Professional Development of Mathematics Teachers: A School-Based Approach

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Abstract

This paper highlights the process and discusses some of the issues in the implementation of a 3-month long school-based professional development project. The participants were a group of secondary school mathematics teachers from a neighbourhood Singaporean school having a large group of minority students. The project aimed at improving the teachers’ pedagogical content knowledge by helping them to work collaboratively to analyse concepts, sequence and plan lessons, choose appropriate mathematical tasks, and so on. The project was led by an educator from the teacher training institution and a Ministry official, taking a course in leadership skills. All participating teachers completed the project and were appreciative of the experience.

The professional development (PD) of in-service teachers is an ongoing process which may take several forms like short courses, higher level degree courses, talks, seminars, and general or focused workshops. However, the formality associated with these forms of PD may not appeal equally to all teachers and may not be tailored to the specific needs of a teacher or groups of teachers within a particular school.

Robinson (1989) described two types of paradigms for PD of teachers: the management paradigm and the empowerment paradigm. The management paradigm is characterized by a focus on change which is viewed as a finite process and has externally specified objectives. The emphasis is on end products, on what things should be like and not on what the reality is. The locus of power or control is on outside agents such as consultants or advisers. On the other hand, the empowerment paradigm views change as an ongoing activity generated within the school by teachers and so is situation specific. There is an emphasis on choice of the teachers and any outside agent is viewed as a facilitator or a colleague. The objectives are not externally imposed and predetermined; they become the object of discussion and so there is no particular end at stake. Hence, the professional development of teachers cannot be regarded as something capable of being predetermined, fixed or settled.

A school-based approach to PD has much in common with the empowerment paradigm described above. It can attend to the specificity of the school and be more beneficial to teachers, particularly to those who are newly qualified or to those who have little experience in teaching. The empowerment paradigm places the teacher at the centre of the choice-change process. Teachers have the right to choose and make responsible decisions about their own futures (Robinson, 1989). In line with the empowerment paradigm, the school-based approach to PD is characterized by the following: (1) there is a perceived need by the teachers; (2) it is initiated by the teachers; (3) it has the support of the school management; (4) it takes place within the school premises at a time most convenient to the teachers; (5) there is no fixed and predetermined content; rather the content unfolds as the group progresses through the project; (6) it has no formal assessments; and (7) the project team is very much part of the group rather than having an outside expert role.

Methodology

This paper highlights the process and discusses some of the issues in the implementation of a 3-month long school-based PD project. The participants were a group of six secondary school mathematics teachers from a neighbourhood Singaporean school having a large group of minority students. The school administration was strongly supportive of this project.

The teachers were Amy (Head), Beth, Colin, Dave, Esther, and Fanny (pseudonyms). Except for Amy who had 24 years of teaching experience, the other teachers were mostly new to teaching as shown in Table 1. Two other lower secondary mathematics teachers and a trainee teacher on practicum also attended many of the discussion sessions. A few sessions were attended by three other more senior teachers.
Table 1: Background of the Six Participating Teachers

<table>
<thead>
<tr>
<th>Name</th>
<th>Amy</th>
<th>Beth</th>
<th>Colin</th>
<th>Dave</th>
<th>Esther</th>
<th>Fanny</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS1 Subject</td>
<td>Mathematics</td>
<td>Mathematics</td>
<td>Physical Education</td>
<td>Mathematics</td>
<td>Mathematics</td>
<td>Mathematics</td>
</tr>
<tr>
<td>CS2 Subject</td>
<td>Science</td>
<td>Chemistry</td>
<td>Lower Sec Mathematics</td>
<td>CPA</td>
<td>English Literature</td>
<td>English Language</td>
</tr>
<tr>
<td>Teaching Experience</td>
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<td>0</td>
<td>0</td>
<td>1.5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Teaching Experience in Current School</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1.5</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

The project aimed at improving the general practice of the teachers, most of whom had less than two years of teaching experience. In particular, the project focused on improving the teachers’ pedagogical content knowledge (Shulman, 1987) by helping them to work collaboratively to analyse concepts, sequence and plan lessons, choose appropriate mathematical tasks, and so on. The project was led by an educator from the teacher training institution and a Ministry official, taking a course in leadership skills. All participating teachers completed the project.

Planning Phase

During the planning phase, the project team collected some background information on the teachers as well as some information on their specific requirements as far as the professional development project was concerned. The expectations from the teachers were that they had to be prepared to work as a team and be open to discussions on topics of their interest. Also, class visits were to be arranged only if the teachers were willing to allow the team into their respective classes. In this connection, the project team worked closely with Amy, the Head of Department, and the principal of the school.

Thus, prior to the start of the project, the participating teachers were surveyed for some background information on their practice as teachers, their attitudes to mathematics, and their beliefs about the teaching and learning of mathematics. The survey revealed some concerns of the teachers regarding their students, as stated below:

- Students do not practice enough.
- The students like last minute revision.
- They do not always do their homework.
- Their work presentation is messy. They do not write final answer statements. Often there are no detailed work and no reasoning shown for the various steps.
- They do not generally like Algebra, 3D problems and Graphs.
- During assessments they cannot recall or do not know how to apply their knowledge, although they generally understand the language. They have a sort of mental block.

Concerns about students’ learning compel attention to teachers, and to what the work of teaching demands, and what teachers know and can do; accordingly no effort to improve students’ opportunities to learn mathematics can succeed without parallel attention to their teachers’ opportunities to learn (International Congress on Mathematical Instruction [ICMI], 2004). Hence, the professional development of teachers is a necessity.

The survey also showed that the teachers generally had more absolutist views about mathematics. For example, it was described as “a subject that requires intensive drill and practice”; “a skill necessary for daily life”; or “number literacy”. Raymond (1997) has concluded that traditional beliefs about the nature of mathematics have the potential to perpetuate mathematics teaching that is more traditional, even when teachers hold non-traditional beliefs about mathematics pedagogy. As most of the teachers are new to the profession, they had some difficulties dealing with the students. The teachers were also asked about the type of professional development that would suit their specific context. Based on the information collected, the project team planned the meeting sessions.
On the basis of the survey, the project team decided that the focus of the project would be on pedagogy where there will be much emphasis on the teachers learning from each other by working as a team. It was decided that initially the group would meet for 2 hours every week on Fridays after regular class hours and that the meeting frequency would be reduced after some time. The topics identified by the teachers for discussion included: geometry, trigonometry, transformation, vectors, relative velocity, permutation and combinations. It was proposed that the meeting sessions would focus on concept analysis, sequencing of topics for teaching, selecting activities, problems and tasks, assessment issues and student misconceptions. It was also agreed that besides regular discussions the teachers would prepare ahead of time individually to facilitate the work of the project team. Although the project team anticipated to focus on topics taught either only at Additional Mathematics level or only at Elementary Mathematics level and either only for Express stream students or only for Normal stream students, this was not actually done. The reason being that the teachers had questions about the teaching of topics from both Additional Mathematics and Elementary Mathematics and also about both Express and Normal stream students.

The Implementation Phase

During the first session the teachers were introduced to the project team and were asked to make suggestions about the type of sessions they would prefer and if they had newer topics for discussion other than what they had indicated in the survey. Initially, the teachers were reluctant but after a while all of them hinted that their biggest concern was pedagogy as previously found from the initial survey of the group. The sessions were set on a very friendly and informal tone which helped the teachers to open up more to the project team. During each two hour session the teachers were invited to ask questions about specific aspects of teaching mathematics in their own classes which was then followed by specific discussion on a topic that was singled out for the day. The focus in each session was on the development of concepts, tasks and activities that could be used in class. Furthermore, specific issues about assessment, presentation of work, and strategies to cope with weaker students were also discussed. The teachers were introduced to concept analysis and the sequencing of topics for teaching. Also, the teachers were advised to adopt a more relational approach to teaching and hence to justify or prove whenever it was necessary. For example, in geometry on circle properties, the teachers were advised to prove all the theorems for circle angle properties. Some of the topics were quite difficult for many of the participating teachers. In particular transformations, permutations and combinations, and vectors and relative velocity were perceived to be demanding. Some of the sharing sessions went well beyond the scheduled 2 hours. As these sessions were like sharing sessions, so there were no formal assessments for the teachers in the project.

One class observation was organized and so the project team visited the class of Esther. The class observation revealed the difficult conditions that the newly qualified teachers have to face. The biggest concern was the general behaviour of the students, who were very disruptive. Getting the students’ attention was a major issue. The teaching seemed to have a standard format with teacher explanation followed by practice exercises from a worksheet.

Post-Implementation Phase

At the end of the project, the teachers were surveyed again for an evaluation of the project. The survey form included items about their general impression of the project and suggestions for improvements that they had. The response was generally quite positive. Beth liked the analysis of a topic and looking at the bigger picture. She mentioned:

I have learned to analyse a topic from a bigger picture before my lesson preparation now. This learning journey has also provided me with many insightful methodologies in teaching a particular topic or concept that was covered during the sharing session.

Esther felt that she was more confident as a teacher by participating in the project. She liked the opportunity given to her to discuss some issues about the teaching of mathematics openly. She said that:

I find that through this learning journey, I have had my previous doubts cleared and a strengthening of concepts in the topics discussed. This has rendered me a more confident teacher.

Dave also was quite positive about what he got out his participation in the project. He felt that many of his doubts were clarified and that he felt more confident as a whole.
I am now more knowledge equipped. I know some of the things I taught may not be the best way. There are some more better ways to bring about the concept to them. I now know how to simplify some of the concepts to make the kids understand. Having them memorised the formula and do the question is not enough. The important thing is have them understand the concept and applied them.

It is interesting to note that most of the participating teachers found the sessions positive. A few issues that are worth mentioning include:

1. While the school environment was very conducive for the project, it was a concern when a few teachers were called for attending to various other school duties while the discussions were on. In particular, Amy, who was the Head of Department, had to be away quite often.

2. Although the project team tried to get familiar with the teachers and encourage them to discuss, initially it was quite difficult. The teachers viewed the two members of the project team as external authorities. At beginning they were reluctant to share ideas and participate in the discussions. It was only much later, after two or three sessions that the teachers felt more comfortable to ask questions and discuss, particularly when Amy, the Head of Department was not around.

3. Pedagogical content knowledge can be built only on the prerequisite content knowledge. In some topics the project team felt that the teachers required better content knowledge to understand the pedagogical implications for teaching that topic.

**Discussion**

Teachers are now becoming more and more accountable for what they do or do not do in their classes. Why mathematics teachers do what they do can be viewed as a function of three variables, namely, what they know and believe about: (a) mathematics, (b) teaching and learning of mathematics, and (c) their tasks as mathematics educators (Siemon, 1989). The teachers in this study seemed to have more absolutist views about mathematics although they believed in a progressive type of pedagogy in their classroom. Their beliefs about the teaching of mathematics was thus couched in an ambivalence of traditional frontal type of teaching and more progressive type in using tasks and activities to teach mathematics.

Initial teacher preparation programs have their own limitations. We cannot expect newly graduated teachers to possess all the necessary skills for teaching. Without a critical appraisal of preexisting images of teaching, knowledge acquired during pre-service teacher education may appear to be superficial and ephemeral. It is difficult to claim how much of pedagogical content knowledge can be imparted prior to actual teaching; hence most of it is learned on the job (Noddings, 1992). Learning on the job can be a tricky affair. Some newly qualified teachers benefit from the experience of their colleagues, but not all. The teaching profession has often failed to identify and document good teaching practice and this has meant that the collective wisdom of our best teachers has not been available to support other teachers interested in reshaping their own practice (Siemon, 1989). As such, the emphasis in this project was on working as a team so that the teachers benefit from each other’s experience. Others rely on their own classroom practices to gain the appropriate pedagogical knowledge. Colin was appreciative of the focus on the key concepts and of the general mood of the sessions. He strongly pointed out that:

Being just out of NIE, the learning journey helps me to prepare myself better for teaching and allows me to revisit and get some insights into the topics after being out of secondary school for such a long time. The sessions conducted were light and the discussions we had were very helpful to me.

Thus, continual professional development is essential for teachers to keep abreast of current pedagogical practices. The school-based PD of teachers can greatly benefit teachers, particularly those who have just graduated, in their classroom practice.

From a methodological point of view, the school-based PD of teachers proceeds in the following three steps. First, there is the planning phase in which the perceived need for PD is acknowledged and help sought by the teachers in a school or department within a school. During this phase the project team is identified and data collected from the participants so as to fine-tune the PD project. Also, in this phase the project team decides on various issues such as the probable content to be discussed, the frequency and time of meetings, the focus of the discussion – pedagogy or content, and so on. Second, there is the implementation phase during which the project team and the teachers work cooperatively to attain the goals of the project. Third, there is the post-implementation phase during which an evaluation of the project is carried out to get some feedback on the whole process.
There are several advantages to the use of a school-based approach to PD of teachers, as was evident in the project described above. A school-based approach to the PD of teachers is geared to the specific needs of the teachers. The teachers are familiar with the environment of the school and hence the environment is more conducive for an open discussion compared to a more formal and unfamiliar context, possibly at a university. The time for meetings is appropriately chosen by mutual consent of the teachers and the project team. Also, the school-based approach to PD is not bound by the formality of university-based courses such as tests, exams, or assignments and projects. Generally there is no prescribed syllabus; the syllabus gets framed as one goes along. Furthermore, teachers are still around if the school need them urgently. The course is run at minimal cost to the schools. There is an opportunity for the teachers to establish good rapport and working relations with the project team. Moreover, there is a focus on things possibly not learned in a formal setting. Perhaps, the most important of all is the fact that the teachers can choose what to do and so this approach to PD gives voice to teachers. The support of the school management ensures good working relations for the teachers in the school.

The school-based approach to PD cannot be the solution to all problems of teachers in schools. If the school management does not support the venture then this approach may not be very effective. The presence of an influential person such as the Head of Department in the group can render the group to be passive. This was noted in the above project when Amy was present in the group. The establishment of rapport between the teachers and the project team is a necessity, otherwise the project fails. The group size needs to be manageable, ten at the most. Larger groups may have individual teachers with a wide range of difficulties that a project team may not cope with. Also, it seems that focusing the project on only one subject; say Additional Mathematics and only one stream may be a better alternative than having a broader focus. There should be more classroom observations and discussion of classroom practice. Videotaping lessons and subsequent discussion may be a good experience for newly qualified teachers.

To conclude, teaching remains a very complex activity. It places high demands on teachers particularly on newly qualified teachers. If novice teachers and even more experienced are not properly supported by the school system then they run the risk of becoming disenchanted of teaching. The school-based PD of teachers may be an alternative that is worthwhile to explore to help teachers in need of pedagogical guidance.

References


