

Teaching Mathematics Together: A Teacher-led Case Study of Lesson Study in Action

Ho Geok Lan, Teaching Fellow
National Institute of Education

Wong Ker Sin, HOD/Maths
Michele Fung, Senior Teacher
Lau Chor Keng, Maths Teacher
Patrick Ng, Maths Teacher
Shirley Sim, Maths Teacher
St. Theresa's Convent Secondary School

Abstract

This paper describes a team of mathematics teachers involved in lesson study initiatives carried out by the school. Following the lesson study model provided by the Japanese, a team of mathematics teachers embark on this project. They planned a unit on teaching 'box and whisker diagram' to a group of Secondary Three Female students. The team met with several challenges while carrying out the lesson study including time, identification of broad goals for the unit, alignment of lesson goals with school goals and missions, researching for materials, etc. Nevertheless, the teachers feel that it is a worthwhile experience because it builds collegiality among the teachers in the team. They benefited in terms of gain in content knowledge and pedagogical knowledge, in particular focusing on the pupils' learning through observations. This paper hopes to provide mathematic teachers and educators with insights into implementing lesson study in the local context.

Introduction

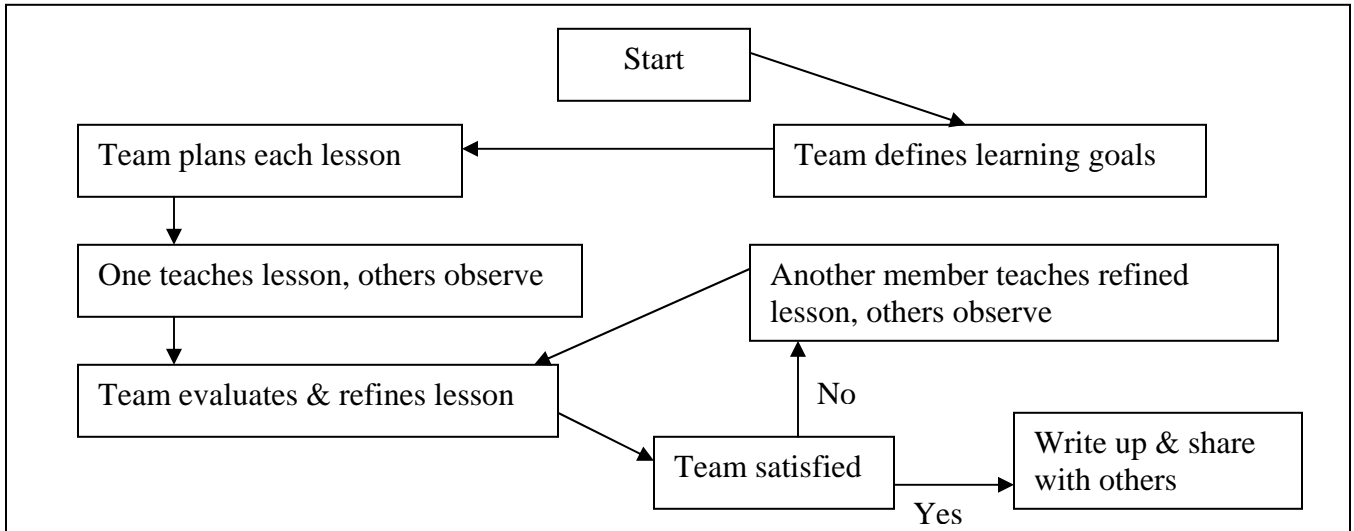
The Singapore curriculum places emphasis on development of skills and processes in the students so that they become independent learners and creative thinkers. The goals are envisioned in the "Thinking Schools Learning Nation" initiatives. Schools are therefore encouraged to "Teach Less Learn More" (TLLM), where teachers should teach less to the examinations but more to encourage thinking in the students. TLLM focus on improving the quality of interaction between teachers and learners, so that our learners can be more engaged in learning and better achieve the desired outcomes of education. There are numerous new innovations introduced to schools, such as IT

Masterplan, National Education, Thinking Skills, etc. The challenge is how schools can keep up with all these new initiatives, at the same time prepare students to pass the examinations. In another words, how do teachers actually enact such ideals in their classrooms. Although innovations can be well-developed and researched extensively, once they are disseminated to the everyday classrooms, they may not be successful. Talbert, McLaughlin and Rowan (1993) criticized “*research carried out in ‘boutique’*” (p. 62) tells little about what happens in everyday classrooms because the settings used for such field experiments usually received extra support and resources so that teachers are monitored carefully to ensure “correct” implementation of the method. Further, such innovations are seldom sustained longer than the implementation period.

Teachers need professional development and support in order to grow and change in their teaching. Like the students, teachers learn best if they were actively engaged in learning new ideas, and were able to translate what they learned into classroom practice. Lappan and Briars (1995) characterized the view of student learning supported by NCTM:

- Learning is contextual: What students learn is fundamentally connected with how they learn it.
- Learning occurs best through dialogue, discussion and interaction.
- Learners must be actively involved in the process.
- A variety of models must be used to meet the [needs] of all learners (e.g. working individually, in pairs, and in cooperative groups).
- Learners benefit from reviewing, critiquing, and revising one another’s work. (p. 133)

Several models are shared in the current educational landscape on such kind of professional development models for teaching, mathematics in particular. In the Japanese context, ‘Lesson Study’, also called ‘Research Lesson’ (translated from the Japanese word, Kenkyuu Jugyou) is pervasive. Lesson Study is embedded in the culture of schools in Japan where teachers come together in professional learning communities to improve instruction based on careful observations of pupils, their learning and work. These lessons are characterized by teachers collaborating with one another in lesson planning, lesson observations, followed by discussion and reflection of lessons conducted. The model can be summarized below:



Lynn Liptak compared the professional development of teachers using the

Traditional	Lesson Study
<ul style="list-style-type: none"> • Begins with answer 	<ul style="list-style-type: none"> • Begins with question
<ul style="list-style-type: none"> • Driven by outside “expert” 	<ul style="list-style-type: none"> • Driven by participants
<ul style="list-style-type: none"> • Communication flow: trainer → teachers 	<ul style="list-style-type: none"> • Communication flow: among teachers
<ul style="list-style-type: none"> • Hierarchical relations between trainer & learners 	<ul style="list-style-type: none"> • Reciprocal relations among learners
<ul style="list-style-type: none"> • Research informs practice 	<ul style="list-style-type: none"> • Practice <i>is</i> research

traditional and lesson study approaches (Lewis 2002, p.12).

It shows that lesson study places teachers in an active role as researchers. Research lessons provide a chance to study the learning and engagement of students in other classrooms, and to inform and fuel one’s own improvement as a classroom teacher.

Lesson study invests time and resources in planning, studying and refining what actually happens in classrooms. It is a system of research and development in which teachers advance theory and practice through the careful study of their own classrooms, constantly testing and improving on “best practices”. Through lesson study, teaching becomes a collaborative effort and teachers, like their learners, learn together as they teach for better student understanding.

Background of Case Study

The current situation in St Theresa’s Convent is outlined below:

- There is a diversity of learners
- Teachers have different degree of teaching skills and experiences
- Curriculum design aims to engage learning by incorporating Cooperative Learning, Multiple Intelligence, Problem Based Learning and Higher Order Thinking
- School Thrust 3: Contribute to the Staff Professional Fraternity

Aim of study

Why does St Theresa’s Convent embark on Lesson Study?

- It serves as platform for teachers to come together to explore, learn, share, research and develop curriculum.
- It is a Teachers initiated approach – learning by teachers for teachers.
- For Staff Professional Development – enhance and develop staff competencies, subject mastery and working with others as teachers examine their teaching practice.
- To build a community of reflective learners (staff and students) and a culture of openness.

Stages of implementation

The following section outlines the stages of Lesson Study implementation for the Mathematics Department in St Theresa’s Convent:

- a. Training, Support and Resources

Under the leadership of the principal, Mrs Kong, the Humanities, Mathematics and Science Department formed three pilot groups of 4 to 5 teachers to embark on the project in 2006. There was a training workshop conducted by Master teacher, Mrs Alice Poh. The principal was instrumental in the support and implementation of the lesson study projects. Besides providing the reading materials and website resources, she constantly encouraged all the teams and empowered the teachers to give their best in the learning journey together.

In 2007, 50% of the staff were trained by Dr Patsy Wong in a full day workshop on 16 July. One mathematics lesson was opened for public viewing, followed by student interviews, group review and panel discussion.

In terms of support and resources, there were provision for expert knowledge and facilitation. Lecturers from National Institute of Education (NIE) became a source of 'knowledgeable others' to give inputs in content and pedagogical content area. There was also IT support to provide video recording of all the team meetings and classroom observations.

b. Team formation

The mathematics team comprised of the Head of Department, one senior teacher and 4 mathematics teachers. A resource person from NIE, Mathematics and Mathematics Education Department, acted as a resource person to provide inputs, feedback and suggestions for the research lesson.

c. Brainstorming – Lesson Planning

The team jointly drew up a detailed lesson plan for the research lesson. They identified and selected an overarching goal and relate it with the content-specific goals. The overarching goal was the department goal: "Students become independent learners." The content-specific goals included: "How to construct and interpret a Whisker-Box plot with a set of data". The team chose to focus on the following:

- “to promote communication and thinking skills through group activities” and
- “to explore how our students create their own meaning and learning through group activities and discussions”.
- The team planned the lesson plan with inputs from the teachers and resource person. The following refinements were made to improve on the lesson plan:
 - Make links with students’ prior knowledge and extension of understanding from lower sec knowledge
 - The group activity – from focus on “picking out 5-data points” to “guided worksheet” on construction of “box and whisker” plot
 - Refinement of worksheet questions
 - Time allocation for activities
 - Refinement to worked examples given
 - Focus on “teaching moments” when contradicting responses come from students, rather than “rushing” through the activities.

d. Teaching and lesson observations

The first lesson observation was conducted by one mathematics teacher and the rest of the team members observed the lesson. Data was collected, focusing on student responses and observable behaviours.

e. Review and Improvement

The team came together to discuss their observation of the lesson. The guiding question was: “Why did the students not think or respond as what we expect them to?” The following changes were made to improve upon the lesson:

- Rearrange the sequence of activities to encourage greater scaffolding and flow in the lesson
- Provide longer wait time
- Include either open-ended or specific questions that encourage higher-order thinking

- Set aside time for observers to interview the students

f. Public lesson, Team Review and Reflection

The second lesson observation was conducted by another mathematics teacher to a different class of students. This time, it was a public lesson used for panel discussion and review by staff attending the Lesson Study workshop facilitated by Dr Patsy Wang and NIE lecturers.

Reflections

The two Lesson Study cycles carried out by the group of mathematics teachers in St Theresa's Convent were excellent opportunities for professional development as well as personal growth in terms of increased knowledge of subject matter and knowledge of instruction. The teachers were asked to reflect upon their learning experiences and these reflections were captured online in their Staff Portal. Such learning experiences and journal entries were subsequently shared during post research discussions to enrich dialogue among teachers. This section gives a summary of the reflection from various perspectives; the participating members in the research team, on how the students learn, about the learning atmosphere as well as collective learning as a department and with other departments.

(a) From members in the research team

The members became more open to give suggestions and receptive to advice to make improvements. There was greater 'buy-in' to the ideas suggested by the colleagues and giving them support. One change observed by the Head of Department was that one senior teacher even proposed the idea of 'designing standard lesson notes' for all classes so as to provide a good resource for new teachers. This idea would mean 'more work' for the teachers, but she was keen to embark on it because that would become the 'collective effort' of the team. Further, the Sec 3 LS team provided encouragement to the Sec 2 LS team which promotes confidence and morale of the whole department.

(b) About students' learning

The teachers in the team felt that they began to understand themselves and the students better. These include their own teaching style, the students' profile and both the students' and their own misconceptions about content that they were teaching. In particular, the teachers no longer assumed that the students would learn what they were taught. In addition, teachers became more aware of why and how lessons were delivered.

(c) About the learning atmosphere

The learning atmosphere was non-threatening as the teachers came to realize that the focus was learner-centered. They became comfortable to laugh over their own mistakes and willing to make changes. Criticism was taken positively and not personally as the lesson was the product of teamwork. They became 'less guarded' and more willing to do things that they usually may not accept or try (be 'out of comfort' zone).

The following remarks were taken from reflections by teachers who were members in the Lesson Study research team:

"...revisited the department action plan, learning skills and social skills...make me more aware and take extra care when planning my lesson to encompass the skills and content that the students need to acquire at the end of the lesson..."

"Lesson progressed smoothly due to the clarity of the devised lesson...I was more confident in the lesson delivery...Because of the hands-on approach and the cooperative learning environment, the lesson was an engaging one for both the students and the teacher..."

"Through the interactions with the other teachers, the ideas were challenged and refined...indeed an enriching experience...Reflecting on what Prime Minister Mr Lee said, content knowledge changes and is created with time. Hence we need to equip our students with skills to manage information..."

“Although we often share teaching resources and ideas, we do not spend as much time as in LSP to critique, clarify and find out more about the purpose and thinking behind the resources/ideas shared...I get affirmation for my ideas as well as guidance to improve my teaching approaches from my colleagues.”

“Our team is more than just a group of individuals. We have gone through a number of dialogues during the LSP process which allow us to understand each other better and form a synergistic team that we can now depend on...”

“The learning experience I have gained through the process is definitely worth more than the time and effort invested...I get to learn from my colleagues (skills and knowledge)...It’s no longer about how to teach a Maths lesson well but a long-term strategy to develop the eyes to see my students learn – what and how they think, learn and respond in a classroom.”

Overall, the team felt that lesson study provided a good platform for staff development and collaborative work and learning among teachers. They see that it is team-driven and everyone played a part ‘automatically’ to complement each other without much ‘delegation’. The team takes pride in whatever they do because it is team effort. They can identify the strengths in each other and get to learn from the overall experience. Finally, it is useful to know that the support is there and the teachers know who to seek help when needs arise.

Lessons learnt from the students

Teaching is complex! Often, teachers cannot predict how the students will respond to a lesson. Teachers must be observant and sensitive to the needs of the students. There are several observations the mathematics team made and have learnt from the Lesson Study project on teaching ‘whiskers and box diagram’:

- Students have different pre-conceptions. Some students mistook “average” for mean. One may question the role that language plays in mathematics. Teacher should take extra care in explaining mathematical terms to students.
- Students have different pre-knowledge. It was surprising to see many students grappled with difficulties while trying to plot a diagram using different scale. Some students extend their knowledge on Dot diagram to relate to “Box and Whisker diagram”.
- Students enjoyed the peer support and group cooperation. Generally students love to work in a group because they can ask their peers for help in a safe environment. Nevertheless, more investigation and research need to be done to explore the role of peer support and quality of communication in a group environment. It appear that students often chose the easier way to copy answers or simply follow the more capable peers, rather than capitalizing the potentials of group work through negotiation and sense making.

Perspectives from the ‘knowledgeable other’

Here the last author acts as a ‘knowledgeable other’ who constantly posed questions, provided inputs and suggestions for improvement in the lesson planning stage. It was important that the decisions were made by lesson planning team since it was their lesson. The role of the ‘knowledgeable other’ simply added ideas and information for their consideration and posed questions that would make them think deeply. During the first meeting, the big ideas and goals for the topic “box and whisker” diagram were emphasized. The objective for learning about the “box and whisker” was allowing students to understand and appreciate another means of statistical representation, in particular for large data sample. Another important goal was to equip students with the skills of interpreting data using this kind of representation. Generally, teachers tended to focus teaching only the drawing of the diagram without clearly and explicitly highlighting the use of statistical diagrams. As a result, students may be very skilful in reproducing diagrams but with poor understanding of its uses. Hence, students may not be able to use these diagrams to interpret information required in the problem.

In the first round of research lesson planning, the team initially tended to focus only on the drawing of the “box-and-whisker” diagram, in particular identifying the 5 critical points on the plot, namely the maxima, minima, median, lower and upper quartile. The emphasis here appeared to focus on the procedural knowledge of acquiring skills in drawing the “box-and-whisker” plot. Hence the first objective of the lesson (‘plot box-and-whisker diagram’) was achieved. However, from the observations and progress of the lesson, the teacher noticed that a number of students were not very clear about meaning of inter-quartile range, resulting in poor understanding of the questions in Activity 2 which required students to interpret meaning using the box-and-whisker plot given.

To a certain extent, the potential of cooperative learning in this lesson can be further realized. The research team explained the flexibility in allowing students to choose learning modes that are more coherent to their own learning styles. In another word, students can choose to work through the problem individually using the guided worksheet or they can discuss with their partner to solve the problem. Observations by the observers revealed that a number of students tended to be left alone to figure out the problem on their own while some copied answers from their peers without clarification. The use of cooperative learning strategies can be further improved in terms of the structures adopted and ways to ensure maximum participation and individual accountability.

For the ‘knowledgeable other’, it was a very enriching experience because of the opportunity to see the enactment of the lesson after the feedback and improvements to the lesson. Though the same lesson was carried out twice, the lesson outcomes turned out to be pretty different. Students from the first group were generally more spontaneous and enthusiastic. However, completing three activities proved to be too ambitious. In fact, the observers felt that the teacher was rushing through the activities without enough time for the students to digest what they had learnt. The pace for the second lesson was better and the teacher repeatedly checked for student understanding by providing prompts and examples to help students clarify their thinking. For example, the teacher gave a nice example on the income of 5 people, ranging from \$1 000, \$2 000, \$3 000, \$4 000, \$5 000 and \$100 000. The students were asked to describe the data using the statistical averages

they had learnt. The example provided the students of a better understanding on the use of mean which students often take for granted. Also, the use of the term “mean” has different meaning when one associates it with “average”. Students tend to use average to represent mean.

Conclusion

Through lesson study, we observe the power of teacher collaboration at work. Teachers share ideas, give suggestions to improve lessons. Teachers feel empowered when they have the autonomy to make decisions and continuously learn and practise on the job. The overall structure encourages teacher collegiality and peer support.

In a way, lesson study also provides a platform for community learning that can enhance inter-schools and teacher-parent partnership. Lesson study promotes learning among teachers from different schools. Teachers may visit another school to serve as observers and the impact can be greater and more engaging compared to attending a training workshop. Similarly, parents may be invited to serve as behavioural observers to gain greater understanding of the teaching and students’ learning attitude in class. These parents, in turn, can provide better home support and facilitation in the school program.

Support from the school middle management and leaders are important driver to ensure sustainability of the project. Examples of tangible support such as common time for teachers to meet up for lesson discussions, observations and time for teacher reflection. The provision of knowledgeable others through network and contact are important resources to enhance the quality of the lesson study experience. For example, the existence of cluster master teachers and senior teachers in the school are good resources to tap on. Further, new programs and initiatives should be aligned with the school goals and missions so that teachers understand their rationale and purpose.

References

- Lappan, G., & Briars, D. (1995). How should mathematics be taught? In I. M. Carl (Ed.), *Prospects for school mathematics* (pp. 131-156). Reston, VA: National Council of Teachers of Mathematics.
- Lewis, C. C. (2002). *Lesson Study: A Handbook of Teacher-Led Instructional Change*. Research for Better Schools, Inc.: Philadelphia, PA
- Talbert, J. E., McLaughlin, M. W., & Rowan, B. (1993). Understanding context effects on secondary school teaching. *Teachers College Record*, 95(1), 45-68.