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Author(s)	Teo Chew Lee, Chiam Ching Leen and Ng Foo Keong
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# Fostering Knowledge Building among Low Achievers through Technologies: A Perspective from Singapore

Teo Chew Lee, Chiam Ching Leen and Ng Foo Keong

## Abstract

*This study explores knowledge building amongst low achievers using Knowledge Forum (KF), an electronic asynchronous discussion medium. A case study was conducted at a government-aided school in Singapore. It was expected that low achievers would be less capable of constructing knowledge independently. However, there was indication of a partial success in fostering a spirit of independent collaborative learning. This could challenge the practice of labelling students according to how well they performed in traditional paper-and-pencil tests. The aim of this case study is to explore the role of information and communication technology (ICT) in shifting the learning pattern of these lower achievers from the different ways the students experienced the process of collaborative knowledge construction using KF. Through analysis of the postings and interviews of students, the shift of views about learning for this group of low achievers in the following major area was identified: perception of knowledge acquisition, process of knowledge construction and the patterns of communication and collaboration.*

## Introduction

In the past, it was thought that prescriptive teaching or didactic knowledge transfer is the most effective way of promoting growth of knowledge. Advancement of research in areas of teaching and learning indicated that knowledge acquisition can occur in different ways — not just through transference from teacher to student but also through student interactions via technologies such as online discussion medium. As such, there arises the need to consider if one could capitalise on what is known about knowledge building, an instructional approach advocated by Scardamalia and Bereiter (1991), and adapt it to help low achievers in their knowledge construction.

The essence of knowledge building is to promote collaborative learning among students in order to focus on idea improvement and to enhance their interest, which is an important aspect of education that deserves our attention. This trend could likely be due to the result of the focus on tangible outcomes, such as

the National School Ranking Exercise in Singapore's education system or simply the overemphasis on student's grades. Teo, the first author in this study, embarked on a project that attempts to build scientific knowledge among a group of low achievers, known as Normal Technical (NT) students in a secondary school in Singapore. The NT stream accepts students at the bottom-third of their cohort according to their aggregate results in the national Primary School Leaving Examination (PSLE). Knowledge Forum (KF), an asynchronous online discussion platform, is used as a tool for knowledge construction among these NT students. This is to provide them an opportunity to work on what they perceive as interesting and important, instead of acquiring knowledge that is dictated to them.

In the following section, the definitions of learning and knowledge building will be discussed. This will be followed by a report on a case study in exploring the impact of using KF to promote collaborative knowledge construction among low achievers.

## **Knowledge and Knowledge Building**

### ***Definition of Knowledge***

Definitions of knowledge appear abstract and are, at best, nebulous. Davenport and Grover (2001), for instance, defined knowledge as the most valuable form of content in a continuum starting at data, encompassing information and ending at knowledge. Whereas data does not have meaning in and of itself, information is described as "data endowed with relevance and purpose" (Drucker, 1998) or "data that makes a difference" (Davenport & Prusak, 1998). Meanwhile, knowledge, according to Bereiter (2002), is embedded in cultural practice and in the tools and artefacts used in these practices. This paper studies the following two models:

- 1) the knowledge creation model presented by Nonaka and Takeuchi (1995).
- 2) the knowledge-building model presented by Bereiter and Scardamalia (1996).

Nonaka and Takeuchi's model distinguishes between two types of knowledge: tacit and explicit knowledge. Tacit knowledge refers to "personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective and the value system". According to Nonaka (2001), tacit knowledge has an important cognitive dimension and therefore cannot be articulated easily. It is this implicit knowledge that shapes profoundly how one perceives the world around him. Explicit knowledge, on the other hand, is easy to articulate and expressed formally. The model presented by Bereiter and Scardamalia (1996), on the other hand, considers Popper's World 3 "objective knowledge", which was absent in Nonaka and Takeuchi's model. Nonaka and Takeuchi's model can be classified under Popper's World 1 (explicit knowledge of the physical world) and World 2 (the internalisation of knowledge, the world inside our minds) (Bereiter & Scardamalia, 1996). The concept of knowledge

building refers to collective work for the advancement and elaboration of conceptual artefacts such as theories in Popper's World 3 (*ibid*). In a way, the three worlds of knowledge are conceptual constructs that are interconnected, and knowledge shifts from one World to another, depending on the context. With this understanding, the authors attempt to expand this awareness to benefit more students in Singapore.

Over time, Singaporeans have shifted from being reticent to being more vocal in politics and matters concerning their lives. This could be an indication that the ground has been prepared for Singaporeans as a community to engage in a co-constructive enterprise such as knowledge building, shifting away from the conventional mode of teaching and learning.

Knowledge building is defined as creative work with ideas that matters to the people doing the work (Bereiter & Scardamalia, in press). Knowledge building involves developing the collective knowledge base of the community and improving the problem-solving expertise of the learners (Gilbert & Driscoll, 2002). Knowledge builders engage in similar processes with a common goal of advancing the frontiers of knowledge in the field of interest. A proposition taken by Bowen, Bereiter, and Scardamalia (1992) characterised knowledge-building communities with four primary traits:

- 1) a focus on knowledge and the advancement of knowledge rather than tasks and projects
- 2) a focus on problem solving rather than performance of routines
- 3) advances made by members requiring dynamic adaptation, which, in turn, requires other members to readapt, resulting in continual progress
- 4) intellectual collaboration as members pool together intellectual resources, making it possible for communities to solve larger problems rather than those individuals or small groups can.

In the following case study, the authors study the ways in which KF, an electronic discussion medium, is used as a means of reframing classroom discourse to support knowledge building among low achievers. Knowledge is predictably gained based on the questions students ask. Implications of knowledge building in classrooms to conventional teaching are also discussed.

## **Using Knowledge Forum — A Case Study**

### ***Subjects***

A total of 38 students from the Normal Technical stream participated in this study. They had had online learning experience via the school's e-learning portal. These students were divided into two groups: 19 (50%) of them continued to use the general discussion forum for their discussion in the implementation phase and the other 19 were exposed to KF, with basic training in KF conducted by the teacher (the researcher).

These NT students were placed in similar learning conditions and environment (tests, examinations and tutorials) as their counterparts. In class, they had short attention spans and were usually irritable and often caused classroom management problems to the teachers. Their countless failures in the academic pursuit in the main stream education might have put them in a vicious cycle where it became almost impossible for them to break away and become accustomed to the existing education system. Most such students end up feeling disappointed over time as there are mismatched expectations among teachers and the students. On the positive side, it may be noted that these students prefer group work where they feel more secure and they are more willing to share when compared with students who come from academically better classes. They are usually not too concerned with their grades, but they enjoy the learning in the classroom. This seems to indicate their desire to learn and acquire knowledge and skills rather than solely obtain better grades. It can be assumed that these students' negative behaviours could have stemmed from the fact that they do not see any relevance and purpose of what takes place in the classroom. Perhaps an alternative approach to promoting learning among these students, who enjoy group work and sharing among themselves, would be to incorporate technology in the existing classroom learning environment.

### ***The Discussion Medium — Knowledge Forum***

The second-generation Computer Supported Intentional Learning Environment (Scardamalia & Bereiter, 1991), now known as Knowledge Forum (KF), has fuelled interest in such tools as a means of knowledge building. It is an asynchronous discussion medium that allows participants to be engaged at different times. It consists of contributions to a community knowledge base that is accessible to everyone in the network. As such, it advocates knowledge preservation, in which notes in the database are preserved and continually available for search, retrieval, comment, reference and revision. This technological affordance promotes the important concept of improvable ideas. Students were not as afraid to post immature ideas, nor were they too conscious of their participation as they could log on to make revisions at any time.

KF has various functionalities that support knowledge building. It has a graphical interface. Various posts comprising of questions and comments and replies to others' posts are organised in a "mind-map" manner. The links between ideas and comments can be seen explicitly. Each post is facilitated by scaffolds that serve to help organise the thoughts and ideas. Examples of scaffolds include "My theory", "New information", "I need to understand", "Putting our knowledge together", "This theory does not explain", "My theory is" and so forth.

Another important feature of KF is the "rise above" function, where students can summarise a group of postings, synthesise views or apply the knowledge obtained from the discussion to a wider context. This feature, if used appropriately,

would give strong evidence of knowledge building; it also ensures sharing of responsibility towards construction and advancement of knowledge (Scardamalia, 2002).

### ***Implementations***

The first two sessions (70 minutes per session) were allocated for familiarisation of KF and creation of individual views. Both sessions were conducted during the curriculum time in the school computer laboratory. Subsequently, a 35-minute weekly session was scheduled within the curriculum time. Students were encouraged to access KF from their homes. Laptops with modem cards were loaned to students without computer access at home. They were taught the basics of accessing the internet via a dial-up account. Two students who had no fixed phone lines at home were helped to gain access to the computers in the library after school opening hour. While these arrangements were being made, normal teaching on the same topic was carried out.

Students worked in groups of six to eight. Each student was allocated a view, which is a space for discussion in KF, to initiate their own discussion based on any of the pictures of Food Technology. The pictures were saved as the background in each view. They were encouraged to make individual contributions to the discussion topics initiated by their group members. This was done to generate a larger pool of topics to allow students to select the one that they were interested in, and it was anticipated that they would build upon the topic with more depth. Most students initiated at least one topic for discussion, and it was interesting to see that there was no repetition in the subtopics chosen based on the broad theme of Food Technology. Most students began with "I need to understand", but there was a significant lack of peer reviews and comments as most threads consisted of four to six posts.

### ***Monitoring Students' Work on KF***

The teacher (researcher) accessed the database frequently but did not add comments or notes on the database. Warnings, however, were given on two occasions to prohibit the use of undesirable language. The teacher put annotation (another feature for adding comments in KF) in several notes to encourage participation. The teacher also conducted group meetings to discuss various aspects of the online discussion.

In the postproject evaluation, there was a significant increase in the percentage of students who found that they were more interested in science. They also began to learn to trust their peer contributions in addition to what was being taught by the teacher and the information found in textbooks.

### ***Duration of Students' Work on KF***

The first note appeared on 12 June 2003; the class continued to contribute and write for a total of 10 weeks. The implementation was affected in the middle of

August due to the School Preliminary Exam for the National Examination. During that time, the teacher did not contribute any notes but continued to read the notes. At the end of the implementation, there were 219 notes posted, an average of 5.6 per student (data analysed on 30th August 2003).

### **Interview**

After each phase of implementation, an interview was conducted. All the students were interviewed in groups. Each interview transcript was parsed into segments consisting of content knowledge receptiveness, social interaction and views about learning. The students were asked questions on whether they like using KF, the difficulties they encountered and thoughts about this mode of learning as compared with teacher-centred classroom education.

### **Results**

There are some unexpected results that show evidence of knowledge building among these NT students, who are considered to be low achievers. There were also difficulties faced by these students in their endeavour to build knowledge in ways envisaged by Scardamalia (2000).

Three major areas were found from the analysis of the interview and posts, namely, students' perception on knowledge acquisition, process of knowledge construction and their mode of communication and collaboration. Data analysis shows an emergence of a shift in their perception towards knowledge building for the three areas. The evidence of knowledge building in the three areas mentioned above will be discussed based on the determinants described in the Socio-Cognitive and Technological determinants of knowledge building of Scardamalia (2002).

### **Postings**

There was no obvious repetition of discussion topics even though this was not predetermined. The topics ranged from the nutrition value of an apple, the nutritional content of yogurt and the choice between goat milk and cow milk to the functionality of an eggshell. This diversity showed a trend of moving away from existing safe and conventional topics, venturing into something of the participants' own interests. This is evident in the posting in one view where there were diverse discussions on just one subtopic on "yoghurt", shown in the following:

- "We know yogurt can help those people who want to go on diet to lose weight. What thing does the yoghurt contain to help them lose weight?" (extracted from actual posting)
- "What does yogurt contain?" (extracted from actual posting)
- "Does anyone knows the process of making yoghurt?"
- "How does yogurt become cheese?" (extracted from actual posting)

This diversity was common in other threads of discussions as well. The participants had begun to appreciate and understand that in order to know the topic in depth, they had to discover all other ideas (contradicting or supporting) surrounding it. The increase in the number of postings shows that the security given to them is felt and that the concept of improvable ideas has been ingrained into them such that they were not afraid to share. They were curious enough to post on topics that they deemed appropriate and were not afraid to differ from one another. More importantly, they were not bound by the content within their textbooks.

KF encourages knowledge building based on idea improvement and it was made obvious when the participants indicated that they were afraid of sharing wrong information and putting up incorrect postings. As such, they were very cautious with their postings and they frequently sought verification with their teachers or other sources such as the internet or books before putting them up. This was a unique characteristic among this group of students as the better classes were usually unwilling to share in fear of "losing out" to their peers. This trait is not present among this group of students; they were willing to share their limited knowledge and were not afraid of "losing out".

### **Knowledge Acquisition**

Knowledge acquisition describes how students look at the way knowledge should be acquired. It determines their acceptance of knowledge building, which translates into the students' own participation and own efforts to learn. It removes the dependence on a teacher to pass on the knowledge. In this section, the authors focus on mainly the ways students look at the source of knowledge, the types of problem they chose and the breadth and depth of the problems discussed.

With regard to the source of knowledge, there was a general tendency that students still preferred the teacher as the main source of information and that they would have KF as an extension of the main curriculum in which they are able to construct new knowledge beyond their text-books. This could be achieved via reading a posting put up by their friends or by their peers or finding information to answer their queries or simply just by formulating questions. These are illustrated by the following comments and postings, which are two of the recurring comments among all the groups interviewed.

- We prefer teacher to teach us, after which we can reflect and share (in KF) what we know.
- More knowledge gain (*sic*) this way as compared with classroom lessons as we do not dare to ask our teachers in class.

For the types of problem they chose, there was strong evidence to indicate that the participants were moving away from thinking that the textbook was their only



source of knowledge. There was also a trend indicating that students preferred to study issues related to real and authentic problems that arise from an effort to understand the world. It is evident that the participants liked the fact that they could ask about anything under the broad heading given (in this case Food Technology), in which they could also choose their subtopics based on their interest. Most of them thought KF was good for gaining new knowledge as they were usually too afraid and too conscious of their language abilities to approach their teacher for help in the past.

### Process of Knowledge Construction

Knowledge construction is crucial to the internalisation of knowledge. The use of KF had created an impact on the way these students took on the task of knowledge construction, and they no longer looked for direct and precise instructions. Students were beginning to see the need to learn to work with “messiness” in order to achieve new synthesis instead of simply receiving all that is transmitted by their teacher. This is evident in the following comments and the use of Rise above in the posting shown in Figure 1.

- “We are able to get new points (*sic*) from the discussions.”
- “It helps to give (*sic*) more knowledge from your friends.”

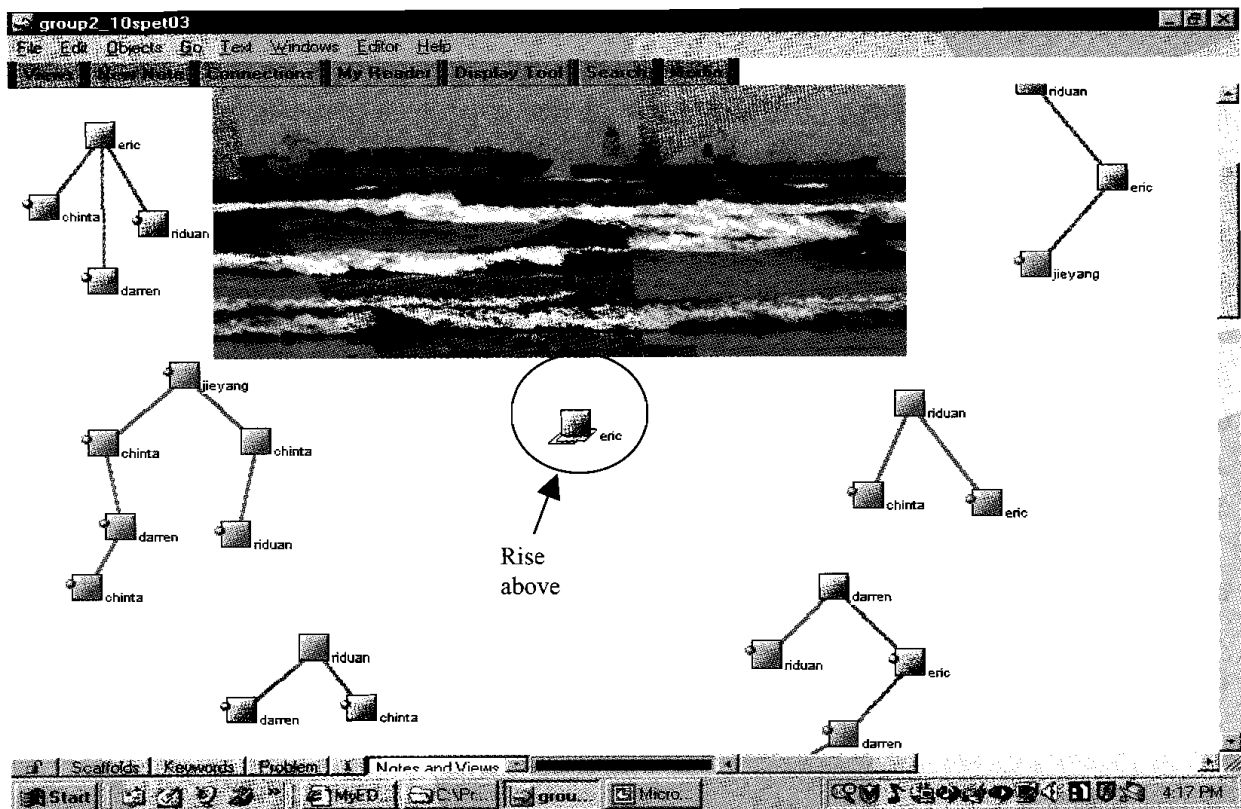


Fig. 1. Use of Rise above in one of the views.

Members from the same group also indicated in the interview that they were able to link new knowledge discussed and expand on what was being taught in class through various discussions.

Throughout the duration of the intervention, there was no indication of the expectation of the teachers. Students were only informed of some ground rules. During the second round of intervention, one of the students put up a "Rise above" to summarise five postings from the groups on the subtopic of "the contributing factors of sea pollution" (Figure 1). Although it was the only Rise above in the whole intervention, it was already a strong indication of a certain level of assimilation and synthesis based on the low language ability of this group of students.

The students showed the ability to appreciate ideas and produce ideas that were valuable not only to themselves but also to others. There is a shared responsibility for their own growth of knowledge. This is evident in the way the group organised their postings in the following description. This group displayed a certain level of organisational ability and emergent goals during the second round of intervention when they managed to organise their postings into different segments such as "facts and information", "putting their knowledge together" and "discussion" (refer to Figure 2). There were posting from each member in all three categories that showed that the responsibility of finding facts, initiating discussion and summarising no longer depended on one or two persons in the group.

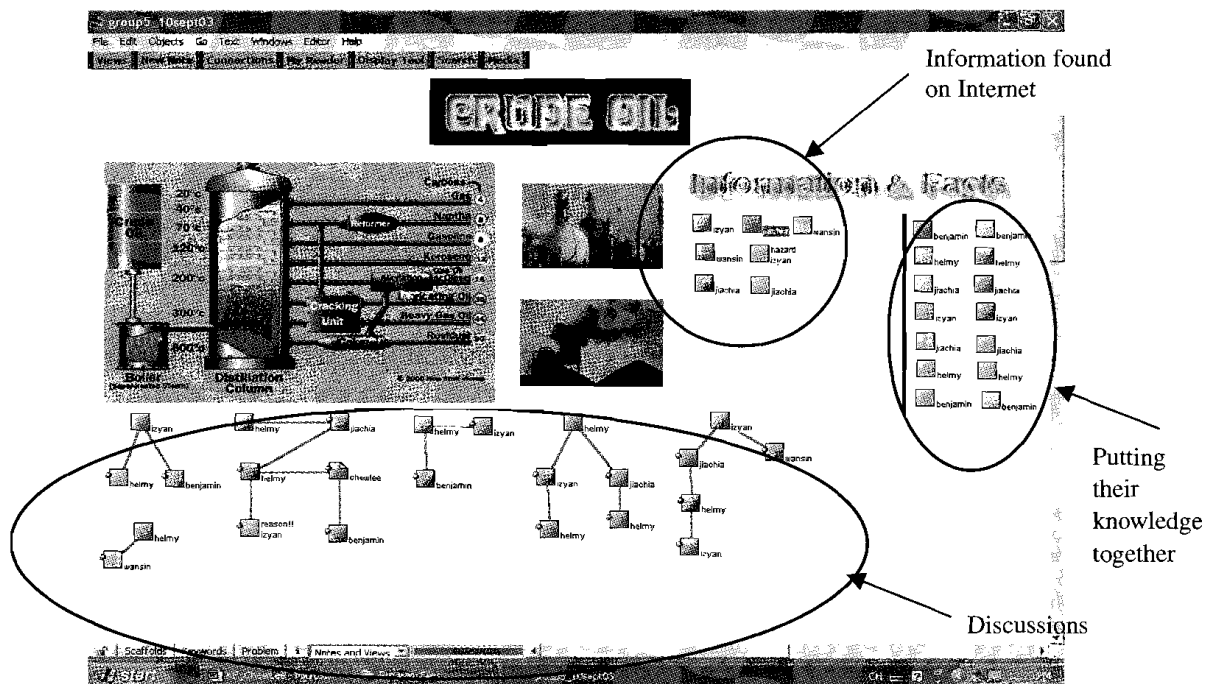


Fig. 2. Organisation ability and emergent as depicted in the KF environment.

This was exceptional as it was done independently, without the teachers' assistance or involvement. This level of independence is rarely seen during the class discussion as discussed earlier. Strategies such as knowledge sharing done within the physical boundary of the classroom had not been successful as students were usually too shy to present or were limited by their command of the language such that they were unable to put forth their thoughts in a coherent manner on the spot. They appreciated the time given in the asynchronous discussion in KF as they could think through their thoughts. In this instance, technology had indeed pushed them a step towards a new process of gaining knowledge through knowledge building.

As the students became accustomed to using KF, they started to use the scaffolds more frequently. The scaffold most commonly used was "I need to understand". This acceptance and appropriation of scaffolds led to a better focus of their thoughts and ensured that the right messages were sent. With further emphasis on the usage of the scaffolds by the teachers in each round of implementation, there was a development of questions in terms of their depth. The scope of the discussion widened as more of the scaffolds were used. New theories and new questions that dwelt deeper on the same topics surfaced. This is evident in the following postings.

*Example 1 (I need to understand) — subtopic Yogurt*

- "What does yogurt contain?"

This is a typical content-based question. As the discussion developed, questions such as the following were formulated

- We know that yogurt can help those people who want to go on diet to loss (*sic*) weight what thing do the yogurt contain to help them to loss (*sic*) weight.

The second question related to their daily experiences and their observations of what went on in the actual world and involved deeper thinking.

*Example 2 (I need to understand)*

Instead of asking about the products of fractional distillation, the question was formulated as

- "Why is it that this (referring to the petrochemical industry) is not in the HDB (meaning residential houses) area?"

Again, there was an improvement in the way the questions were structured in that it involved an understanding of the issues surrounding pollution, not merely on the technical aspect of pollution.

Another example that dwelt deeper and further is shown below. The posting led to a Rise above conclusion (as described above):

- "Do you think that most of the water pollution are caused by the human?"
- "How can we prevent from pollution in the sea water?"

### **Patterns of Communication and Collaboration**

The social aspect of the KF that helps mediate learning is very important. There was a better connection among students as they participated in KF and developed subconsciously social process that was integrated seamlessly in their discussion online.

Participants showed more willingness to accept one another's ideas and took responsibility for one's own contribution as compared with the past classroom experienced with the teacher. They accepted one another's opinions and were keen to contribute by putting in efforts to formulate postings and checking for their validity. Some of the participants were so uncertain they sent their postings to Teo (one of the authors of the group) for vetting a submission to KF. This was discouraged, and the participants soon took on the challenge to verify their own posts — an indication that the students had assimilated tacitly the concept of accountability (to others as well as to disciplinary norms), which is one of the elements for fostering productive disciplinary engagement according to Engle and Conant (2002).

The new development in the social practices was seen in the following comments and postings:

- "scared(*sic*) of spelling, grammar and also afraid of posting up wrong information, so we check before we put it up" — [this made them verify the facts and information]
- "dare not talk to teachers, but dared to use KF to share information with their friends"
- "very difficult questions, don't know how to answer, try to find out"

### **Limitations and Difficulties**

Language could be a constraint in promoting effective knowledge building among students. The poor language ability contributed to the "shallow knowledge building" (as shown in the postings) and the fact that the students needed more time to grasp and assimilate the postings. However, this limitation has actually brought positive outcomes in the KF environment. Due to the poor language ability, the students tend to check their work before posting, and they do not misuse KF to chat. There is general acceptance of knowledge building as a new mode of learning that could complement the existing didactic mode of teaching. One of the participants rightfully put it in her interview, "I prefer teacher to teach in class first then go on KF to discuss more things and get more information (*sic*)".

### **Discussion of Findings**

Based on the findings in this study, the authors recommend that educators should find authentic reasons for the use of such online tools (as KF) before they implement knowledge building using KF.

Since this group of students was not considered in the National School Ranking Exercise, they are not susceptible to typical exam pressure. This could have attributed to the positive outcome of knowledge building among them. It is important to acknowledge that the authors of this study did not anticipate such positive outcomes among this group of low achievers as they had earlier hypothesised that knowledge building would achieve better among higher achievers. In other words, this could indicate that the concept of knowledge building is expandable beyond its current scope.

As discussed earlier, the NT students' lack of confidence in expressing themselves actually worked in their favour. Instead of abusing KF for social chat, they behaved more responsibly by regulating themselves before posting. Their sense of self-esteem and sense of ownership and responsibility in learning improved. As a community of learners, they have begun to be enculturated in this process of knowledge building. This is considered an achievement because NT students are usually reserved as far as scholastic matters are concerned. Their observed patterns of discourse are usually no deeper than simple one-question and one-answer dialectics. The structures provided by KF as a tool proved to be constructive in scaffolding these learners into assimilating thought patterns useful for knowledge building.

It is noteworthy also to make an informal comparison between typical classroom discussions among this group of students and those of KF at this juncture. Although no actual recording or study was done by the authors prior to this implementation, as these students were unable to express their thoughts verbally in proper English sentences, presentations in class done after group discussions were usually given by the same few people who could articulate the points better than the rest of the class. As a result, discussions were normally dominated by these few students, and participation from the rest was rare. This took a turn in KF, in which even the weakest students put up at least 10–12 postings in the discussions.

The openness and user-friendliness of the platform allows constant improvement and correction. This could be one of the contributing factors to the increase in participation rate. The privacy and stress-free environment that KF provided could also have contributed to reducing the students' consciousness of their own weaknesses. Students become more propelled by their curiosity to learn.

Taken in its totality, knowledge building among the students could be explored as a way of complementing existing teaching methods for the lower achievers as this paper has shown that lower achievers can also build knowledge. There is a need to correct the misconception that low achievers cannot participate in knowledge building in schools.

*Teo Chew Lee is a postgraduate student pursuing the Master of Arts (Instructional Design and Technology) degree at the National Institute of Education, Nanyang Technological University, Singapore. She is currently a physics teacher and holds the position of Head of Information and Technology Department in a local secondary school.*

Chiam Ching Leen is a Singapore Millenium Foundation (SMF) scholar pursuing in a full-time Doctor of Philosophy programme under the Centre of Research in Pedagogy and Practice at the National Institute of Education, Nanyang Technological University, Singapore.

Ng Foo Keong is a postgraduate student pursuing the Master of Arts (Instructional Design and Technology) degree at the National Institute of Education, Nanyang Technological University, Singapore. Ng had taught mathematics in Raffles Institution and Ngee Ann Polytechnic and was the Head of Instructional Design at ASKnLearn.com. At present, he is a freelance consultant taking on instructional design and/or multimedia development contracts. His specialty is in developing simulations and interactive learning objects using Macromedia Flash or Director.

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