

# Chapter 9

## Mathematics Teachers Professional Development in Taiwan

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**Abstract** In this chapter, we present the current status of mathematics teachers' professional development in Taiwan. We first elaborate three policy directions to outline a holistic view on three types of teachers' professional development. The three policy directions are aimed to (1) encourage teachers to take *academic degree program*, especially master degree of teaching, to afford benefits for teaching; (2) provide one-shot or semester-based workshops for teachers' *lifelong learning* for them to catch up on contemporary educational issues and reforms; and (3) incorporate teachers' professional, evaluation, and growth into one system for the convenience of teachers' learning, herein the *network platform*. We summarize the three types with a framework to show the structure of professional development programs involving teachers, their facilitators and contexts. Next, to enhance mathematics teachers' motivation and professions in learning from the workshops, we give two examples of ongoing professional development program, conducted nationally, which assist mathematics teachers in designing tasks and teaching practice, while cultivating their active thinking and learning. Finally, we make a concluding remark on the three types of teachers professional programs in Taiwan.

### 9.1 Introduction

Teachers Professional Development [TPD] is a complex process but an important avenue to facilitate the quality of teachers, especially in their teaching practice. The process of TPD is commonly understood as teachers learning, teachers learning how to learn, and teachers transforming knowledge and beliefs into teaching practice for the benefit of students' growth (Avalos 2011). How to provide in-service teachers good professional development [PD] has been argued for years

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**Table 9.1** Needs of MTs for PD in academic year 2014

School Levels	Number		
	Teachers (2013)	MTs (2013)	MTs seeking PD in Math (%)
Elementary	88,784	87,306 <sup>a</sup>	18,625 (21.33 %)
Secondary (Junior High) (Senior High) (Vocational High)	93,487 (45,604) (33,634) (14,249)	17,248 <sup>b</sup>	7335 (42.53 %) (4484) (1902) (949)
Total	182,271	104,554	25,960 (24.83 %)

<sup>a</sup>This number is teachers registered with the speciality in primary education and they can teach mathematics subject

<sup>b</sup>This number is teachers registered with the speciality in mathematics

(Ball and Cohen 1999). Usually, it is viewed that TPD should be flexible and responsive to the changing needs of teachers and professionals (Darling-Hammond and McLaughlin 1995). Since quality mathematics education [QME] differs in countries, and TPD relies on the QME, therefore, the challenges and approaches to TPD differ among countries. In this chapter, we focus on TPD in Taiwan.

In the academic year 2014 in Taiwan, the needs<sup>1</sup> of mathematics teachers [MTs] for PD in the subject of mathematics was around 24.83 % (see Table 9.1) and the number is increasing. To discuss how TPD operates, we intend to introduce the status of TPD with its policy in Taiwan to provide a holistic view of types of TPD programs. Meanwhile in order to present the influential TPD programs in mathematics in Taiwan, we select two ongoing TPD programs as examples to present how local MTs learn to improve their professions.

## 9.2 Three Types of Teachers Professional Development

There is no doubt that the relationship between policy and instructional practice is close (Cohen and Ball 1990). It means that policy might influence teachers' practice and teachers' teaching might motivate to enact new policy. Regardless of the causal relationship between them both, it needs a bridge to connect them both, and professional development [PD] might be that suitable bridge. In Taiwan though teachers are not specifically regulated to participate in specific TPD in the Education Act, they were required to attend at least 18 h or 1 credit each semester for further education, or accumulated 90 h or 5 credits every 5 years, in the regulation of inservice teachers' further education since 1996. However, this regulation was appealed in 2003. Nowadays, inservice teachers' further education is more

<sup>1</sup>It is supported by the registered numbers, retrieved from the national data (see <http://inservice.nknu.edu.tw/Download/103inserviceinvestigations.pdf>).

Note: There are around 196,024 school teachers recorded in MOE in 2013.

close to the spirit of TPD which aims to enhance the quality of teachers' teaching practice without any constraints on teachers. However, the situations including personal requirement, school phenomenon/necessity, and educational reforms, push teachers to attend the activities of PD. The activities of PD built by the government can be categorized into three directions: (1) the encouragement and benefit of promotion to motivate teachers to take academic degree; (2) provision of workshops in assisting teachers to understand contemporary educational reform or latest educational issues, e.g., curriculum reform; and (3) construction of a network platform to provide opportunities for teachers to learn conveniently, e.g., the TEACHERNET (<https://teachernet.moe.edu.tw>) joining various teaching resources, assessments, learning communities, etc. Herein, we discuss three different types of TPD supported by the ideas of those three policy directions.

### ***9.2.1 Type 1: Academic Degree Program***

The first direction of TPD encouraging individual teachers pursuing for advanced academic degrees, i.e., master degree or Ph.D. degree, or applying for research program, is under the protection and support of the Teacher Act since 1995. The goal of this direction is for increasing quality education and fostering advanced study among teachers. In latest 20 years, teachers in elementary schools with master degree or PhD degree increase from 1.8 to 43.8 %<sup>2</sup>; in junior high school increase from 4.9 to 40.9 %; in public senior high school increase from 15.4 to 59.1 %; and in public vocational high school increase from 7.8 to 60 %. Though teachers with higher academic degrees increase rapidly in latest two decades, it cannot guarantee the quality education. Therefore, the second direction for improving teachers' expertise is relatively important.

### ***9.2.2 Type 2: Lifelong Learning***

In order to provide teachers opportunities to connect contemporary educational issues and reforms to their professions, the MOE authorizes academic institutes, mainly the National Academy for Educational Research [NAER], the Shi-Da Institute for Mathematics Education [SDiME] and universities in Taiwan, to hold workshops regarding to various themes for teachers to learn in different subject domains. The ideas of this direction are close to create *lifelong learning*

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<sup>2</sup>Data retrieved from [http://stats.moe.gov.tw/files/important/OVERVIEW\\_M13.XLS](http://stats.moe.gov.tw/files/important/OVERVIEW_M13.XLS) are for teachers in elementary school and junior high school, and from [http://stats.moe.gov.tw/files/important/OVERVIEW\\_H11.XLS](http://stats.moe.gov.tw/files/important/OVERVIEW_H11.XLS) are for teachers in senior high school and vocational high school.

opportunities for teachers. The workshops can be categorized into two representative groups according to its influences on teachers.

The first categorization is a so-called *learning by listening workshop*. This kind of workshop provides teachers the lectures in general subjects especially related to the latest educational reform issues. However, those lectures might be asked by the government but not necessarily connected to teachers' teaching practice. For example, in latest years, the 12-year compulsory education is one very important and pressing educational reform in Taiwan and is planned to link the connection of all school levels from 2014 to 2020. In order to promote this reform, all the teachers are required by MOE to attend at least five workshops (lectures) in total 18 h, in the themes of *Differentiated Instruction* (tsa-i-hua-chiao-shwei, 差異化教學), *Effective Instruction* (yo-siow-chiao-shwei, 有效教學), and *Multiple Assessment* (duo-yuan-sin-pin-lian, 多元性評量). Those lectures provide issues in general for teachers but rarely related to their teaching practice. Therefore, many teachers make an ironic slogan for those lectures according to the acronym of the first Chinese character of those three themes, *yo-duo-tsa* (有多差) that means *how bad it will be*.

The second categorization is a pioneer in current workshops especially for MTs to participate, named *learning by doing workshop*. This categorization of workshops provides opportunities for MTs to have active and longitudinal, usually semester-based, participation in learning. The aim of these workshops is to transfer the learning style from educators' lectures (learning by listening) to teachers' participation (learning by doing) in designing tasks and teaching practice with the guidance from educators. We later discuss two significant TPD workshops of this categorization in next section as examples.

### 9.2.3 Type 3: Network Platform

Last, since the information goes rapidly in technological era, it is considered the necessity to integrate learning opportunities for all teachers in Taiwan. Since 2009, the MOE promoted a project to integrate the opportunities of PD for teachers. This project aims to promote a collaborated professional development system TEACHERNET<sup>3</sup> for school teachers. The system provide seven different approaches to assisting in teacher professional growth, including (1) academic courses; (2) resources of digital learning; (3) paradigm; (4) teaching practice and research; (5) professional learning community; (6) professional supporting system; and (7) the system for self-planning professional growth. The former three approaches can be categorized as '*self-regulated learning*', the following three as '*professional collaboration*', and the last one is a synthesis to apply the resources of the former six approaches. Excluding the aforementioned network platform for general subjects supported by the policy, there are also network platform constructed by

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<sup>3</sup>See <http://teachernet.moe.edu.tw/MAIN/index.aspx>.

			Teachers			Facilitator	Context
			Elementary School	Junior High School	Senior (incl. Vocational) High School		
PD Program	Course (Type 1)	Academic Program (incl. degree program)	X	X	X	Educators (incl. Mathematicians, MTEs & MTE-Rs)	Universities
	Workshop (Type 2)	Semester-based workshop	X	X	X	MTEs & MTE-Rs	Schools
		One-shot workshop	X	X	X	Educators (general)	Schools; Academic Institutes
	Research Project (Types 1-3)	Participant	X	X	X	Project Investigators	Schools; Universities
		Independent (anti-network)	X	X	X	Teachers	Mobility

Fig. 9.1 The structure of mathematics TPD in Taiwan

teachers or researchers voluntarily. For example, there is one specific network platform (<http://tame.tw/forum.php>) for mathematics education. This platform provides all latest mathematics education information in the world and is constructed by a volunteer mathematics educator for decades. This platform is nowadays cooperated with the Taiwan Association for Mathematics Education.

Borko (2004) synthesized the four key elements of making up any professional development system: (1) the professional development *program*; (2) the *teachers*, who are the learners in the system; (3) the *facilitator*, who guides teachers as they construct new knowledge and practices; and (4) the *context* in which the professional development occurs. We structure the mathematics TPD in Taiwan in the following summarized figure (see Fig. 9.1) based on her four elements.

### 9.3 Examples of Teachers’ Active Engagement

TPD Workshops in Taiwan are usually organized by the government as *one-shot* workshops and in a style of *learning by listening*. Not all teachers in school are interested in attending such kind of workshop. Therefore, there are so-called ‘professional workshop teachers’ assigned by schools to attend such one-shot workshops with very limited efficiency in teaching. How to motivate teachers to participate continually in TPD programs is relatively important and challenging. In this section, we introduce two TPD programs in mathematics, conducted in latest years in Taiwan, which are the style of *learning by doing* in a *semester-based* period, with a lifelong learning spirit in developing teachers’ professions by motivating their active participation. Lighten-Up School-Based Program [LUSBP] and Just Do Math (JDM) Project are two prominent and ongoing PD programs for MTs. Both of these two programs are national; however, focus mainly on teachers in the levels of elementary school and junior high school, that is, from grades 1 to 9.

### 9.3.1 *The Lighten-up School-Based Program*

The first program is the LUSBP which is a school-based TPD and it provides seven innovative teaching themes in mathematics: *mathematical conjecturing and argumentation, diagnostic teaching, mathematical literacy and assessment, mathematical modeling, ICT, inquiry-based teaching, and reading comprehension*, for schools to choose in each semester since the academic year 2011<sup>4</sup> (see chapter by Lin, Hsu, and Chen in this book for details). The members of the program composed of the MTs, mathematics teacher educators [MTEs], and mathematics teacher educator-researchers [MTE-Rs]. One specific feature of this TPD program is that all the attendants are learners (Lee et al. in review), not only the MTs are learners but also the MTEs and MTE-Rs are learners, though this condition is not emphasized in the program. Here, we present why this program can work successfully in Taiwan by focusing on the attendant MTs' reflections and MTE-Rs' support to the MTs with some excerpts as examples. What this program can provide to teachers and how they feel about this program are included.

In attending this program, the attendant MTs gradually understand the essence of the theme they choose and can try to reflect from the connection between their teaching practice and students' learning. They also show their passions in learning and teaching.

...via these four times workshop, I gradually feel the importance of the process of analyzing and discussing students' misconceptions and learning difficulties. To solidify the foundation of students' mathematical concepts is far more important than to hurry to finish the curriculum content...the purpose of assessment is to help us to adjust and reflect on our teaching... (one MT from the theme group *diagnostic teaching*)

(after guiding students explaining their solutions on one geometric problem)...I was impressed with students' solutions and started to believe in their capability that is out of my imagination...I can feel my students' confidence and accomplishment in doing mathematics. I think I am doing the right thing...I also started to appreciate students thinking. (one MT from the the group *diagnostic teaching*)

Moreover, though there are challenges the MTE-Rs meet in the workshop, they try to solve them in the process of TPD workshop. For example, one MTE-R elaborates what problem he met and how he solved it in his theme group:

After the interaction with teachers and the questionnaire survey, they started to relax a bit from the defensive attitude, and I started to guide them to share...I emphasized it (the workshop) is not instruction, but a process of learning from each other. Theory was less mentioned here (in the workshop). (one MTE-R from the theme of *reading comprehension*)

With more than 3 years experiences of LUSBP TPD workshop for MTs and its extended Light-Up workshop for MTEs and MTE-Rs in Taiwan, it may well conclude that within such TPD workshop all the participants: students, MTs, MTEs,

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<sup>4</sup>The pilot TPD workshop started in the academic year 2011 before the official program conducted from 2012.

and MTE-Rs, are positioned as learners in several learning communities. This stand supports the policy to motivate teachers' lifelong learning. However, meanwhile it is found that there are tensions faced by MTEs and MTE-Rs, for example, (1) the different identities of in-service MTs, (2) elaborations of theories and principles to MTs, (3) MTs' vulnerability in learning processes, and (4) the weak school support. Moreover, the participant MTs also faces the tensions of designing tasks, tensions on teaching, and tensions on students' learning when they participated in this TPD workshop (Lin 2013).

### 9.3.2 *The Just Do Math Project*

There are challenges in mathematics education in Taiwan. Though students outperformed in the large-scale international assessments on mathematics, i.e., PISA and TIMSS, the allocation of high-achieving group and low-achieving group shows a polarization which unveils a serious local mathematics education problem, that is, students' passive learning attitudes and the deficit learning activities of school mathematics (Lin 2015). In order to deal with the challenges of students' passive learning attitudes and the deficit learning activities in school mathematics in Taiwan, the SDiME plans and launches a project to increase students interests and attainments in learning mathematics, called the Just Do Math (JDM) Project. To achieve the aim of this project, it is necessary to cultivate teachers. Therefore, the workshops for teachers are under preparation. The JDM TPD workshop, planned by SDiME and supported by MOE, concentrates on coaching MTEs to design activities and MTs to apply designed activity module to students mathematics learning, in the levels of elementary school and junior high school since 2014.<sup>5</sup>

In this program, the participants are MTs and MTEs. In order to deliver the activity module, MTs have to be certificated as *activity spreader teachers* after a serial coaching workshops. Those activity spreader teachers can choose either Summer/Winter Math Camp or Weekend Math Camp to run those learning activities in schools. Before conduct the project, teachers need deep involvement of designing their specific curriculum and interact actively with the module to make sure the activities can run smoothly. It is expected that there will be at least 2 activity spreader teachers in each school in 1 year. In Taiwan there are around 3500 elementary and junior high schools, therefore, 7000 activity spreader teachers are supposed to be generated in delivering activity module every year. With this expectation that these spreader teachers can coach a new set of spreader teachers in schools, it might ultimately reach the number of 20,000–30,000 in two years.

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<sup>5</sup>The JDM program has started its pilot workshop since the academic year 2014. There have been 622 MTs certificated as activity spreader teachers and finished their missions in delivering the activity module to students in this year.

With regard to the roles of MTEs in this program, they have to be instructed by the MTE-R, the director of the SDiME and also the first author of this article, to design the mathematics activities for students who have low attitudes and competencies in learning (see exemplary activities in [http://mec.math.ntnu.edu.tw/?page\\_id=551](http://mec.math.ntnu.edu.tw/?page_id=551)) and host the workshops for candidate activity spreader teachers to coach them to understand the essence of those activities. Since the JDM aims to equalize students' learning inequality, and provides supports to teachers by the means of cultivating inservice teachers in utilizing designed mathematics activity module to develop students' fundamental mathematical concepts, this program is thought to be a workable way to reform the recent status.

With the pilot experience of the JDM TPD workshop, there are several constructive suggestions in designing learning activities based on the interaction between the MTs, MTEs, and the MTE-R. To better design activity module, the solid ideas kept by the designers are necessary, those are:

- Structuralist approach to designing mathematical concepts in embodied tasks
- The connection between iconic/symbolic representation and manupulation
- Starting from students' misconception with a neo diagnostic conjecturing approach
- Familiarity with students' thinking patterns.

## 9.4 Concluding Remark

The first type of TPD program in Taiwan functions well with the evidence of increasing percentage of teachers having higher academic degrees as the aforementioned trend. However, such demand for the first type TPD is going to be stuck or decreasing in the societal situation. Instead, the needs for enhancing teachers' professions are increasing. Therefore, the second type of TPD program becomes relatively important.

The two exemplary workshops, LUSBP and JDM, provide MTs opportunities to transfer from learning by listening (one-shot workshop) to learning by doing (semester-based workshop). Studying the two TPD workshops, it is found that participant MTs become more active and creative in learning and thinking according to their revised designs in different versions during the workshops and increase their interactions with students in their teaching practices. The communication and interaction between MTs, MTEs, and MTE-Rs in one learning community are becoming more positive as well. However, a fixation on improving students' learning achievement by injecting more tasks still disturbs MTs. Such belief is not easy to ease in participating TPD workshops. Nevertheless, those MTs come to TPD workshop for improving their students' learning and their teaching practice is undoubted. The experiences of semester-based workshops might provide a good model for those one-shot workshops to follow.

Last, though the third type TPD program in Taiwan is in the period of developing, we believe that once the interactions within and between teachers and educators act reciprocally and immediately, the network platforms can work efficiently.

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