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Using asynchronous online discussions in primary school project work

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Using asynchronous online discussions for interschool collaborative project work represents one of the innovative practices in the Singapore classroom. With anytime, anywhere access to interactions among the students and teachers, the asynchronous nature of these interactions leads to new paradigms for teaching and learning, with both unique problems of coordination and unique opportunities to support active participation and collaborative learning. A research study was conducted to investigate how primary school students participate and learn in project work based on co-construction of knowledge in asynchronous online learning environments. 10 teachers and 20 students from 5 primary schools participated in this half-year long research study. Teachers crafted project tasks for implementation at the students' level and these tasks were addressed collaboratively by the students who formed project groups with members from another school. Quantitative and qualitative analyses of students' activity in the asynchronous online environment were conducted. Students' sent and received notes as well as the frequency of scaffolds used in the online environment were evaluated. Each note was also ranked according to Gunawardena, Lowe and Anderson's (1997) *Interaction Analysis Model*. The findings provided evidence to suggest that primary school students participating in the online project work learning environment were capable of the co-construction of knowledge up till Phase IV of the *Interaction Analysis Model.*

Introduction

The integration of asynchronous Internet technology into learning processes in schools is reshaping education in significant ways (Imel, 2001) and has created vast opportunities for new technology based practices. The wide use of such technology is also part of an instructional shift towards project based, constructivist approaches to teaching and learning within a context of school improvement or reform. Instead of focusing solely on increasing acquisition of facts related to specific subject areas, students are collaboratively engaged in solving complex, authentic problems that cross

disciplinary boundaries and are supported by computer mediated communication (Murchu, 2005). Previous studies have showed that computer mediated communication has been widely used to support small and large group communication in distance learning (Beaudrie, 2000; Gunawardena, Lowe, & Anderson, 1997; Kanuka & Anderson, 1998; Myers, 2002) as well as supplementing project based learning courses (Kramarski, 2002; Miller, 1999). Computer mediated collaborative learning creates the opportunity for a small group of students to actively co-construct knowledge (Gunawardena et al., 1997; Kanuka & Anderson, 1998; Warschauer, 1997) and to engage in critical thinking (Garrison, Anderson, & Archer, 2001; Jeong, 2003) as well as serving as a "possible cognitive amplifier that can encourage both reflection and interactions" (Warschauer, 1997). Despite its attractiveness as an instructional tool, its adoption has surpassed the understanding of how this medium best promotes collaborative learning. Generic questions related to the quantity and quality of interactions and satisfactions of participants have been answered (Berge & Mrozowski, 2001; Levin, Kim, & Riel, 1990; Mason, 1992), as well as the 'no significant difference' phenomenon between face to face courses and their online counterparts (Russell, 1999; Weems, 2002).

Table 1: Overview of Project Work

Domain	Focus of evaluation	Skills developed
Knowledge acquisition and application	Process • Information gathering • Processing of information (including the design process for intervention tasks) • Evaluation of work towards improvement Product • Application of knowledge from various subjects and skills • Conveying of intent / purpose of project task • Evidence of creativity / thoughtfulness	• Exploration • Investigation • Analysis • Perception • Application • Creativity and thoughtfulness • Ability to convey intent / purpose of project task to target audience
Commun-ication	• Clarity • Coherence • Effectiveness of aids • Managing questions	• Effective presentation • Use of visuals / IT • Sharing • Listening
Collabor-ation	• Completion of tasks as scheduled • Fair allocation of tasks • Team spirit • Contribution to completion of project	• Time management • Conflict resolution • Teamwork
Independent learning	• Plan and monitor his / her own work • Attitude towards learning and work • Know when to seek help	• Planning and management • Self evaluation • Self motivation

[Source: Adapted from Ministry of Education, 1999]

In Singapore, interdisciplinary, project based learning ('Project Work') has been incorporated into the academic curriculum since 2000, leveraging on the value of collaboration as a tool to promote learning. There are four domains highlighted in Project Work (PW): 'knowledge acquisition and application', 'communication', 'collaboration', and 'independent learning' (Ministry of Education, 1999). Based on these four domains, the teacher-facilitator can derive desired learning outcomes that can then be further defined as skills by students (Kwok & Tan, 2004). Table 1 provides an overview of the four domains in PW with the respective desired skills.

An examination of the current literature reveals little discussion about the use of Internet technologies in Singapore's primary school PW classrooms. Most primary school PW lessons still take place in the traditional classroom setting with students collaborating face to face in groups formed within their own class. Few studies have examined the nature and quality of the online PW communications that occur during computer mediated collaborative learning in Singapore PW classrooms (Jamaludin & Quek, 2004). In Mason's (1992) review of evaluation methodologies for computer mediated communication, she recommended broadening the research to include educational objectives such as critical thinking and the co-construction of knowledge (Kosiak, 2004). While many current studies have examined Mason's suggestions in computer conferencing debates and graduate level distance education courses, these studies are mostly in the context of secondary and tertiary sector models (Quek, Peer, Divaharan, Liu, Williams, Wong & Jamaludin, 2005). To date, there are few extensive descriptions of how students at the primary level participate and co-construct knowledge in online, collaborative, project based learning. Thus, the need for studies which investigate the interaction, collaboration and co-construction of knowledge in primary school students' PW motivates this research. The research questions examined in the study were:

RQ1: How do primary school students participate in Project Work online learning environment?

RQ2: How do primary school students learn while using asynchronous online discussions for Project Work?

Methodology

The research study was set within the context of PW in five primary schools of an eastern school cluster in Singapore. Ten teachers and twenty students (2 teachers and 4 students from each primary school) were involved in the research. The students were at the primary 5 level (10-11 year olds; 12 girls and 8 boys) and were not novices in using educational technology. They worked collaboratively in five different groups. Figure 1

shows the inter-school Project Work groups formed. Each group consisted of four members who came from two different schools. A total of five project groups were formed (2 Water Cycle groups, 2 Exciting Reading groups and 1 Environment and You group) and each group was facilitated by two teachers, each from a different primary school. The entire collaboration process was mediated by an asynchronous online discussion platform, *Knowledge Community* (Tan, 2002). In the first cycle of the research study which lasted for three months, the ten teachers participated in asynchronous online discussions and worked collaboratively to design three project tasks for the students:

- Water Cycle
- Environment and You
- Exciting Reading

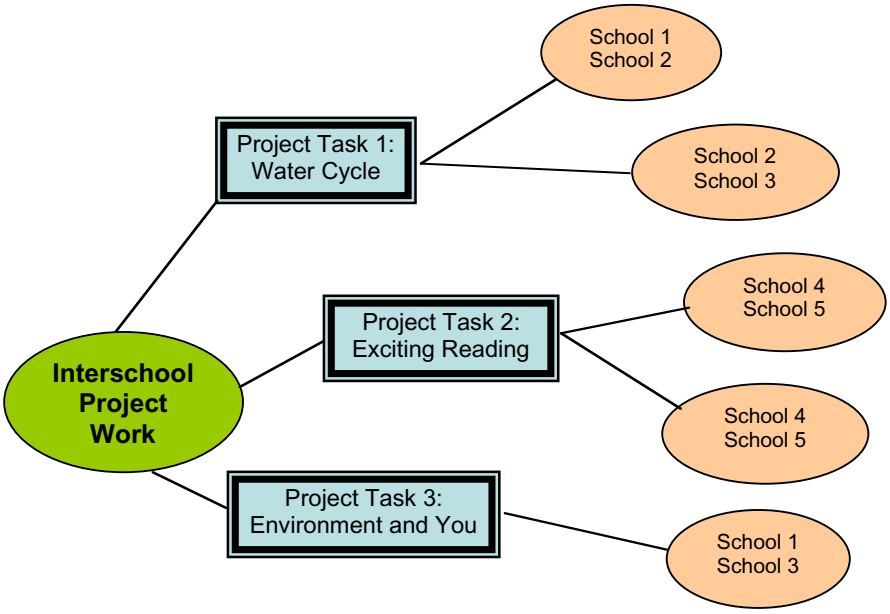

Figure 1: Interschool Project Work groups

The project tasks were centered on project activities which mimic characteristics of a real life design problem. The aim of the project tasks was to encourage students to develop their collaborative, communication, knowledge and independent learning skills by learning in an authentic context (Honebein, Duffy & Fishman, 1993; Jonassen, Beissner & Yacci, 1993). These project tasks were then implemented in the PW classrooms, conducted for one term (10 weeks). In this 10-week period, students

communicated through asynchronous online discussions and worked on their chosen project tasks with their interschool project group members. Two periods (1.5 hours) were allocated per week for PW. In each session, the PW teachers used it to facilitate their students' learning and to teach them "just in time" skills. Time was also set aside for students to log on and discuss with their team members from the other schools. Beyond curriculum hours, students were also encouraged to log on to the online discussion platform using the computers in the school laboratories, or from home. Within the 10-week period, the students also had a face to face meeting to meet up with their project group members to finalise their project proposal. The meeting was facilitated by the PW teachers and the researchers.

Quantitative analysis

To assess how primary school students participate in the asynchronous online environment, a quantitative analysis of the online discussions in terms of mean numbers of notes written and read was reported. In an online environment, participation can be defined through writing notes and reading notes (Lipponen, Rahikainen, Lallimo & Hakkarainen, 2003). According to Bereiter and Scardamalia (1987), writing has a crucial role in the explication and articulation of one's thinking and the advantages of writing as a tool of thinking in the online environment are recognised by several researchers. In this study, writing notes was chosen as an indicator of participation; the definition of who is active and inactive was based on the number of written notes posted.

For every note written, the student must select a suitable scaffold to represent what their note content is all about, for example "An idea", "A theory", "My reflection " or "Example". Scaffolds are used in note writing forms to help students understand and construct a complex idea or task in a strategic way (Kwok & Tan, 2004). In this study, students learn to use scaffolds to best represent what they write and post in the online discussions. This helps the primary school students in organising their thought processes before they post their notes in the online discussions. Thus if a student would like to contribute to the asynchronous online discussions by suggesting an idea to the other group members, the scaffold selected to represent the note would be "An idea". The scaffolds were created by the teachers who collaborated to come up with a set of scaffolds based on the types of skills expected to be developed by pupils working on their collaborative projects. An important aspect of scaffolding instruction is that the scaffolds are temporary (Vygotsky, 1978). As the learner's abilities increase, the scaffolding is progressively withdrawn until the learner is able to complete the task or master the concepts independently. Therefore the goal of the educator when using the scaffolding teaching

strategy is for the student to become an independent and self regulating learner and problem solver who gradually decreases the use of scaffolds over time (Van Der Stuyf, 2002). A quantitative analysis of primary school students' use of scaffolds over the 10-week period was conducted in this study.

Qualitative analysis

Qualitative content analysis was used to assess how primary school students learn collaboratively, using asynchronous online discussions for PW. Students' online discussions transcripts were downloaded from the online discussion platform and coded using the Interaction Analysis Model (IAM) that was developed by Gunawardena et al. (1997) (Figure 2).

Phase I: Sharing / comparing of information. Stage one operation includes:		
A.	A statement of observation or opinion	[PhI / A]
B.	A statement of agreement from one or more participants	[PhI / B]
C.	Corroborating examples provided by one or more participants	[PhI / C]
D.	Asking and answering questions to clarify details of statements	[PhI / D]
E.	Definition, description, or identification of a problem	[PhI / E]
Phase II: The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements. Operations which occur at this stage include:		
A.	Identifying and stating areas of disagreement	[PhII / A]
B.	Asking and answering questions to clarify the source and extent of disagreement	[PhII / B]
C.	Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participants experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view	[PhII / C]
Phase III: Negotiation of meaning / co-construction of knowledge		
A.	Negotiation or clarification of the meaning of terms	[PhIII / A]
B.	Negotiation of the relative weight to be assigned to types of argument	[PhIII / B]
C.	Identification of areas of agreement to overlap among conflicting concepts	[PhIII / C]
D.	Proposal and negotiation of new statements embodying compromise, co-construction	[PhIII / D]
E.	Proposal of integrating or accommodating metaphors or analogies	[PhIII / E]

Phase IV: Testing and modification of proposed synthesis or co-construction		
A.	Testing the proposed synthesis against "received fact" as shared by the participants and / or their culture	[PhIV / A]
B.	Testing against existing cognitive schema	[PhIV / B]
C.	Testing against personal experience	[PhIV / C]
D.	Testing against formal data collected	[PhIV / D]
E.	Testing against contradictory testimony in the literature	[PhIV / E]
Phase V: Agreement statements(s) / applications of newly-constructed meaning		
A.	Summarisation of agreement(s)	[PhV / A]
B.	Applications of new knowledge	[PhV / B]
C.	Metacognitive statements by participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction	[PhV / C]

Figure 2: Interaction analysis model for examining social construction of knowledge in computer conferencing

The IAM was initially developed to examine the co-construction of knowledge in an adult professional development online debate. It analyses the entire online transcript to determine: a) the type of cognitive activity such as asking questions, clarifying statements, negotiating agreements and disagreements, and synthesising information; b) resources used by the participants for exploring and negotiating the problem; and c) evidence of changes in understanding or the co-construction of knowledge as a result of collaborative interactions (Gunawardena et al., 1997). The IAM consisted of five phases of development in the knowledge construction process and enables researchers to identify the different elements of a discourse through phases that correspond to a progression in the thought building process. Each phase develops into a set of operations that are used to identify the elements of meaning contained in the discourse. According to Gunawardena et al. (1997), notes ranked in Phase I and Phase II are considered to "represent the lower mental functions", while notes rated in Phase III, Phase IV, and Phase V "represent the higher mental functions".

Two raters coded the students' notes separately and the Cohen Kappa (Cohen, 1969) statistic was used to determine the extent to which the coding schemes produced the same results when the notes were coded by a second rater (Kosiak, 2004). The authors chose to code an entire note message rather than code different sections of the note. According to Gunawardena et al. (1997), using this kind of analysis does not "merely describe the pattern of connection among notes, but the entire gestalt to which the notes contribute". Several research studies have been conducted to evaluate transcripts drawn from computer conferences using the IAM

(Kanuka & Kreber, 1999; Aviv, Erlich, Ravid & Geva, 2003; Turcotte & Laferrière, 2004; Hendriks & Maor, 2004) but most were in the context of higher education and tertiary and adult learners. In order to lend credibility and validity (Denzin & Lincoln, 1994; Denzin, 1994, 2000) to the use of the IAM model in a primary school PW context, findings from the students' transcripts were triangulated with data from students' reflection logs and open ended questions administered after the 10-week period. Students were required to write a reflection log and answer open ended questions at the end of their 10-week PW class, expressing their feelings about their online PW learning experience and collaboration with other group members. The teachers provided a standard reflection log template (Figure 3). The reflection log contained 10 questions which were divided into three sections: my involvement, my learning, my project group, providing an opportunity for the students to evaluate and reflect upon their PW learning experience. The open ended questions were administered to obtain further insights into students' learning experiences through their perceptions of the learning environment and overall learning experience. These responses were then triangulated with data from the IAM findings.

Findings and discussions

Research question 1: How do primary school students participate in Project Work online learning environment?

The online learning environment was able to present evaluative information on the level of participation in terms of notes sent and received and the frequency of use of scaffolds. Over the course of the semester, students posted a total of 402 notes. Participation varied significantly among each individual. On average, each student posted 19.75 notes and read 76.8 notes throughout the course of the research study. No significant correlations were observed between mean notes posted and mean notes read. This is to say that although Water Cycle Group 1 (WCY1) had the highest mean notes posted, the group's mean notes read is still below average (66.5). An interesting observation was seen in the Exciting Reading Group 2 (ER2). This group had the lowest mean notes posted (16.25) but highest mean notes read (103.5). The concept of lurking can be used to explain the participatory activity of project group ER2. Lurkers are learners who are bystanders to course discussions, lack commitment to the community, and receive benefits without giving anything back (Rovai, 2001). Although, McKendree and Mayes (1997) argue that dialogue between learners can benefit lurkers who read the discussions, one of the domains of PW is collaboration which emphasises teamwork and fair contribution by all members of a project group. Based on previous studies (Gudzial & Turns, 2000; Lipponen, 1999; Stahl, 1999), low level and uneven

Figure 3: A sample reflection log template

participation in online environments have been cause for much concern in computer mediated communication research. Intervention by teacher-facilitators would need to be conducted for ER2 to ensure fair participation and collaboration by all members. Teacher-facilitators should also encourage active online communication and interaction to promote co-construction of knowledge (Gunawardena et al., 1997; Kanuka & Anderson, 1998; Warschauer, 1997) and critical thinking (Garrison et al., 2001; Jeong, 2003). Table 2 shows the mean numbers of notes students posted and read in the online environment.

Table 2: Mean notes posted and read (N = 20)

Project Group	Mean number of notes posted	Mean number of notes read
Water Cycle Group 1 (WCY1)	23.5	66.5
Water Cycle Group 2 (WCY2)	21.5	76.5
Exciting Reading Group 1 (ER1)	16.25	71.5
Exciting Reading Group 2 (ER2)	16.0	103.5
Environment and You Group 1 (EY1)	21.5	66.0
Total	19.75	76.8

Forum postings

Students posted their notes according to the forum topics set up by the two teacher-facilitators for each group. For example, for groups working on the project task Water Cycle, teacher-facilitators set up the following forums:

- How are you?
- What are my project ideas?
- What is Water Cycle?
- Discuss and think of ways to prevent water pollution in Singapore

The first forum topic “How are you?” was made consistent for all groups. This forum was meant to serve only as an introductory topic for project group members to introduce themselves and become familiar with one another.

Table 3: Mean number of notes sent for each group per forum (N = 20)

Group	Forum Topic 1	Forum Topic 2	Forum Topic 3	Mean
Water Cycle Group 1 (WCY1)	29	21	8	19.3
Water Cycle Group 2 (WCY2)	41	35	2	26
Exciting Reading Group 1 (ER1)	26	22	12	20
Exciting Reading Group 2 (ER2)	14	10	8	10.6
Environment and You Group 1 (EY1)	16	16	7	13

Table 3 shows the number of notes contributed by each group for each of the forum topics in the online environment. In this table, the mean number of notes for each group differs from that of Table 2, as notes from the "How are you" forum were excluded. In all five project groups, the total number of notes sent and received declined from Forum 1 to Forum 3. Among the project groups, Water Cycle Group 2 (WCY2) shows the highest number of mean notes posted (26) as compared to the Environment and You group (EY1) which shows the least number of mean notes posted (13). Three causes can be associated with this decline. First, the number of notes declined even when the number of active participants remained the same. This phenomenon can be explained by examining both the type of notes sent, as well as the length of these notes in the later forums (Kosiak, 2004). There was a significant decline in the number of social messages and messages regarding group processes throughout the forums. In addition, the length of the notes in the later forums tended to be longer. Instead of containing ideas regarding a single problem, the notes posted in these later forums tended to contain ideas on multiple problems. This finding was similar to a research study conducted by Kosiak (2004) where the decrease in the number of total notes sent may be attributed to the Hawthorne effect. As students became used to working in their online project groups, the newness of this environment might have worn off. Another likely possibility was that the availability of time may have decreased as continual assessments and examinations take place. The nature of communication exhibited in the online transcripts of this study was consistent with those found in studies of face to face communication (Pirie & Schwarzenberger, 1998; Stacey & Gooding, 1998), as well as computer mediated communication (Myers 2002).

Use of scaffolds

Students met their virtual partners face to face after half a term (5 weeks) of online communication and collaboration. The face to face meeting was used as a mid way mark to evaluate for any preliminary differences that might occur before and after the students meet their virtual partners "in the flesh". Preliminary findings reveal that there was an increase in the use of embedded scaffolds in KC after the face to face meeting. In their online discussions, students made use of these built in scaffolds to articulate their thoughts, communicate their ideas and to elaborate their notes. Table 4 shows the frequency of scaffolds used by students before and after their face to face meeting.

A quantitative analysis of the frequency of scaffolds used in the online learning environment revealed a total of 229 scaffolds used by students. Out of these 229 scaffolds used, less than half (27.9%) were used in the period before the face to face meeting while the number increased significantly after the face to face meeting (72.1%). This trend is similar to

the research findings by Van Aalst and Chan (2001), which reflected on the value of face to face meetings. These contribute to the development of identity of each online group, which in turn helps to establish a sense of group cohesion and social presence which makes group electronic conferences easier to establish (Stacey, 1999). In this study, students tend to be more active in their online activities, taking time to use scaffolds to better articulate themselves in the online group discussions after the face to face meeting. This observation highlights the importance of personal contact for building the identity of the group and helping to establish the group's social cohesion.

It was also observed that there was highest increase in the use of the scaffold "Question". Students tend to ask more questions after the face to face meeting. This could be attributed to the personal contact established after the face to face meeting. Students also tend to agree more with their peers as indicated by the use of scaffold "I agree". Interestingly, no students used the scaffold "I disagree" throughout the entire Project Work cycle. As mentioned earlier, an important aspect of scaffolding instruction is that the scaffolds are temporary. As the learner's abilities increase the scaffolding provided is progressively withdrawn (Vygotsky, 1978). Teacher-facilitators should evaluate students' ability to organise their thought processes when posting notes in the online discussions. When students are observed to have reached a mature level of online discussions, the use of built in scaffolds in the online platform could be removed.

Table 4: Frequency of scaffolds used in the Project Work Cycle (N = 20)

Scaffolds (built in within the online learning tool)	Project Work Cycle	
	Before face to face meeting	After face to face meeting
Example	5	7
Illustration	0	1
An idea	15	23
I agree	9	47
I do not agree	0	0
A theory	0	0
Opinion	4	8
A case	9	26
Question	22	52
My reflection	0	1
Total	64	165

Research question 2: How do primary school students learn while using asynchronous online discussions for Project Work?

To assess how students learn in terms of knowledge constructed, we looked at how they actually communicated in terms of articulation of ideas,

thoughts and feelings in coming up with their group projects. The Interaction Analysis Model (Gunawardena et al., 1997) schema was used to better understand the content of their communication that went on during the entire PW cycle. 402 notes were posted by the students. Of these 402 notes, 48 (12%) were coded as Not Ranked (NR) because they were not appropriate in the context of PW (Kosiak, 2004), for example notes which talked about a personal funny incident or notes that sought suggestions for places to lunch at. The remaining 354 notes were coded according to the IAM schema. Each note was coded based on the operations in each IAM phase (Figure 1). These were then collapsed into the five different phases. The Cohen Kappa statistic for coding validity (Cohen, 1969) returned a value of 0.821. This value is acceptable and it was concluded that the inter-coder reliability was satisfactory.

Within the five phases of the IAM, notes ranked in Phase I and Phase II are considered to "represent the lower mental functions", while notes rated in Phase III, Phase IV, and Phase V "represent the higher mental functions" (Beaudrie, 2000). A major area of interest of this research study was whether or not primary school students participating in online Project Work learning environments would reach the high levels of communication that are associated with the co-construction of knowledge (Phase III, IV, or V). Table 5 shows the total number of ranked notes at each of the five phase levels. 86% of the total scored notes was classified as low level notes (Phase I or II). Over half (65.8%) of the total number of scored notes were coded as the sharing and comparing of information (Phase I). The content of Phase I notes were mostly of students stating their opinion, posting statement of agreements and giving examples. For instance, the following note thread shows students responses to a group member's question on "what is a water cycle". The coding of each student's note is indicated at the end of the note, in parentheses. Students' names have been coded S1, S2, S3, and so on.

Cycle by S1 8/8/2004 15:39:5
"What is a water cycle?" [PhI/D]

> **The water cycle is about the.....** by S2 11/8/2004 11:49:43
> they (the water) evaporate into clouds and then condense into rain that's all I have to say. Bye [PhI/A]
>
> > **Think about it** by S2 11/8/2004 11:54:24
> > run and get a glass of water and put it on the table next to you. Take a good long look at the water. The water in your glass may have fallen from the sky as rain just last week, but the water itself has been around pretty much as long as the earth has! [PhI/A]

Here too by S3 11/8/2004 11:58:44
This is a picture of a cloud formed by the water cycle.

[PhI/C]

Where do by S2 11/8/2004 12:13:5
where do clouds come from? [PhI/D]

Where do clouds come from? by S1 11/8/2004 15:21:19
I think clouds come from lots of water vapour [PhI/A]

Where do clouds come from by S4 4/9/2004 9:21:46
My science teacher told me that clouds are made of lots and lots of water vapour.....that's right!!!!!!! [PhI/B]

A cycle is by S2 11/8/2004 12:7:26
it repeats itself over and over again like a frog it lays its eggs the eggs becomes tadpoles and then frog, soon the frog lays eggs. A picture of a frog:

[PhI/C]

Cycle is.... by S3 11/8/2004 12:15:6
A cycle is a pattern which comes from the beginning and goes back to the beginning again e.g. water cycle experiencing day and night, plant cycle and many other more [PhI/C]

Several operations/statements at Phase I of the IAM were found in this note thread. The thread started off with a question asked by one of the group members. This was followed by responses in the forms of statements of observation, opinion and corroborating examples of a water cycle. It is interesting to note that primary school students frequently include pictures and graphics in their notes postings.

The second largest percentage of scored notes (20.6%) was in Phase II. An example of a Phase II coded note:

> **A reply** by S5 12/8/2004 13:7:18
> I need to understand more information please, S6! Some readers do not like books! You should elaborate more on the content. For example, a reluctant reader can be quite fussy. Maybe they enjoy other hobbies like sports and many more. Sometimes, it is related to their ambition. [PhII/B]

Most of the content of the classified Phase II notes were questions to clarify disagreement. High level notes (Phase III, IV, or V) showing evidence of the co-construction of knowledge accounted for only 14% of the total notes sent. The third largest percentage of scored notes (12.7%) was coded as the negotiation of meaning and/or the co-construction of knowledge (Phase III). No notes from the online transcripts were coded as a Phase V note. The following note thread shows an example of high level notes and how the discussion moves from a lower phase to a higher phase:

> **Reluctant reader** by S5 17/8/2004 12:51:1
> Most reluctant readers, whom are usually boys, enjoy reading comic books than the books that can help them in improving their knowledge. I found out that reluctant readers find information from the internet. But does this help them in widening their knowledge? I think not. This is because they choose what they like to read from the internet too. [PhIII/A]
>
> > **A suggestion** by S7 5/8/2004 14:49:30
> > People do not learn anything from the Internet because they might be online, addicted to computer games or some other web activity. So, I suggest that we should spend time finding out evidence for reluctant readers. [PhIII/A]
> >
> > > **A reply** by S8 12/8/2004 13:7:18
> > > There may be other reasons a reluctant reader has. In my observations, I had an interview with a reluctant reader and she said that books are all the same. For another reluctant reader, she said it depends on the book. [PhIV/D]

Overall, the qualitative findings from the IAM provide evidence to suggest that students participating in the online PW learning environment were capable of the co-construction of knowledge although to a limited extent (up till Phase IV). The number of scored notes and percentage at each phase level shed significant light on how individuals within groups communicated. Figure 3 provides a summary of the percentage of notes in each Phase of the IAM. One explanation for the lack of Phase V notes could have been that students were unfamiliar as to how to communicate the application of newly constructed knowledge in the online environment. Although teacher-facilitators provided guidance for students' online participation, it was unclear whether this helped students communicate effectively. It is suggested that greater teacher facilitation during the online discussions may help students reach higher phases of PW communication.

The lack of Phase V notes could also be attributed to the reflection logs which students were required to answer at the end of their PW project. In their reflection logs, which were submitted directly to the teacher-facilitators, students illustrated understanding that they have learnt more through the online discussions. These responses could have been coded in Phase V [PhV/C] of the IAM if they were posted as notes in the online discussion platform instead. It is also important to note that the majority of notes occurred in the lowest phase of communication, Phase I, implying that notes involving the sharing and comparing of PW information may be the easiest form of online communication for students across all levels. In a study by Kosiak (2004) on college students, an explanation for the large percentage of Phase I notes may lie in the assumption that the co-construction of knowledge may not always be an observable phenomenon in the online medium. Kanuka and Anderson (1998), theorised that knowledge construction may take place over time, after the final note has been posted. Therefore, instead of student's jointly constructing knowledge during exchanges of notes, the online environment might serve as a mechanism for the parallel construction of knowledge. It may also be possible that students who posted their PW ideas or research findings may have internally processed these ideas and findings through the stages of the construction of knowledge. Under this assumption, the construction of knowledge occurred prior to posting their notes (Kosiak, 2004).

Table 5: Total Number of notes Scored at each IAM (Gunawardena et al, 1997) Phase Level (N = 354)

Phases	Description	Notes posted
I	Sharing and comparing	233
II	Discovery and explanation of dissonance	73
III	Negotiation of meaning/ Co-construction of knowledge	45
IV	Testing and modification	3
V	Agreement statement(s) application of newly constructed knowledge	0

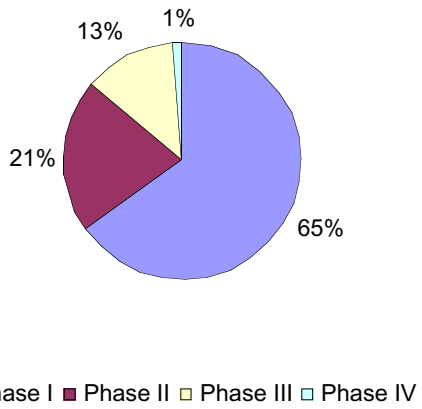

Figure 3: Percentage of notes in each Phase of the IAM

Interaction Analysis Model in the primary school PW context

The IAM analysis of primary school PW students' notes showed that 86% of students' notes were coded as low level notes (Phases I and II) and only 14% were coded as high level notes (Phases III, IV and V). According to Gunawardena et al. (1997), all five phases of knowledge construction are necessary for social construction of new knowledge, thus a very low percentage of high level notes would imply an unsatisfactory quality of knowledge co-construction. The authors triangulated data from the IAM with students' responses from their reflection logs and open ended questions. From the students' reflection logs, all 20 students responded that their contributions to the online discussions were focused on providing more information from the Internet: operations in Phase I and II of the IAM. Yet, almost every student felt that they had learnt something new by participating in the online environment and had gained new information from their project group members. Examples of student's responses:

> … I have learnt a lot of things about the water cycle and I was assigned to do the model with another partner. I like working with friends from other schools. They tell me about their school and I tell them about mine. My contribution is by getting more and more information about the water cycle. I went to my friend's house to go on the Internet and put in the information on KC. We don't have enough time to log in to KC as we have our common tests. Sometimes, I cannot log in to KC because the computer flickered and became blank. (Student S1, reflection log)

> … I was assigned to find out about the recycling project. I found some information about the three recycling projects that was assigned to me. I searched for the information at Yahoo and AltaVista and they provide me with good information. I faced some difficulties when I was searching for information but I overcome the problem by looking one by one through the

> information they gave me. I might try to find some other Internet websites that can provide me with good information. … (Student S16, reflection log)

> … with KC, we do not need to travel to our friends' schools. However, sometimes my group members' reply very slow and I have to wait. I enjoyed doing this project. I learnt a lot from my group members when they share their research and survey findings online. I like to work with students from other schools. It is not boring and I can learn more about their school … (Student S12, open ended response)

> … sometimes we will also discuss during recess time or after school. We talk about what our group members from the other school have posted. After discussing, we will put up online so that they can read from their school computers. It makes us learn more… (Student S6, open ended response)

One of the domains of PW is knowledge acquisition and application (Table 1), where the focus of evaluation is on information gathering and processing. The high number of Phase I and II notes indicate that primary school students are capable of information gathering and exploration, acquiring the desired skills to be developed in this domain. The reflection logs and open ended responses also indicate that students learn to share, listen and resolve their group conflicts; skills to be developed in the communication and collaboration domains of PW learning. Students also expressed that they valued learning through the online interaction with their interschool group members, and that they had learned something new and gained valuable information through the online discussion platform. This would suggest that the process of reading and replying to their group members' postings provided more value than simply that of the knowledge gained, and is as described by Ramsden (1998), essential for a deep and meaningful learning experience (Hendriks & Maor, 2004).

Informal interviews with the teacher-facilitators corroborate the purported value of using asynchronous online discussions in primary school PW, as they observed that the online discussions had served as a trigger to primary school students' own reflective thinking processes, enhancing their personal cognitive skills through reflective thinking and shared ideas, and promoting their social skills through social interaction with interschool project group members. This implies that the use of Gunawardena et al's. (1997) IAM model in the primary school PW context was useful as a preliminary means to qualitatively analyse and define the type of discourse that was most frequently used in the discussions. However, beyond this it does not necessarily reflect the true meaning of students' PW learning and skills acquisition in the context of PW.

Conclusions and future research

The interaction analysis model identifies the phases in which primary school students' discourse was situated throughout the study. This has proven to be helpful in defining the type of discourse that was most frequently used in the online discussions, and determining the progression of the postings through the different phases of the model. However, it does not necessarily reflect the true meaning of primary school students' learning and skills acquisition in the context of PW.

There were several pertinent issues that arose from the discussion of the results of this research study. The first objective addressed the participatory activities of primary school students in the online PW environment. The findings revealed that the mean number of notes posted was 19.75 while the mean number of notes read was 76.8. No significant correlations were observed between mean notes posted and mean notes read. Instead, students tend to take the role of a lurker in the online environment. There was also a general decline of notes posted as time progressed. This could be explained by the augmented length of notes posted in the later forums. Instead of containing ideas regarding a single problem, the notes posted in these later forums tended to contain ideas on multiple problems. It was also observed that there was highest increase in the use of the scaffold "Question" after a face to face meeting was conducted. Students tended to ask more questions after the face to face meeting. This could be attributed to the personal contact established after face to face meetings.

These findings provide important learning points for the implementation of online PW classrooms in Singapore as well as for PW teacher-facilitators. With the transfer of collaborative learning to the online environment, additional studies should focus on how this new medium influences interactions. For example, more studies could be done to assess the difference in the dynamics of face to face communication versus online communication when groups of students are working on the same tasks.

In terms of assessing how primary school students learn in terms of knowledge construction, the findings provided evidence to suggest that students participating in the online PW learning environment were capable of the co-construction of knowledge, although to a limited extent (up till Phase IV). The number of scored notes and percentage at each phase level shed significant light on how individuals within groups communicated. One explanation for the lack of Phase V notes could have been that students were unfamiliar with to how to communicate their application of newly constructed knowledge in the online environment. Evidence from students' reflection logs and open ended questions show that students value the new information they have gained through online collaboration.

They believed that they had gained new knowledge through the interaction with their project group members. Students also raised concerns about slow responses and inactive communication from their group members. Although teacher facilitators provided guidance for students' online participation, it was unclear whether this helped students communicate effectively. The notion of the co-construction of knowledge in an online environment is based partially on the assumption that other group members actively participate in the discussion, by reading the responses of others. It is suggested that greater teacher facilitation on students' participatory activities during the online discussions may help them to reach higher phases of knowledge construction. Future studies should be developed to ascertain the effect of teacher facilitation on primary school student's construction of PW knowledge in Singapore's cultural context.

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