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All correspondence, including comments, suggestions, subscriptions, contributions or other related inquiries should be addressed to:

The Director, SEAMEO RECSAM,
Jalan Sultan Azlan Shah,
11700 Gelugor, Penang MALAYSIA
Tel: 60-4-6522700 Fax: 60-4-6522737
E-mail:director@recsam.edu.my
URL: http://www.recsam.edu.my

Journal of Science and Mathematics Education in Southeast Asia
2011, Vol. 34 No. 1

Journal of Science and Mathematics Education in Southeast Asia
2011, Vol. 34 No. 1

CONTENTS

Journal of Science and Mathematics
Education in Southeast Asia
2011, Vol. 34 No. 1, 67 - 89

Mathematics Teachers' Perception of Lesson Study as a Continuous Professional Development Programme

Hj Ade Shahren bin Hj Suhaili
Sekolah Rendah Jerudong
Brunei Darussalam

Madihah Khalid
Universiti Brunei Darussalam

Lesson Study can be viewed as a continuous development programme because it offers teachers support in an environment unlike other traditional continuous development programmes. In this study, 28 primary mathematics teachers were surveyed and 4 out of the 28 were interviewed to examine how they perceived Lesson Study as professional development. Data were also obtained from reflective journals of four of the teachers. Three themes related to the positive aspect of teachers' perceptions of Lesson Study as a professional development process emerged. Evidence from interviews, informal discussion and the journals of the teachers suggests the following: Lesson Study promotes the practice of teaching innovatively; Lesson Study provides teachers with a platform to improve and reflect their own teaching; Lesson Study has many advantages compared to other professional development programmes.

Key words: Lesson Study; Mathematics teachers' perception; Continuous professional development; Primary Brunei teachers

Introduction

After the release of the Third International Mathematics and Science Study, Lesson Study was given a special mention as a result of the comparative TIMSS video study of three countries: United States, Germany and Japan. Lesson Study has been used as a form of teacher professional development in Japan and has been cited as a crucial element in the improvement of mathematics and science education in that country (Stigler & Hiebert, 1999).

According to Baba (2007), Lesson Study refers to a process in which teachers progressively strive to improve their teaching methods by working with other teachers to examine and critique one another's teaching techniques. It also describes a form of long term teacher-led professional learning developed in Japan where teachers work collaboratively and systematically to conduct research on teaching and learning in the classroom with one goal in mind, which is to enrich and improve students' learning experiences and teaching methods (Yoshida, 2005).

The above descriptions of Lesson Study view it as a form of teacher professional development, which will influence the improvement of the teaching and learning processes in classrooms. The effectiveness of Lesson Study depends heavily upon the quality of the experiences that the teachers go through in order to be able to implement effective lessons. Similarly, students' learning relies heavily on the quality of teaching and instructional practices that a teacher provides. The quality of teaching is the one ingredient that is most likely to make a difference in students' learning (Stigler & Hiebert, 1999).

In Brunei Darussalam, most primary mathematics teachers who have been posted in schools usually have very limited or no 'meaningful' interaction with other mathematics teachers from other schools. Teachers do engage in a form of informal professional dialogue within the schools to discuss problems and challenges that they face in teaching mathematics, but these engagements are not planned and can perhaps be characterised as unsystematic. Due to the limited number of mathematics teachers teaching at the same level in a school, the output of the discussions usually has little bearing on professional growth.

Traditional teachers' professional development programmes are widely used and exist in the Bruneian education system. Most of the professional development programmes are in the form of in-service and pre-service training provided by Universiti Brunei Darussalam and the Ministry of Education. These traditional teachers' professional development primarily provides a passive experience to teachers as they offer little opportunity for the teachers to share their thoughts or understandings of the teaching material.

The new national education system for Brunei Darussalam has recently been implemented and most teachers' professional development

programmes are conducted in the form of briefings or workshops related to the new curriculum. Although numerous workshops and briefings have been organised by the Curriculum Development Department and the Department of Schools in the Ministry of Education, these traditional teacher professional development programmes have been perceived as being brief, fragmented, incoherent encounters that are decontextualised and isolated from real classroom situations (Organisation for Economic Co-operation and Development, 2005; Villegas-Reimers, 2003). In this regard, Lesson Study appears to have the potential to facilitate growth in teachers' knowledge of the content and pedagogical processes that are required for the intended curriculum to be implemented effectively. This type of ongoing teachers' professional development system sets up a kind of a 'stage' for mathematics teachers to be involved in reflecting on their practice.

Background of the Study

In 2009, the New Education System (SPN21) was introduced and implemented in all primary and secondary schools throughout Brunei Darussalam. The aims for the New Education System (SPN21) are as follows:

- To meet the social and economic challenges of the 21st Century
- To realise the Ministry of Education's vision and mission
- To equip students with 21st Century skills
- To fulfil the Strategic Themes as outlined in the Ministry of Education's Strategic Plan (2007-2011)

(Ministry of Education Brunei Darussalam, 2009)

Over the past decades, the Brunei education system has undergone some major and minor changes. The old education system was viewed as inadequate in providing Bruneian students with appropriate skills, knowledge, attitudes and values that are essential in the twenty-first century. With the introduction and implementation of the new education system (SPN21), it is hoped that Bruneian students will be able to compete intellectually and academically with other students world-wide. Lesson Study may well be the 'tool' that can be used to facilitate the implementation of SPN21 in Brunei Darussalam.

The SPN21 Mathematics Curriculum

The current SPN21 mathematics curriculum of the Brunei Mathematics Syllabus builds on the earlier 2006 revision. Figure 1 illustrates the conceptual framework of the new mathematics curriculum.

The conceptual framework illustrates how mathematical processes (skills, communication and connections; mental computation and estimation; problem solving, reasoning and creativity; ICT and visualisation; attitudes and values) are to be embedded throughout the teaching of the mathematics content. However, embedding the mathematical processes into the teaching and learning of mathematics content in the new syllabus poses a significant challenge to teachers.

To realise the objectives of the new mathematics curriculum, instructional approaches using active learning in mathematics classrooms are recommended. The use of multiple representations in teaching mathematics according to the age and stages of the students are encouraged. The six different representations that can be used to facilitate the development of the content knowledge and processes are concrete, real life, diagram, verbal, ICT and symbolic representations (Curriculum Development Department, 2009).

However, acquiring the understanding of the six different representations above alone may not necessarily bring about the success in the implementation of the recommended instructional approaches. We believe that the most important challenge is to improve the ability and knowledge of teachers to include mathematical thinking, connection, reasoning, communication etc. via the representations in the teaching of mathematics contents. Teachers need effective professional development in order that the skills and processes mentioned are integrated into their teaching.

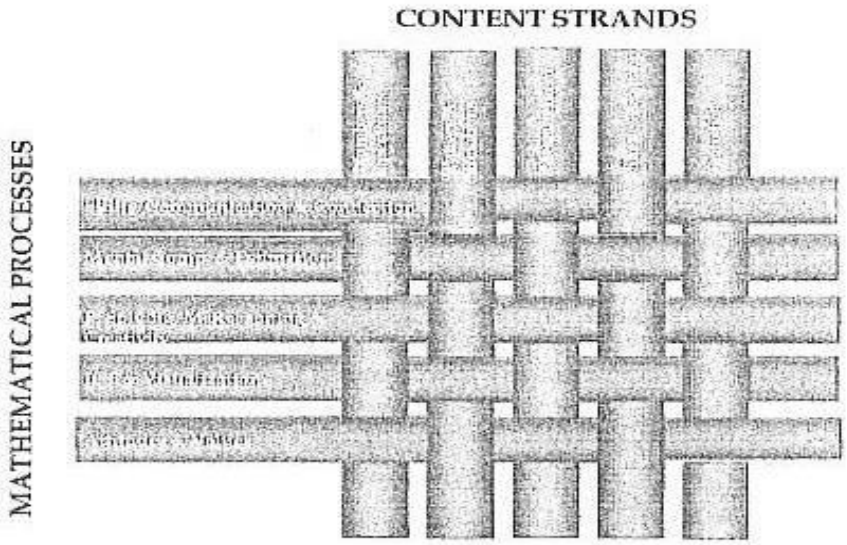

Figure 1. The conceptual framework (Curriculum Development Department, 2009).

Research on Lesson Study as a Professional Development Tool

Lesson Study is a model of professional development designed to assist teachers to produce quality lesson plans and gain better understanding of student-learning (White & Southwell, 2003). It is different from other forms of teachers' professional development programmes. In traditional professional development programmes, teachers are usually 'passive' where they receive a lot of information but have little opportunity to share their thoughts and ideas on the materials (Sparks & Hirsh, 1997). In contrast, researchers have recommended an inquiry type of professional development where teachers are required to identify areas of instructional interest, collect data to analyse it, and then make instructional changes based on the data. Lesson Study belongs to a set of professional practices that focus on the examination of practice either through direct observation by colleagues of each other's practice, through the examination of classroom artefacts, or case studies of teachers by teachers (White & Southwell, 2003).

According to Iverson and Yoshida (2005), Lesson Study is unique as it provides the following:

- It is teacher-led, long term professional learning.
- It is planned collaboratively over a period of time through intensive study of materials, standards, and students.
- It supports a collaborative focus on students' thinking through observation of classroom practice in real time with outside guests.
- It offers a process that makes concrete in an actual lesson a goal for learning.
- It provides new and outsiders' perspectives of teaching and learning.
- It fosters shared reflection based on classroom evidence.
- It makes concrete what reflection means, what problem solving looks like, and what thinking entails.
- It involves long-term participation of knowledgeable others.

(Iverson & Yoshida, 2005, pg.16)

Iverson and Yoshida (2005) also distinguished Lesson Study from other traditional professional development as shown in Table 1.

Table 1
Differences between Traditional Professional Development and Lesson Study

Traditional professional development:	Lesson study:
• Begins with an answer	• Begins with a question
• Is driven by the expert trainer	• Is driven by participant.
• Is workshop-based	• Is classroom based
• Features communication flow from the trainer to the participants	• Features communication flow from conversation among participants.
• Reinforces (tacitly) hierarchical relationships	• Reinforces reciprocal relationship
• Uses research to inform practice	• Treats practice as research.

By immersing teachers within the right kind of professional development, their attitudes and beliefs towards the teaching of mathematics and students' learning can be changed positively. In this way the teaching and learning process can be implemented effectively and efficiently. However, not much research had been done on the impact of Lesson Study as a professional development model in Brunei Darussalam. Results and findings on Lesson Study from other countries have suggested that it is a model or a kind of teachers' professional development program that can positively result in the improvement of teachers' content knowledge and pedagogical skills.

Aim of the Study

The aim of this study is to explore the relationship between Lesson Study and how mathematics teachers' develop proficiency to enable them to teach the difficult topics confidently and effectively. The hypothesis is that teachers' who are exposed to Lesson Study will be better able to teach difficult topics effectively and confidently.

Implementing effective Lesson Study in mathematics in Brunei schools requires a cultural change. It is still not a common practice in Brunei for teachers to open up their classes to allow other teachers to observe their lessons. The key research question is, "How do teachers involved in the study perceive Lesson Study as a continuous professional development process?"

Investigating teachers' perception of Lesson Study as continuous professional development programme was part of a bigger study carried out. The theoretical framework of the whole study is as shown in Figure 2. The social constructivist theory emphasises that knowledge is constructed in response to social interactions through social negotiation, discourse, reflection, and explanation. Teachers as learners are engaged in activities that necessitate interaction with both novices and experts in their field of study. During the Lesson Study process, these interactions occur as teachers with various levels of experiences work together in groups during lesson planning, implementation of a research lesson and reflection, in the presence of knowledgeable others.

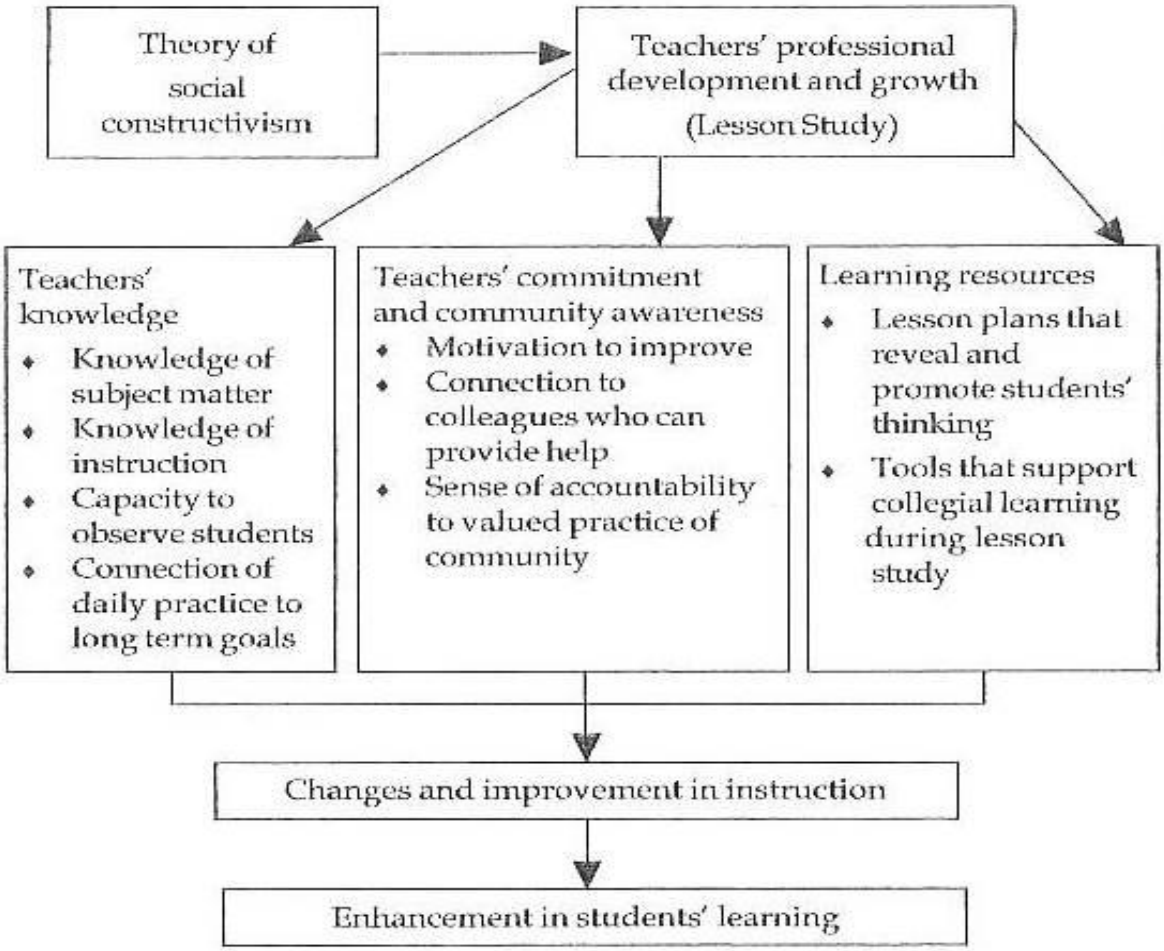

Figure 2. Theoretical framework of the whole study.

Methodology

Sample

This study included a combination of both qualitative and quantitative approaches. Teacher questionnaires, reflective journals and interviews were used to collect data. For the quantitative data, 28 teachers from 14 schools involved in the project were surveyed. The demographic information of the 28 teachers is presented in Table 2.

The qualitative sources of data include interviews, observations (classroom and the meeting sessions in Lesson Study) and reflective journals of four teachers from the Lesson Study Project Group 1 (LSPG1) were studied and analysed. The teachers in LSPG1 were teaching in classes at the Grades 2 and 5 levels. The four selected teachers were from Grade 5 and they chose to work on the topic of 'comparison of fractions'. Table 3 represents the details of the four teachers.

Table 2
Demographics Information

Description	Group 1 (N=8)	Group 2 (n=10)	Group 3 (N=10)
Gender			
Male	0	1	4
Female	8	9	6
Age			
18-25	1	3	1
26-35	2	7	8
36-45	5	0	1
46 and above	0	0	0
Highest Qualification			
Certificate or Diploma	4	5	6
Bachelor Degree	4	5	4
Masters' Degree	0	0	0
Number of years as a Mathematics teacher			
0-5 years	1	7	4
6-10 years	4	2	5
11-15 years	3	1	1
16 years and above	0	0	0

Table 3
Details of the Four Teachers Involved in the Interviews

	Teacher A	Teacher B	Teacher C	Teacher D
School	Primary School A	Primary School B	Primary School C	Primary School D
Gender	Female	Female	Female	Female
Age-group	30-39	30-39	30-39	40-49
Highest level of education	Bachelor Degree	Bachelor Degree	Certificate of Education	Certificate of Education
Number of years as a Mathematics teacher	11-15 years	11-15 years	11-15 years	16-20 years

Teachers' Questionnaire

The researchers adapted and modified the teachers' questionnaire from three previous researches on Lesson Study and Learning Study, namely; the research done by White and Southwell (2003) on the teachers' perceptions of the impact of the Lesson Study project on their knowledge and their learning, research done by Lo (2008) entitled *The Learning Study - A Framework for Enhancing School-University Collaboration that Focuses Upon Individual Lessons*, and a research by Fernandez (2005) entitled *Exploring 'Lesson Study' in Teacher Preparation*.

The teachers' questionnaire was divided into five sections and had 43 items which used Likert-type items. Nineteen items addressed teachers' perceptions in the three stages of Lesson Study (TQ1). Fifteen items of the questionnaire consisted of statements on teachers' overall perception of the whole Lesson Study project (TQ2). This was followed by 8 items collecting data on the impact of Lesson Study on the teachers (TQ3) and the final section consisted of an open ended question on teachers' views of the usefulness of Lesson Study. For each statement, teachers were asked to designate their agreement on a 4-point scale: which were (1) strongly agree, (2) agree, (3) disagree and (4) strongly disagree. The final eight statements in the forced choice items asked teachers to respond to a different 4-point scale: (1) No impact, (2) little impact, (3) moderate impact and (4) large impact.

Interviews

The main purpose of the interviews was to obtain information that cannot be readily observed such as feelings, thoughts and intentions. The main aim of the interview was to validate the responses and analysis from the teachers' questionnaire and observations.

For the interview, sixteen questions were prepared, including relevant probes to be used if necessary. The interview questions were adapted and modified from previous research done by Stafford-Plummer (2002) entitled *An Analysis of the Influence of Lesson Study on Pre-service Secondary Mathematics Teachers' View of Self- As Mathematics Experts*. Teachers were interviewed within a two week-period after they completed the Lesson Study Project. The structured interviews used a series of 16 open-ended questions focusing on teachers perceptions on the process of lesson study, and lasted between thirty minutes to one hour.

Using a Reflective Journal

The reflective journal were adapted and modified from the *Teaching Improvement Profile Template* by Cerbin and Kopp (2006). The teachers wrote the reflective journals after they completed the Lesson Study project. Only the four grade 5 teachers in LSPG1 were required to complete the teachers' reflective journal. The researchers' main aim of using teachers' reflective journal was to have a clearer picture of the teachers' experiences when they were engaged in the Lesson Study process. The journals included teachers' ideas, fears, mistakes, confusion and the reactions towards the experience that they had during the lesson study processes. The teachers were asked to write a reflective journal after each stage of the lesson study; planning stage, implementation stage (class observation) and reflection stage.

Results

Table 4 shows the teachers' mean scores on every item. The overall Cronbach alpha reliability index for all statements in Table 4 is 0.910 showing that the items were satisfactory in terms of their internal consistency. The overall mean of 1.63 suggests that teachers were generally positive (strongly agree to agree) with the advantages and improvements that Lesson Study had produced. They had positive overall perception of Lesson Study. The six items with mean scores suggesting the most positive perception of Lesson Study were items 12, 8, 14, 5, 3 and 10.

Table 4
Items in Section 3 of the Teachers' Questionnaire

	Descriptive Statistics				
		N	Min	Max	Mean
1)	My teaching has improved after taking part in lesson study	28	1	3	1.89
2)	I have developed a deeper understanding of the subject matter.	28	1	3	1.71
3)	I have become more conscious and sensitive to students' learning needs and difficulties.	28	1	3	1.61
4)	I will change my mathematics instructional practices after the lesson study project.	28	1	3	1.71
5)	The lesson study contributes to teachers' professional development.	27	1	2	1.52
6)	The lesson study has improved my perceptions on collaborative work practices to design lessons that engage students with their learning	28	1	3	1.61
7)	The lesson study has improved my understanding of students' learning	28	1	3	1.68
8)	I learnt a better way to teach the topic	28	1	3	1.39
9)	I have a deeper understanding of mathematics content now	27	1	3	1.63
10)	I have a deeper understanding of how students learn mathematics content in the lessons	28	1	2	1.61
11)	I have a deeper understanding of the new SPN21 mathematics curriculum.	28	1	3	1.75
12)	I learnt that it is important to provide activities that encourage students to think critically and creatively.	28	1	2	1.39
13)	I learnt that lesson study can be implemented and are sustainable in my school	28	1	2	1.68
14)	Experiences and knowledge I gained during the lesson study is very valuable and important in order to make me a better mathematics teacher.	28	1	3	1.43
15)	I am willing to take part in lesson study	28	1	4	1.86
	Valid N (listwise)	27			
	Overall mean			1.63	

Out of the six items, item 12 (I learnt that it is important to provide activities that encourage students to think critically and creatively) has the lowest mean score. This suggested that, most teachers who responded strongly agree to the statement and mostly perceive Lesson Study as a professional development process that made them learn that it is important to provide activities that encourage students to think critically and creatively in teaching and learning of mathematics. This is followed by item 8 (I learnt a better way to teach the topic.). From the table, it is clear that teachers in this study mostly perceive Lesson Study as a professional development process that allows them to learn a better way to teach the chosen topic in mathematics.

Item 14 (Experiences and knowledge I gained during the Lesson Study is very valuable and important in order to make me a better mathematics teacher) has the third least mean score. For this item, most of the teachers strongly agreed or agreed that Lesson Study provided them with valuable experiences and knowledge that can make them better mathematics teachers. That Lesson Study contributes to teachers' professional development is the next most clearly held belief for this group of teachers. All teachers agreed that Lesson Study contributed to their professional development. Finally, the teachers indicated that Lesson Study made them more conscious and sensitive towards students' learning needs and difficulties as well as understanding more about how students learn mathematics content in the lessons.

What was interesting is that although teachers were generally positive about their experiences in Lesson Study, the responses to the question on willingness to take part in Lesson Study were more widely spread. The entries in Table 5 represent the themes that emerged from the study of the open ended question.

Table 5
Themes from the Analysis of the Open Ended Question

Type of Responses	Themes
Positive responses	• The development of pedagogical knowledge • The development of students' learning knowledge • The development of subject matter/ content knowledge • The experiences and knowledge gained as a result of positive collaboration with peers and the 'knowledgeable others'
Negative responses	• More work; teaching other subjects besides mathematics • Missing a lot of classes during the observation of the teaching of research lessons.

For the negative responses and the mixture of positive and negative responses (negative aspect of the responses), six teachers wrote that the negative aspect of Lesson Study was due to the work load of the project (time and commitment problems). Five teachers mentioned that they were not only teaching mathematics but also other subjects such as science and English. The other four teachers commented that they missed a lot of classes during the implementation of the research lesson. However, the important and holistic view of the results of the teachers' questionnaire, clearly indicate that most participants and teachers who were involved in the Lesson Study project have positive general perception and ideas of Lesson Study as a professional development process.

Based on the teachers' comments and responses throughout the interview sessions and their journals, there seemed to be a mix of positive and negative perceptions of Lesson Study. Three themes related to the positive aspects of teachers' perceptions of Lesson Study as a professional development process emerged. Evidence from interviews, informal discussion and journals of the teachers suggests the following:

1. Lesson Study promotes the practice of teaching innovatively.
2. Lesson Study provides teachers with the platform to improve and reflect on their own teaching.

3. Lesson Study has many advantages compared to other professional development programmes.

Lesson Study promotes the practice of innovative teaching practices. A broad range and in-depth knowledge about pedagogy are required for teachers to be competent in teaching mathematics in primary schools. Lesson Study provides opportunities and platforms for teachers to develop and to practice innovative teaching practices. This was evident from the teachers' comments:

> Lesson Study would be useful for teachers as Lesson Study exposed teachers to student centred rather than teacher centred teaching methods. It allows students to think in their own way and express their ideas to teachers and other students. (Interview session: Teacher A, 18th August 2010)

The following interview excerpt demonstrates Teacher B's realisation of the importance in changing the roles of both teachers and students in a student centred teaching method.

> Student-oriented is important. Students should be brave and confident, and must be able to communicate with their friends, group members and with teachers. It's different from the traditional teaching methods where students were passive in class. They have to ask questions in class and teachers should also be 'approachable'. It used to be a one way communication. (Interview session: Teacher B, 17th August 2010)

From the comment, it is clear that teacher A supports the idea of Lesson Study as a useful tool to promote the practice of innovative teaching practices. In Lesson Study, teachers were given the opportunities to 'try out' and implement innovative teaching practices to their own students. In the comment above, she also pointed out to the two components of the project's research theme; which is to enhance students' communication and thinking skills. It also shows that teacher B understands the expected roles of students and teachers in a student-centred setting. She explained the differences between students' roles in a traditional setting and student-centred setting. Collectively the two comments show the teachers' support for the Lesson Study as a tool for promoting innovative teaching practices among the teachers.

Lesson Study provides teachers with the platform to improve and reflect on their own teaching. The observations of research lessons in Lesson Study were regarded not as an end in themselves but as a window of the larger vision of education shared by the group of teachers, one of whom agreed to teach the lesson while all the others made detailed records of the learning and teaching as it unfolded. These data were shared during a post-lesson colloquium, where they were used to reflect on the lesson and on learning and teaching more broadly. For example, one teacher commented that she did realise her weaknesses and strengths in teaching when observing and reflecting on other teachers' research lessons:

> Observing teachers is the most helpful aspect of Lesson Study. We can reflect on our own teaching. That's the most helpful stage for me. When observing, I can reflect myself, I know my weaknesses and strengths. (Interview session: Teacher C, 14th August 2010)

The following comments made by teacher D is consistent with the statement made by teacher C above:

> I like to observe teachers from different schools...I can learn from the teachers. Observing different teachers teach...emmmm.... I can see and learn through observing teachers teaching. I can compare my teaching with the other teachers and think of my own teaching....where is my weak and strong points in teaching (Interview session: Teacher D, 28th August 2010)

Based on the above interview excerpts, there is no doubt that the stage of implementation of research lesson where teachers observe other teachers teaching, is perhaps the crucial aspect of Lesson Study that contributes towards the development of positive perceptions of teachers on the Lesson Study model.

Lesson Study has many advantages compared to other professional development programmes. Although Lesson Study requires the tremendous time and commitment of the teachers and participants compared to other professional development programmes, it was seen to be worth the effort. The unique nature and characteristic of Lesson Study provided the teachers with a unique and conducive learning environment. This is evident with the interview excerpt below:

> It's different from other professional development programmes...its only one way...we only listen...they just give us ideas...its boring

> and unmotivated...it's usually in the afternoon and we feel sleepy and tired and it's useless. For Lesson Study, it's fun because we think and involve our students, share our ideas and then try out our own methods and lesson plans. (Interview session: Teacher D, 28th August 2010)

Perhaps, the most pleasing aspect of Lesson Study was the impact on the teachers. Most of the teachers who were involved in the Lesson Study project indicated that they were experiencing and learning new knowledge and skills that would benefit them as evident in this comment:

> Yes, Lesson Study would be useful for teachers. I have gained lots and lots of knowledge and experience from doing LS. I have also managed to experience good teamwork and cooperation 'showered' to our team. It was the most unforgettable experience that I have ever had. (Teachers' questionnaire)

In conclusion, it was evident that despite the commitment and effort needed for the Lesson Study to be successful, most of the teachers were happy and satisfied with the experiences and knowledge that they have gained during the project.

However it is important to temper these comments with the negative responses made by teachers about Lesson Study as a professional development process. The negative perceptions of lesson study appeared to be in the following areas:

1. Collaboration work between group members
2. Missing a lot of classes during the research lesson implementation.

Collaboration between group members. The collaboration between group members during the process of Lesson Study can be considered as vital for the success of Lesson Study. The degree and nature of teachers' learning and development greatly depended on the success of the collaborative work amongst teachers and group members. However, there were numerous negative comments made by the four teachers regarding the nature of their collaboration, especially during the planning stage. This was evident in the quote from Teacher A.

> It was just that sometimes I don't understand. When we do teamwork (planning session), we need to discuss with each other. It doesn't mean that-the other teachers just said '...for me it's ok..everything is ok'.

> But during the reflective stage, she commented a lot, as if she was not satisfied with the lesson plan. But she herself was one of the group members. That's the difficult thing. During the process of doing the lesson plan, everything was ok....and then...after I was doing the teaching of the research lesson, there were a lot of things that she did not agree on.(Interview session: Teacher A, 18th August 2010)

Some teachers expressed frustration about the problem of absenteeism of Teacher C. Other teachers felt that because of the regular absenteeism of Teacher C, the flow of planning the lesson plan was interrupted. They were unable to finish the planning of the research lesson which ultimately caused some group members to discuss and prepare the lesson plan outside the planning session. The following interview excerpt demonstrates this frustration.

> During the planning, we have difficulties. We have to fix our time with other teachers. And when we have meeting, Teacher C didn't come or some teachers came late. It seemed to be no collaboration. So when I need to discuss with my group members, I sometimes called my colleague, Teacher B, until midnight doing the lesson planning. (Interview session: Teacher D: 28th August 2010)

And the problem of absenteeism of teacher C was also stated by some teachers in their reflective journal. These findings are consistent with the statement made by teacher D above.

> In our group, there are 4 members, 3 of us are always there to discuss and modify the lesson plan. One of our member is always absent for our meeting. (Teachers' Journal: Teacher A, 20th July 2010)

Both interview excerpts and the statement written in the teachers' reflective journal demonstrated that collaboration among teachers during the planning session were interrupted by the two factors as explained above; absenteeism and teachers' reluctance to be actively involved in the discussion of planning the research lesson. As a result of these 'interruptions', two of the four teachers were not satisfied with their final lesson plan before the initial implementation of the research lesson. This concern may be addressed by providing guidelines explaining the roles of teachers and the objectives of the planning state of the Lesson Study prior to the Lesson Study project.

Missing classes during the research lesson implementations. During the implementation of research lessons, teachers were required to observe other

teachers from other schools. As a result they have to leave their schools on four occasions during the Lesson Study project. It was found that most of the teachers were uneasy and a bit reluctant to leave their students during the four days. From the numerous interview sessions, although schools did provide them with 'relief' or 'substitute' teachers, some of teachers were not happy to leave their students in the hands of relief teachers. This was evident from the interview excerpt below:

> I don't like to leave my students. I don't know whether there were relief teachers looking after my students when I was missing. I love to observe other teachers but I have to think about my students. The administration should not only give relief teachers to look after my students but I need the teachers to actually teach my students. (Interview session: Teacher D, 28th August 2010)

This issue was also stated by other teachers in their interview sessions. These comments are consistent with the interview excerpt of Teacher D above:

> But it's just the time when we were given the chance to observe other schools. That is what we need to discuss with our headmasters, because sometimes, we can't go...three of us from the same school....can't go missing at the same time. And sometimes when the headmaster and deputy headmaster were not in, someone has to look after the school which is me. That's why I can't observe some of our group members. And then there was also one day during that time, I was allowed to go but my timetable was full and compact. So I didn't go because if I go, and if I swap my subjects with other teachers, I would have other days with many lessons to teach. (Interview session: Teacher A, 18th August 2010)

Based on both the interview excerpts above, there was a need for schools to be able to accommodate any 'disruptions' to the teachers' lesson in school during the Lesson Study project. Provision of relief and substitute teachers are paramount to avoid any disruptions towards students' learning. The role of the relief teachers should also be defined and agreed upon by both the relief teachers and the teachers who were involved in Lesson Study. However we believed that the school had taken care of this matter and the students were under the guidance of capable hands. The arrangement of substituting teachers should be agreed upon long before the second stage of

implementing the research lesson. Early discussions and arrangements by both parties may have avoided this problem.

Discussion

From the analysis of all the research instruments, teachers' perception of Lesson Study as a professional development process can be categorised and summarised into two main themes. The themes are as follows:

1. Lesson Study is a professional development process that provides teachers with valuable experiences and knowledge in helping them to be better teachers through collaboration of peers and specialists and through the reflection of their own teaching.
2. Lesson Study can improve and develop teachers' pedagogical knowledge and students' learning knowledge which can help them to adapt innovative teaching practices.

In this study, teachers stated that Lesson Study is a professional development model that provides them with valuable and meaningful experiences and knowledge which were built during the process of reflection and collaboration with their peers and the 'knowledgeable others'. The process of collaboration was mostly observed during the planning stage of Lesson Study, where teachers were involved in at least five planning meetings and sessions. In each of the two hour meeting sessions, teachers exchanged ideas in selecting the method of instruction, teaching materials and mathematical activities; every idea was critically examined with respect to their own students' current knowledge and skills on the concept of fractions.

This is similar to the findings of research done by Lawrence and Chong (2010) in which they stated that the collaborative structure of Lesson Study provided numerous opportunities to help teachers develop and shape the skills of critical thinking and good questioning. The intensity of collaborative work by teachers in these meetings appeared to influence the extent and the nature of their learning. This is again supported by Lawrence and Chong (2010), in which they stated that for collaborative learning to have a positive impact on teaching and student achievement and to transform practice, teachers participatory efforts should be intense and sustained over a substantial period of time.

The impact of 'knowledgeable others' in the collaboration process on teachers' learning should not be overlooked. In the study, the teachers mentioned that 'knowledgeable others' contributed a lot towards their development of pedagogical and content knowledge. Teachers were guided and advised on the process of selecting the methods of teaching, teaching materials and mathematical activities and providing critical comments on the teaching of the research lesson in the reflective stage of Lesson Study. It is important to point out that, the role of the 'knowledgeable others' in the study expanded more from just being a facilitator and contributor of ideas. They were heavily involved and supported the teachers throughout the process of Lesson Study. This is supported by Watanabe and Iverson (2005) who stated that the role of 'knowledgeable others' before the research lesson is to offer encouragement, support and guidance with content learning and developmental theory; during the research lesson, the 'knowledgeable others' model the observation process for others. After the research lesson, the 'knowledgeable others' provide feedback, comments and suggestions for next steps.

In this study, teachers also stated that they have developed pedagogical knowledge as well as students' learning knowledge which can help them to adapt innovative teaching practices. The term innovative teaching practices in the context of this study referred to teaching practices to develop students' mathematical and communication skills and also focuses on making students' thinking visible during the course of the lesson.

According to Lieberman (2009), making students' thinking visible involves having students show and discuss their methods in groups, having students show and discuss their method with the whole class, having students write out in words what they did and why they did it that way. In the research lesson, students were seen discussing their answers with their group members and also showed their answers and explained the rationale of their answers to the whole class.

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Authors:

Hj Ade Shahren bin Hj Suhaili; Sekolah Rendah Jerudong, Brunei Darussalam;
e-mail: hjade501@gmail.com

Madihah Khalid; Universiti Brunei Darussalam;
e-mail: madihah.khalid@ubd.edu.bn