL	0	0	0	0	0	0	3	3	1	1	0	0	0	3	2	2
IN	0	0	0	0	0	1	1	2	2	2	2	1	2	8	7	4
EV/JD	0	0	0	0	0	2	1	3	1	3	2	0	0	5	6	3
non- KC	3	2	8	3	0	3	2	3	3	4	4	1	0	6	8	4
non-EP	2	0	7	0	1	4	1	2	0	0	0	0	0	1	0	2
Social dimension																
EX	2	3	6	2	2	6	5	12	6	1	3	3	1	3	6	3
EL	3	3	6	3	3	5	5	12	6	3	3	4	2	4	6	4
QCB	3	2	2	2	2	4	3	10	6	1	2	1	0	3	3	2
ICB	0	0	0	0	0	1	0	0	0	0	1	1	1	5	3	1
CCB	0	0	0	0	0	1	1	2	1	2	1	0	0	2	5	2

Note: ECL= Elementary Clarification, QS= Question, RP= Reply, ICL= In-depth Clarification, IN= Interpretation, EV/JD= Evaluation/Judgment, Non-KC= Statements not conductive to knowledge construction, Non-EP= Non-epistemic activities, EX= Externalisation, EL= Elicitation, QCB= Quick consensus building, ICB= Integrated-oriented consensus building, CCB= Conflict-oriented consensus building

A comparison of the occurrences of statements across all three stations reveals an unequal distribution of statement types. The bulk of the utterances during the task-discourse at yellow and red station for all three groups fall chiefly into basic clarification, reply, externalization, elicitation and quick consensus building categories. Clarification statements in the epistemic dimension remain mostly in the elementary phase except for Group 1 and Group 3 which manage to raise some in-depth discussion during Tasks 1 and 2 at the yellow station. For the red station, there are no occurrences of in-depth clarification, interpretation, judgment/evaluation, integrated-oriented and conflicted oriented statements for tasks 3 and 5. This unequal distribution of occurrences of statements becomes more apparent when one compares the task-discourse between the red and green stations for all three groups. The task-discourse at green station sees marked improvement in the occurrences of interpretation and judgment/evaluation across all three groups. Similarly in the social dimension, there are also reportedly fewer externalization and elicitation statements. Instead, we saw some instances of integrated-oriented and conflict-oriented statements. Statements not conductive to knowledge construction also witnessed a noticeable decline. Learners were more engaged in-depth discussions that require them to consider one another's contributions, give comments and propose suggestions in the course of arriving at a consensus.

Impact of Task-design on Discourse Types

We argue that one reason to explain the above phenomenon lies in the *nature of task*. Tasks 3, 4 and 5 at the red station are chiefly application and procedural which require learners to transfer acquired geography knowledge and skills into real world situations. Hence, in the social dimension, statements made were pre-dominantly externalisation to verbalise what they already knew about a specific application or problem-solving process, and likewise, elicitation statements to seek affirmation of known procedures. Learners were also inclined towards quick consensus building to proceed with tasks since they were relatively familiar with task requirements and protocol. Likewise, we could also conclude that the task-type also accounts for the occurrences of basic clarification, question and reply statements in the epistemic dimension. Comparatively, the task on design thinking at green station (Task 7) allows more space for collective knowledge generation and construction. To visualize the difference between performative and knowledge generative tasks, we selected Tasks 3 and 7 and plotted the frequency of discourse types for each group in Figure 2. The column graphs show that the content of the contributions from the learners indeed show an increase in more in-depth clarification statements, evaluation, integrated-oriented and conflict oriented statements for Task 7 across all the three groups.

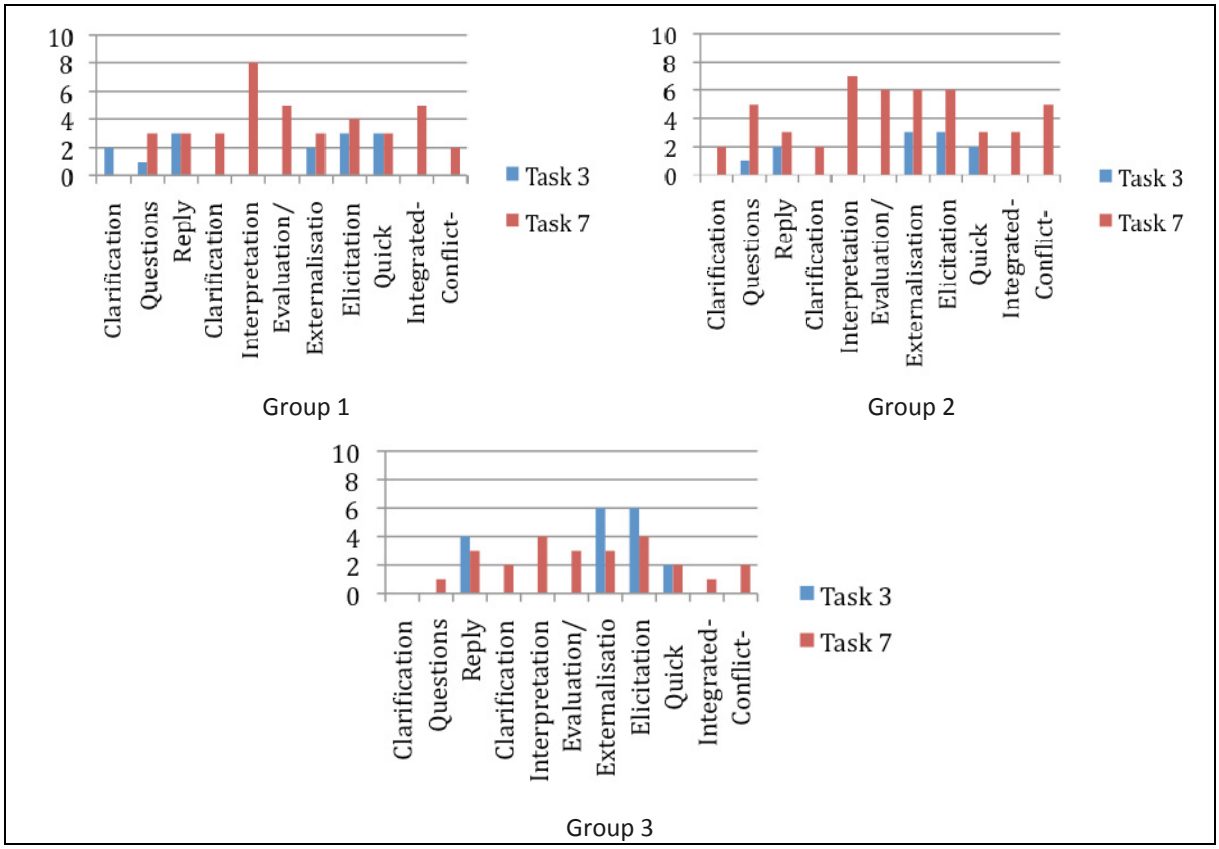

Figure 2. Discourse frequency charts between Performative Task (Task 3) & Knowledge Generative Task (Task 7).

Our findings and analysis further accentuated that different epistemic activities are also likely to dictate the learners' task-discourse. This inherently implies a close relationship between the types of epistemic activities and the social modes of co- constructing and advancing knowledge. On this note, Weinberger and Fischer (2006) posit that the varying social modes indicate both the degree and extent of "how learners work on the task and formulate arguments together (as opposed to individually)" (p.86). In a similar fashion, Salomon (1993 in Pena-Shaff & Nicholls 2004, p.244) postulates that new knowledge arises in the course of exchange, negotiation and transformation, and he contends that the "exchange of ideas and negotiation of meaning affects not only the individual's cognition but also the group's distributed cognitions". In the social process dimension, our case study also shows that pure application and/ or procedural tasks tend to yield more externalization, elicitation and quick consensus building, as surfaced in the conversational discourse for tasks at red and yellow stations. Discussion often remains at the elementary level of acknowledgement and affirmation of known procedures. And in the epistemic dimension, there are also significantly fewer evidences of a rigorous interaction in the sharing and improvement of ideas amongst learners to construct and advance knowledge.

Role of the Physical Environment in Relation to Task-design and Task Discourse Types

The essence of location-based collaborative learning is embodied in the constructivist approach on learning environments, where students are presented opportunities to think about the object and subject of study, construct meaning on their own and with others and to apply knowledge in real world context. A review of the task discourse for Group1 and Group 3 at yellow station Task 1 and Group 1 and Group 2 at red station Task 4 (see Table 3), shows that this task-type (though mainly skill-based and application) generated some in-depth clarification, interpretation and evaluation statements in the epistemic dimension, as well as, integrated and conflict-oriented consensus building in the social modes of co-construction. We attribute this phenomenon to the *affordances of in-situ learning*, where students are confronted with the real world platform to translate their acquired geography skills and knowledge into practice. Notwithstanding, the nature of tasks may not have changed drastically from the usual mundane procedural tasks which might have been accomplished in the four walls of a classroom, but the presence of the real physical environment certainly presented a different facet. The seemingly straight-forward application tasks such as the measuring and ranking of the gradient of slopes at the designated beach sections, and calculating tower height at the observation point saw unusual engagement in the task-discourse and greater collective knowledge construction. The interaction with the real environment presented some *unforeseen variables* where students found the application of known formulas was no longer as clear-cut, and the problem-solving process necessitated collective review of ideas and consensus. Students had to exercise more critical thinking in the course of finding and affirming solutions collaboratively.

Impact of Facilitation on Discourse Types in Relation to Task

Our findings surface another critical factor, which has significantly impacted the nature, intensity and scope of discussion, i.e. *facilitation*. It is evident from the relatively different occurrences of statements though the nature of task was similar, as in the case of Task 6 at the red station and the design-thinking task at the green station (see Table 3) that the nature and type of facilitation has a direct bearing on the group discourse. As mentioned above, the task-discourse at green station witnessed a visible increase of interpretation and judgment/evaluation across all three groups. Although this trend of discussion ought to have surfaced for Task 6 at the red station for Group 1 and Group 2 where the nature of the task also necessitated more collaborative critical thinking in the problem-solving process, there were only slightly fewer externalization and elicitation statements and sparse occurrence of interpretation and integrated-oriented consensus building statements. Taking a step further to re-trace the task- discourse for Group 1 and Group 2 at the red station, shows that where facilitator intervened frequently in the course of discussion and/ or posed highly structured questions, participants became less forth-coming with ideas. On the role of facilitation and its significance in collaborative learning environments, we concurred with Hmelo-Silver and Barrows (2008) that there exists a definitive relationship between "how the facilitator provided opportunities for knowledge-building discourse and how the learners accomplished collective knowledge building" (p.48). In other words, the type of questions posed will have a bearing on the *discourse moves* that inherently associate with effective collaborative knowledge building process and outcomes, in which Hmelo-Silver and Barrows (2008) spoke of *shared responsibility* of both the learners and the facilitator to move the discourse forward. Facilitation plays a significant role in culminating a productive discourse.

Conclusion

Overall findings provide accounts supporting the close relationship between task types and discourse types. When groups participated in the tasks that afford space for knowledge generation, the occurrence of interpretative and evaluative discourse appears to be high. On the other hand, when groups participated in performative tasks that are rather fixed and procedural, groups' discursive practices tend to be clustered around the sequence of question-answer and quick-consensus building. However, this is not to say that performative tasks are not desirable in collaborative learning practices. As we have presented in this paper, performative tasks do play important roles in supporting learners to internalize and externalize their knowledge and skills. Specifically in the context of location-based learning, applying knowledge and skills learned in classroom is not straightforward in authentic contexts due to unforeseen variables and complex interaction with the physical environment. Such complex situations of application are important learning opportunities for students to learn disciplinary problems through struggles, conflicts and even initial failures.

In relation to the conference theme on *connecting CSCL to policy and practices*, this study highlights the importance of paying close attention to the design configurations in mobile learning practices. In recent years, we have witnessed policy initiatives at the national and institutional levels to provide more affordable and accessible mobile devices to learners. In addition, there have been increasing interests about how to connect learning experiences in and out of school contexts through the mediation to mobile technology and applications. Field trips or outdoor learning supported with mobile technology is one form of situated learning that schools are exploring to provide students with rich, authentic experiences. We argue that whether such initiatives make

any impact on collaborative learning practices in schools is closely associated with how learning tasks are designed and enacted to support authentic learning experiences. As this study shows, the dominance of performative tasks and/or highly structured facilitation is likely to reproduce the traditional discourse pattern like IRE in classrooms. Hence, we proposed that a three-prong approach (FAT) – Facilitation, Activities in-situ, and Technology – should be considered to support meaningful collaborative learning practices in mobile learning. To conclude, we believe that this study provides some insights about how the three intricate dimensions –task design, discursive practices, and facilitation – are unfolded in the situated context of collaborative learning. We argue that a balanced approach in task design is critical to make a transition from doing tasks to doing tasks *with understanding*.

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