The EPMT Project – A harbinger for teachers’ meaningful production of pedagogical knowledge

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Abstract:
Enhancing the pedagogy of mathematics teachers (EPMT) project exemplifies a critical development in the professional development of teachers in many parts of the world. This development reflects a gradual shift in the centre of gravity away from the University-based, “supply-side”, “off-line” forms of knowledge production conducted by university researchers for teachers towards an emergent school-based, demand-side, on-line, in situ forms of knowledge production by teachers for teachers. Supporters of this transition do not deny the value of university based research but they do insist that in a knowledge economy, improving the quality of teaching and learning is going to depend increasingly on carefully crafted partnerships between university scholars and classroom teachers. Critically, they also insist that one key outcome of such partnerships ought to be the codification, verification, dissemination and institutionalization of expert teacher knowledge.

The aims of the project were three fold. The first was to engage mathematics teachers in professional development to improve their classroom pedagogy and ultimately improve student learning in terms of reasoning and communication skills in mathematics lessons. The second was to create teacher practitioner learning communities at the school level who will work together to advance the knowledge they gain from the professional development modules and also put it into practice; and the third was to enthuse and support teachers to put together their work in print form and support other fellow teachers. Teachers from ten schools participated in the project. This paper describes aspects of the project that makes it a harbinger for teachers’ meaningful production of pedagogical knowledge in Singapore.

Keywords: Professional development, mathematics teachers, expert teacher knowledge, Singapore, school-based.
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Introduction

Since 1998 all teachers in Singapore are entitled to 100 hours of training and core-upgrading courses each year to keep abreast with the current knowledge and skills. The Professional Development (PD) is funded by the Ministry of Education. Yet another subsequent development that has accorded teachers the responsibility of their own PD is the Enhanced Performance Management System (EPMS) (Ministry of Education, undated) put in place by the Ministry of Education (MOE) in 2005. The EPMS is an appraisal system that contains rubrics pertaining to fields of excellence in the education system be it teaching, leadership or senior specialist. Over the past couple of years, mathematics teachers have been focused on excellence in their mathematics classrooms.

Upon the completion of pre-service education, teachers continue their learning journey through participation in many types of PD activities. For a long while the most common traditional type of PD in Singapore has been in-service courses. These courses are conducted for about 3 hours each day either for about 4 to 10 consecutive days or spread over a number of weeks. They are conducted by experts in the field and are “off-line” forms of knowledge production. After the completion of the course there is no follow up with the teachers about the use of the knowledge acquired and any impact that knowledge may have had on student achievement. Over time the nature and scope of PD has expanded and at present it includes any activity and interaction that may increase the knowledge and skills and improve teaching practice. These experiences can range from formal, structured topic-specific seminars, workshops to school-based activities involving curriculum design, discussions on instruction techniques, day to day collaborative activities that enhance teachers’ knowledge and skills, co-teaching, peer observation, mentoring, etc. In Singapore, the Teachers Network (TN) and Centres for Excellence in Mathematics (COE) have been instrumental in creating and supporting professional learning communities amongst teachers (See Chua, 2009). Most notably, TN equips teachers with the methodology of Learning Circle (LC) while the COE promotes Action Research (AR) amongst teachers. The COE also conducts seminars, one-off type of workshops for teachers in their clusters.

The EPMT Project

Enhancing the Pedagogy of Mathematics Teachers (EPMT) project, a school based project of the Centre for Research and Pedagogy at the National Institute of Education of Singapore, is a project that exemplifies a critical development in the professional development of teachers in many parts of the world. This development reflects a gradual shift in the centre of gravity away from the University-based, “supply-side”, “off-line” forms of knowledge production conducted by university researchers for teachers towards an emergent school-based, demand-side, on-line, in situ forms of knowledge production conducted by teachers for teachers. Supporters of this transition do not deny the value of university based research but they do insist that in a knowledge economy, improving the quality of teaching and learning is going to depend increasingly on carefully crafted partnerships between university scholars and classroom teachers. Critically, they also
insist that one key outcome of such partnerships ought to be the codification, verification, dissemination and institutionalization of expert teacher knowledge.

The aims of the EPMT project were three fold. The first was to engage mathematics teachers in professional development to improve their classroom pedagogy and ultimately improve student learning in terms of reasoning and communication skills in mathematics lessons. The second was to create teacher practitioner learning communities at the school level who will work together to advance the knowledge they gain from the experts (university scholars) and also put it into practice; and the third was to enthuse and support teachers to put together their work in print form and showcase it to other fellow teachers.

The learning journey of teachers in the project

Teachers from ten schools, 5 primary and 5 secondary, participated in the project for two years. From each school there were 4 teachers in the project. The project comprised of three phases. During the first phase university scholars, one of which is the author of this paper, conducted workshops for the teachers. During the workshops teachers worked in small groups to make sense of the knowledge that was disseminated by the university scholars and also craft mathematical tasks for use in their lessons. During the second phase of the project, teachers worked collectively at the school level to put into practice their newly acquired knowledge. They were given specific tasks to do by the university scholars. The university scholars were available for consultation through e-mail contact and also during the fortnightly meetings that were held for teachers to share with the group their lessons and experiences. During the third phase teachers were left to work with their project mates in their schools to advance the knowledge they have gained from the first two phases. They were also encouraged and supported to make conference presentations, school based presentations and cluster level presentations.

Knowledge production by the teachers

In this paper, we will focus on the processes and products of the teachers’ work in codifying their knowledge, during the first two phases of the project.

Phase I

In this phase, teachers attended workshops conducted by the university scholars. The workshops were organised as two modules, the first centred around crafting of tasks that would engage students in reasoning and communication and the second centred around teaching for understanding. Each workshop began with the university scholar introducing the teachers to an idea. In the case of the first module, they were introduced to ideas of how typical textbook questions could be crafted into tasks that would engage students in reasoning and communication. In the first module they were introduced to 8 strategies. In the second module they were introduced to frameworks that may be used to plan for lessons that teach for understanding. In this paper, we report on how one strategy from the first module was developed. This strategy is “What’s wrong?”. Teachers were introduced to the strategy: What’s wrong? as follows:

In, “What’s wrong?” the students are provided with an opportunity to use their critical thinking skills. They are presented with a problem and its solution. However
the solution contains an error, either conceptual or computational. The student’s task is to discover the error, correct it and then explain what was wrong, why it was wrong and what was done to correct the error (Krulik and Rudnick, 1999).

Next textbook questions were used to craft the tasks. One question from the primary school textbook led to the following task.

**Example 1: Prize Money**

John and Henry won a prize of $500 at a Charity Fair.
With the money, John bought a bicycle for $140.
On their way home they decided to share the prize money equally.
How much did John get?
This is how John thought they will share the money:
$500 - $140 = $360
$360 ÷ 2 = $180

Therefore John will get $180
Is John correct? If not,
1. Show how you would find the answer to the problem.
2. Explain the mistake in John’s thinking.

Another question from the secondary school textbook led to the following task.

**Example 2: Triangular Poster**

Rani made a triangular poster for the coming math competition.
It was in the shape of an equilateral triangle with side 30 cm.
Her teacher liked the poster very much.
She asked Rani to make another similar poster but with an area twice that of the first poster.

To make the new poster Rani decides to double the sides of the equilateral triangle.

Rani’s thinking:-
- Original side of poster = 30 cm
- Multiply each side by 2
- 30 cm x 2 = 60 cm
- therefore,
- the new poster is an equilateral triangle of side 60 cm

Is Rani’s thinking correct? If not,
1. Show how you would solve the problem.
2. Explain the error in Rani’s thinking.

Following a discussion of how such tasks are crafted, teachers were made aware of the need to ensure that students are engaged in class discussion after completing the task. Groups of students or individuals may contribute towards the class discussion. It is important that students get to see as many ways as possible of arriving at solutions. Furthermore the group interaction that occurs during these discussions often leads to deeper mathematical understanding (Krulik and Rudnick, 2001; 2002). Teachers were also assured that such tasks are not difficult for them to craft as they are constantly exposed to errors that students make in class and in their written assignments.

Next, the teachers got into their groups that were organised according to the grade levels they were teaching and crafted “What’s wrong” tasks for their use. Teachers had
with them their textbooks and schemes of work. They chose their own topics and crafted tasks that would be used in their lessons, in the next few days. Most often as each workshop drew to a close, after three hours many teachers left with at least one task they had crafted. The teachers were encouraged to craft as many tasks as they liked. An e-portal was set up by the university scholars for the teachers to share their tasks with the rest of the project teachers. The collection of the tasks from this portal, later contributed towards the two print resources (Kaur and Yeap, 2009a; 2009b) for mathematics teachers in Singapore schools.

Phase II

During this phase teachers were encouraged to infuse in their lessons their learning from the workshops conducted during the first phase of the project. Teachers were given specific assignments by the university scholars. They were assigned the following tasks to complete in their own time collaboratively with their fellow project participants in the school.

Plan, design and teach,
(i) [A] at least 1 lesson that infuse reasoning tasks and facilitate communication in your mathematics classrooms over a period of the next 10 - 15 weeks.
(ii) [B] at least 1 lesson that teach for understanding in your mathematics classrooms over a period of the next 10 - 15 weeks.
(iii) Video-tape anyone of the above lessons in A or B.
For all lessons, you must submit the lesson plan, samples of student work and your reflections about the lesson. A guide was provided for teachers to guide them in their reflection of the lesson.

While teachers were working on their assignments, the university scholars facilitated fortnightly sessions during which teachers shared their work with the others and invited critique. It was during these sessions that teachers’ shared with the rest of the project participants their tasks, lessons (through video-records), students’ work and students’ voices. They invited both applause and critique. We must say that after the first few sessions, the activity picked up momentum and teachers became more “welcoming” of critique. It was during these sessions that teachers were meaningfully engaged in the production of pedagogical knowledge, creating and testing their plans, most importantly taking into consideration their students’ inputs like what made the lessons, enjoyable and meaningful. Using video records of their lessons they watched the performance of their students in class, reflected on their goals and evaluated their lessons. These actions led to revision / modification of plans for subsequent lessons. Towards the end of this phase teachers submitted their assignments.

The assignments submitted by the teachers were a source of data that was used by the university scholars to draw on explicit examples of teachers’ work that showcased “engaged learning” in mathematics lessons. In this paper we show one example that illustrates how students were engaged in learning by inquiry and another that illustrates how students were engaged in learning by reflecting.

Learning by Inquiry
The inquiry method is a student-centred method that focuses on asking questions. Students are encouraged to ask questions that are meaningful to them. Teachers often ask further questions in response to students’ questions instead of giving answers.
Lesson X:
Topic: Solution of Quadratic Equations
Grade Level: Secondary 2
Goal of lesson: To consolidate a skill
Lesson Development:
1. Teacher designed task sheet A for the lesson.
2. Students are put into pairs or groups.
3. Students are told to identify any mistakes in the solution and to explain the mistake.
4. Teacher asks questions such as “What is the mistake?” and “Why is it a mistake?”
5. Students are asked to correct the mistake.

Task Sheet A

Topic: Quadratic Equations
Grade Level: 8

Jim is given the following equation to solve.

\[(2x - 4)(3x + 1) = 12\]

He came up with two possible solutions. Are both solutions correct? Explain the errors in the solution(s).

Solution 1
\[
\begin{align*}
6x^2 + 2x - 12x - 4 &= 12 \\
6x^2 - 10x &= 16 \\
x(6x - 10) &= 16 \\
x = 16 \text{ or } 6x - 10 &= 16 \\
x &= 26 \\
x &= \frac{26}{6}
\end{align*}
\]

Solution 2
\[
\begin{align*}
2x - 4 &= 12 \text{ or } 3x + 1 &= 12 \\
2x &= 16 \\
x &= 8 \\
3x &= 11 \\
x &= \frac{11}{3}
\end{align*}
\]

Learning by Reflecting
Reflection involves “active, persistent and careful consideration’ of any form of knowledge (Dewey, 1933). The following lesson shows how a teacher engaged her grade 8 students in learning by reflecting. The students were given the following data set in the form of a stem-and-leaf graph. The data was the time taken, in minutes, to complete a homework assignment. The teacher asked the students to pose questions that can be answered using the data set.
The time (in minutes) taken to complete a particular homework assignment by students from a class.

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Write as many questions as you can based on the graph above.

Find the answers to two of the questions.
Show your working.

The students worked in groups and were encouraged to pose as many questions as possible. They were also required to provide answers to two of the questions they posed. The groups wrote their questions on large sheets of paper. One of the groups asked these questions: What is the mode? What is the mean? What is the median? How many students did the assignment? What is the total time taken? One group was heard discussing the possibility of asking a question that required solvers to draw a histogram to show the given data. Another group posed this question: What is the percentage of students who completed their homework within 30 minutes?

During the presentation of questions posed by the groups, the teacher made comments that helped the students to focus on the clarity of their questions, for e.g. pointing to the question: “Find the mean?” she asked “Find the mean of what? She also got the students to explain how the solutions to the questions were arrived at.

In contrast to simply giving the students the stem-and-leaf graph with a set of teacher generated questions to work through, this teacher decided to engage her students in “learning by reflecting” by engaging them in the generation of questions, their solutions and explaining both the questions and solutions to their peers. The task the teacher had created for use in her lesson was based on the strategy, “What questions can you answer?” from the first module of the PD.

So, why do we claim that EPMT was a harbinger for teachers’ meaningful production of pedagogical knowledge?

In this paper we have given you a very brief idea of how teachers in the EPMT project were supported and encouraged to put into practice their learning from the two PD modules that were conducted by the university scholars. Of interest and noteworthy are the teachers’ successful attempts to put into practice the knowledge gained and also make their pedagogical knowledge available for others, in particular fellow teachers. The EPMT project may be claimed to be a harbinger for teachers’ meaningful production of pedagogical knowledge as the project is the first to support teachers to significantly contribute towards the development of fellow mathematics teachers in Singapore schools.
The carefully crafted partnership between the university scholars and classroom teachers made it possible for teachers to codify their knowledge and disseminate it fellow teachers through the publication of three print resources:


The production of the print resources were hailed by the Maths Unit of the Curriculum Planning and Development Division (CPDD) of the Ministry of Education as they supported the intended school mathematics curriculum and showcased teachers’ work in implementing it. The print resources were given to all heads of mathematics departments during their annual Mathematics Heads of Department seminars in 2009 and 2010. During the seminar time was also allotted for project teachers to brief the seminar participants on the project and introduce the contents of the books to them.

References

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