

Chapter 18

Post-service Education of Mathematical Teachers

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Abstract The post-service education of mathematics teachers in China addresses three levels, novice, common, and backbone teachers. The education of a novice teacher is overseen by a tutor who is a member of the mathematics team in the teacher's school. The education of common teachers has two main categories; one is regular teaching and research activities (public lectures, discussion lectures on different ways of teaching certain content, teaching philosophy contests, problem-solving contests, etc.) that are held by schools or teaching and research groups at city or county level. The other category is online in-service training that is organized and implemented by municipal governments' trusted training institutions. The training of backbone teachers is divided into city and national levels. It usually consists of short-term, focused training projects combined with subsequent follow-up seminars. The main focus of training is the implementation of new basic education courses, as well as to meet personalized needs relating to teachers' professional development, and to guide teachers in their professional growth. The training content can be divided into six categories, development of teachers' professional ethics, revision and expansion of knowledge, mathematics education theory and its applications, research methods in mathematical education, modern education skills, and discussions about teaching practice problems. The administration and assessment processes are concerned mainly with the state's construction of information and administrative systems for national teacher training, the establishment and monitoring of training quality standards, and the regular implementation of training quality assessment.

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The post-service education of mathematics teachers in China addresses three levels, novice, common, and backbone teachers. The following sections will describe each of these according to training objectives, training methods, and training content.

18.1 Training for Novice Teachers

Novice teachers are those who have been in service for one to two years. Most of them have graduated from normal (teacher education) universities or colleges, and only a few from non-normal universities. In the case of certain senior middle schools, teachers are hired for their high academic achievements even if they have not received specific education training.

18.1.1 Training Objective

The training objectives for novice teachers include to explicate professional ethics code for teachers, to become familiar with a school's administrative regulations for teaching, teachers in charge, and teachers, as well as to become familiar with the content and requirements of mathematics teaching, master basic mathematics teaching methods, and become familiar with daily administrative tasks for teachers in charge.

18.1.2 Training Method

18.1.2.1 Collective System

Usually organized by the school which engages them, training for all novice teachers in all subjects is carried out under the supervision of the principal, vice-principal, dean, and grade leaders, mainly by means of thematic reporting, consultations about studies, and sharing with outstanding peers.

18.1.2.2 Tutorial System

Generally, the school will assign every novice teacher to a senior teacher who has been teaching for more than ten years and is experienced as a tutor. New teachers observe their tutors' classes and consult with them, and the tutors observe the new teachers' classes to give feedback and guidance. This tutorial system, under which the experienced are leading the inexperienced, has greatly advanced the development of novice teachers' professional skills.

18.1.2.3 Post-system

Unless it is necessary for a particular school or teacher to have a high ability level, novice teachers are generally not required to undertake the tasks of a teacher in charge of a class. However, as long as the new teacher's performance is reasonably satisfactory, he/she will be assigned some tasks of a teacher in charge from the second or third year. The purpose of this process is to familiarize the novice teacher with daily administrative tasks and gradually develop class administration skills.

18.1.3 Content of Training

The training content for novice teachers includes professional ethics; education laws and regulations; teaching administrative requirements of the school; administrative regulations for teachers in charge; administration rules and regulations for teachers; establishing and understanding standards for teaching courses; outlines of entrance examinations; content and requirements of collective preparation; skills for teaching mathematics; and daily administrative tasks for teachers in charge.

18.2 Training for Common Teachers

Common teachers are those who have been in service for more than two years, and the training is led by clusters of schools or teaching and research groups at city or county level, or municipal governments' trusted training institutions.

18.2.1 Training Objectives

The objectives of common teacher training are focused on general enhancement of their abilities to teach mathematics and reviews of their teaching skills. The professional development aims at developing teachers' understanding of newly added content, mastery of corresponding teaching strategies, familiarity with challenges and obstacles to students' learning of this content, and strategies for expanding and optimizing mathematics teachers' professional knowledge structures.

Professional development at this level is also aimed at defining the standards of mathematics teaching design, attending and evaluating demonstration classes, discussing mathematics teaching problems, rethinking their own class teaching, and learning from the experiences of outstanding mathematics teachers and outstanding teachers in charge.

18.2.2 Training Methods

18.2.2.1 School-Based Training

School-based training refers to training that is organized and implemented by the school, including novice teachers' public lectures, internal and external outstanding teachers' public lectures, and the introduction of internal and external outstanding in-charge teachers' experiences.

18.2.2.2 Region-Based Training

Region-based training is organized and implemented by regional teaching and research groups or educational institutions. The formats are usually demonstration lessons that are attended by related schools in the local region, discussion forums about different approaches to teaching certain topics, teaching philosophy contests, and problem-solving contests.

18.2.2.3 Distance Training

Distance training refers to online in-service training that is organized and implemented by municipal governments' trusted training institutions. For example, the South China Normal University Cyber Institute (www.gdou.com) undertakes distance training for junior middle school mathematics teachers in some regions; in-service training for Guangdong senior middle school mathematics teachers is offered through www.teacher.com.cn and www.teacheredu.cn.

18.2.3 Training Content

Here, only the content of region-based training and distance training is introduced.

18.2.3.1 Content of Region-Based Training

1. Demonstration lessons

Demonstration lessons are given by outstanding backbone teachers or senior teachers who are selected in local regions. After a lesson, the demonstration teacher describes the lesson design and reflects on the strengths and weaknesses; the observers describe what they have learned from the demonstration and critique the teaching. This model of demonstration lessons for clusters of mathematics teachers in a region is effective in enhancing the teachers' professional growth.

2. Discussions about different approaches to teaching particular content

In this approach, the same topic is taught in different classes by different teachers, after which they meet to review and discuss their experiences. Because of the differences in demonstrators' abilities, years of teaching experience, teaching standards and teaching designs, the teaching processes, and teaching effects will differ a great deal, thus providing teaching cases for different effects, styles, and value standards to the observers of these activities, which will improve their reflections on teaching.

3. Teaching philosophy contests

In teaching philosophy contests, 10–20 min lectures are given to expound the design of a lesson or a unit of work, based on theories of education and teaching, and making use of multimedia. The audience is a group of peers, administrators, or teaching and research professionals, and the topics can include lesson objectives and planning, discussion of difficult or key points, and the assessment of teaching effects and quality (He & Yao, 2012).

Other content of teaching philosophy contests includes the analysis of teaching materials (status, vertical and horizontal connections, functions), the analysis of students' cognitive development and learning difficulties, the designing of teaching objectives (knowledge and skill, process and method, affective factors), the selection of appropriate teaching methods, and examples of teaching processes.

The participating competitors are selected by their schools, and the experts in the audience give feedback and select winners.

4. Problem-solving contests

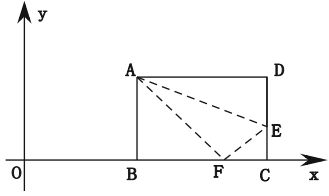
Problem-solving contests involve teachers discussing how to solve a mathematical problem and the teaching strategies for doing so, based on theories of mathematics education. Again, the audience consists of peers, experts, teaching, and research professionals.

The content of problem-solving competitions mostly includes analysis of the problem context, analysis of the thinking involved in solving the problem, and the problem's value as a teaching tool.

Again the audience of experts gives feedback and selects the best presentations.

As problem-solving contests have favorable effects, some normal colleges and universities have also launched this kind of contest. One such contest was conducted for Guangdong Normal School students majoring in mathematics in the South China Normal University Cyber Institute in August 2013. The problems selected are described in Fig. 18.1.

Problem 1. As shown in the diagram, the edge BC of the rectangle $ABCD$ is on the x -axis of the rectangular coordinate system. Fold the edge AD , so that the point D joins with the point F on the x -axis. The crease is AE , and it is known that $AB = 8$, and $AD = 10$. Set the coordinates of point B as $(m, 0)$, $m > 0$.



(i) Figure out the coordinates of the points E and F (to be expressed in a formula that involves m);

(ii) Connect OA . If $\triangle OAF$ is an isosceles triangle, try to figure out the value of m .

Problem 2. Try to prove the basic theorem of the plane vector.

Problem 3. An express company has n ($n \geq 2$) delivery sites on a straight path, and it needs to build a goods distribution site on this straight path. Please figure out where the distribution site should be built to obtain a minimum sum of the distances from it to each delivery site.

Fig. 18.1 Sample problems

18.2.3.2 Remote Training Content

The remote training curriculum for the South China Normal University Cyber Institute's Network Institute for Mathematics Teachers of Junior Middle Schools is shown in Table 18.1.

The 2014 remote training curriculum for high school mathematics teachers in Guangdong Province is described below and summarized in Table 18.2.

The first subject is the professional qualities of mathematics teachers, followed by dissemination of research into teaching methods, then a series of commentaries on mathematics teaching. Each of these subjects is presented as a brief introductory text, specialist lecture videos, text case descriptions and comments on the cases on videos and in readings, readings about mathematical thinking and activities, reference materials, and readings on homework design.

The training time is 2–4 weeks with 60 h of class time, combining the remote training with school-based educational research. The participants are required to select at least one module from each of subjects one, two, and three, and 10 modules should be selected in total.

The curriculum specialist team implements the program. The chief specialist (author of this chapter) allocates the responsibilities to team members as follows:

Table 18.1 The remote training curriculum for the Mathematics Teachers of Junior Middle Schools

Training module	Training subject (45 min for each subject)
Hot issues for research and study	Basic ideas and strategies for implementing the <i>Mathematics Curriculum Standard for Full-time Compulsory Education</i>
	“Numbers and Algebra” and “Geometry and Graphics” content analysis
	“Statistics and Probability” and “Synthesis and Practice” content analysis
	Basic qualities and professional standards of junior middle school and middle school mathematics teachers
	An educational war on mathematics
	The future of mathematics education
	Misunderstandings in mathematics education research
	Mathematical education research case studies
	New ideas for mathematics teaching design
	Setting mathematics objectives
	The essence of learning mathematical concepts
	The essence of learning mathematical principle
	Teaching mathematical problem solving
Professional qualities	Topics on mathematical competence (I)
	Topics on mathematical competence (II)
	Exploration of numbers
	Depiction of graphics
	Solving equations
	Angle trisection
	Discussing probability problems
Non-euclidean geometry	
Number and algebra	Main knowledge, methods, and ideas of numbers and algebra
	Teaching and learning algebraic expressions in the middle school
	Teaching and learning equations and inequalities in the middle school
	Teaching and learning functions in the middle school
	“Number and Algebra” Features of questions and analysis of questions in the senior high school entrance examination
	“Number and Algebra” teaching materials and class case analysis (first)
	“Number and Algebra” teaching materials and class case analysis (second)
	“Number and Algebra” teaching materials and class case analysis (third)
“Number and Algebra” teaching materials and class case analysis (fourth)	

(continued)

Table 18.1 (continued)

Training module	Training subject (45 min for each subject)
Graphics and geometry	How to understand “intuitive geometry” in middle school mathematics
	How to understand the “geometric transformation” in middle school mathematics
	How to understand the “coordinate geometry” in middle school mathematics
	How to understand the “reasoning and argumentation” in middle school mathematics
	“Geometry and graphics” Features of questions and analysis of questions in the senior high school entrance examination
	“Geometry and graphics” teaching materials and class case analysis (I)
	“Geometry and graphics” teaching materials and class cases analysis (II)
	“Geometry and graphics” teaching materials and class case analysis (III)
	“Geometry and graphics” teaching materials and class cases analysis (IV)
Statistics and probability	Understanding data analysis concepts
	How to teach statistics
	Understanding the relationship between statistics and probability
	Understanding probability theory and its implementation
	“Statistics and Probability” Features of questions and analysis of questions in the senior high school entrance examination
	“Statistics and Probability” teaching materials and class case analysis (I)
	“Statistics and Probability” teaching materials and class case analysis (II)
	“Statistics and Probability” teaching materials and class case analysis (III)
	“Statistics and Probability” teaching materials and class case analysis (IV)
Synthesis and practice	Reasons for setting up synthesis and practice
	Basis of setting up synthesis and practice
	Cases of synthesis and practice classes

1. Developing the training curriculum

Developing the content of the training curriculum includes demands analysis, scheme formulation, curriculum design, making videos, text materials, reference materials, homework design, and marking criteria.

Table 18.2 The 2014 remote training curriculum for high school mathematics teachers in Guangdong Province

	Category	Curriculum name	Source of curriculum
1	Subject III	Linear inequalities in two variables and planar domain (course video and comments) (1)	Guangdong curriculum
2	Subject III	Linear inequalities in two variables and planar domain (course video and comments) (2)	GC
3	Subject III	Linear inequalities in two variables and planar domain (course video and comments) (3)	GC
4	Subject III	Cases and reflection in teaching the same mathematical subject by different teachers	GC
5	Subject III	The world of mathematical modeling	GC
6	Subject III	New design of mathematical induction teaching	GC
7	Subject I	High school teaching research	Continuing education website
8	Subject I	High school mathematics test question setting: theories and techniques	CEW
9	Subject II	High school mathematics module teaching research	CEW
10	Subject II	High school mathematics “Set and Logic” teaching research	CEW
11	Subject II	High school mathematics “Concepts and Properties of Functions” teaching research	CEW
12	Subject II	High school mathematics “Derivative and its Applications” teaching research	CEW
13	Subject II	High school mathematics “Transformation of Triangle Functions and Solving Triangles” teaching research	CEW
14	Subject II	High school mathematics Plane Vectors teaching research	CEW
15	Subject II	High school mathematics “Spatial Vectors and Solid Geometry” teaching research	CEW
16	Subject II	High school mathematics “Counting Principles” teaching research	CEW
17	Subject II	High school mathematics “Probability” teaching research	CEW
18	Subject II	High school mathematics “Statistics” teaching research	CEW
19	Subject II	High school mathematics “Algorithms and Block Diagram” teaching research	CEW
20	Subject II	High school mathematics “Applications of Functions” teaching research	CEW
21	Subject II	High school mathematics “Conic Section” teaching research	CEW

(continued)

Table 18.2 (continued)

	Category	Curriculum name	Source of curriculum
22	Subject II	High school mathematics “Preliminary Analytic Geometry” teaching research	CEW
23	Subject II	High school mathematics “Preliminary Solid Geometry” teaching research	CEW
24	Subject II	High school compulsory mathematics 1 Module introduction	CEW
25	Subject II	High school compulsory mathematics 1 “Function Monotonicity” teaching research	CEW
26	Subject II	High school compulsory mathematics 1 “Logarithm Operations” teaching research	CEW
27	Subject II	High school compulsory mathematics 1 “Applications of Functions” teaching research	CEW
28	Subject II	High school compulsory mathematics 1 High-end lesson preparation	CEW
29	Subject II	High school compulsory mathematics 2 Module introduction	CEW
30	Subject II	High school compulsory mathematics 2 “Preliminary Solid Geometry introductory course” teaching research	CEW
31	Subject II	High school compulsory mathematics 2 “Parallel and Vertical” teaching research	CEW
32	Subject II	High school compulsory mathematics 2 “Plane Analytic Geometry review lesson” teaching research	CEW
33	Subject II	High school compulsory mathematics 2 High-end lesson preparation	CEW
34	Subject II	High school mathematics 1 Module introduction	Teachers’ website
35	Subject II	High school mathematics “Function Monotonicity” teaching discussion	TW
36	Subject II	High school mathematics “Logarithm Operations” teaching discussion	TW
37	Subject II	High school mathematics “Applications of Functions” teaching discussion	TW
38	Subject II	High school mathematics 1 High-end lesson preparation	TW
39	Subject II	High school mathematics 2 Module overall introduction	TW
40	Subject II	High school mathematics “Preliminary Solid Geometry” teaching discussion	TW
41	Subject II	High school mathematics “Parallel and Vertical” teaching discussion	TW

(continued)

Table 18.2 (continued)

	Category	Curriculum name	Source of curriculum
42	Subject II	High school mathematics “Plane Analytic Geometry” teaching discussion	TW
43	Subject II	High school mathematics 2 High-end lesson preparation	TW
44	Subject II	High school mathematics III Module overall introduction	TW
45	Subject II	High school mathematics “Emphasis and Functions of Algorithm Lessons” teaching discussion	TW
46	Subject II	High school mathematics “How to Have a Good Activity Lesson” teaching discussion	TW
47	Subject II	High school mathematics “Probability” teaching discussion	TW
48	Subject II	High school mathematics III High-end lesson preparation	TW
49	Subject II	High school mathematics IV Module overall introduction	TW
50	Subject II	High school mathematics “Functions of Unit Circle in Trigonometric Function Study” teaching discussion	TW
51	Subject II	High school mathematics “ $y = A \sin(\omega x + \varphi) + b$ ” teaching discussion	TW
52	Subject II	High school mathematics “Improve Operational Capability” teaching discussion	TW
53	Subject II	High school mathematics IV high-end lesson preparation	TW

2. Guiding the training process

- These duties include sampling and commenting on the homework of the trainees and the expanded resources recommended by the coaching teachers. The number of pieces sampled each day for each subject should not be less than six on average.
- Interactive online Q&A
This involves organizing at least one online Q&A discussion per week during the whole training period, collecting the Q&A achievements once a week to make a Q&A Summary and publishing it in the Subject Announcement column.

3. During the training period, the specialist team members need to take it in turn to be on duty, in groups of no less than three. They need to assist trainees with problems and answer their questions when they experience difficulties. The

platform has a Specialist Homepage for each specialist participating in the training. Each specialist is required to enrich his/her own homepage so as to provide convenient learning modes and resources for the trainees. The content to be added includes expanded learning resources that the specialists consider worth recommending; specialist subject posts; samples and comments on the trainees' homework and expanded resources; and recommendations for school-based activity achievements that the trainees have evaluated as excellent.

4. Composing the subject briefing

One- or two-person teams are formed to compose subject briefings. After being checked and confirmed by the specialist group leader, these are uploaded to the platform homepage.

5. Summarizing the training

After the training, the chief specialist needs to write a summary report. The content should include a basic evaluation of the curriculum training, the experiences and achievements occurring in the training process, problems arising, and some suggestions for carrying out the next training.

18.2.3.3 Assessment Scheme

1. Purpose and principles of the assessment

The purpose is to guide the trainees to participate in the study and to communicate actively. The assessment process is intended to guarantee the training quality and effectiveness and to conduct an overall, systematic evaluation of the training. The evaluation focuses separately on the remote study (accounting for 80%) and the school-based training (20%). The minimum score to pass the course is 60%, and no makeup examinations are provided. The evaluation scoring is done according to the following formula, which is the sum of:

- the score for the objective questions (30%);
- the score for the subjective questions (30%);
- participation in the online mentoring (10%);
- posting and replying (5%);
- commenting on the subject and the brief reports (5%);
- score for School-based Activity Achievements (20%).

2. Assessment criteria for the remote study component

The assessment is composed of four parts: project work, participation in online discussion, posting and replying as well as contributing brief reports and School-based Activity Achievements project work. This training applies the "5 + 1" elective system, which means trainees must randomly pick five curriculum

modules in the subject curricula (of which there must be at least one from the special topic III) and one general education compulsory module.

The assessment requirements of the project work are carried out as follows:

- Each set of objective questions is worth a total score of 100, and the scores are calculated automatically by the system. The final score of objective questions is equivalent to 30% of the total score.
- Trainees must and can only submit one subjective item marked by tutors.
- Participation in online discussion: Every trainee must take part in the online Q&A discussion organized by the experts. They get 1 point for every follow-up discussion, 3 points if their post is set as a sticky post by the experts, and no points if their discussion has no practical meaning and is deleted.
- Posting and replying as well as contributing brief reports: Trainees are required to participate actively in their class forum discussions and communications, and to read and comment on brief subject reports. Points are awarded as follows:
 - 0.5 point for every post and 2 points for every sticky post (sticky post should be recommended by tutors);
 - 1 point for every reply to another trainee’s post or comment on a brief report;
 - No points if the post has no practical meaning and gets deleted;
- School-based Activity Achievements: Trainees are expected to take part actively in the school-based activities which are based on this project, and the class president needs to submit a complete list of attendance at the school-based activities. The counting rules are:
 - Trainees must and can only submit one School-based Activity Achievement.
 - Trainees must read and appraise at least three students’ School-based Activity Achievements; for these, they will receive three review scores.
 - If one is judged by three students to have cheated, he/she gets no points.
- Criteria for excellent trainees
 - Excellent trainees need to show that they have studied for no less than 3 h every day, as evidenced by the online course learning records showing no less than 900 min. As well, they are expected to participate actively in online discussion.
 - The assessment scores must all be over 85, and all examinations must show even scores, with no zeros recorded.
 - Contributions such as resources have been selected for uploading as brief reports.
 - The students take part actively in the school-based activities that are based on high school teachers post-training projects; the original School-based Activity Achievements are recommended.

18.3 Training of Backbone Teachers

The backbone teachers include those chosen to be specially trained (divided into provincial-level and national-level) from the common and the professional teachers (the future trainers). In order to learn more comprehensively and deeply about China's backbone teacher training, we will first introduce the national-level ideology, policies, and measures, and then give details about the training of the national-level backbone teachers and trainers.

18.3.1 State Policies for Teachers' Professional Training

In order to adapt to the economy's high-speed development, at the beginning of the twenty-first century, a big reform was introduced to China's basic education. In July, 2001, the Chinese Ministry of Education released the *Mathematics Curriculum Standards (Experiment Draft) for the Full-Time Compulsory Education Stage* and, in April, 2003, and launched the *Mathematics Curriculum Standards (Experiment) for Regular High Schools*. The success of this reform depends mainly on the quality of mathematics teacher teams. For this purpose, in September, 2004, the Chinese Ministry of Education launched the new set of *2003–2007 Plan for Training All Workers and Staff for Primary and Middle School Teachers*. This plan established the policy of “everyone is included; the backbones are highlighted; attention is given to rural areas,” and focused on “new ideas, new courses, new technologies” as well as promoting the development of teachers' ethics, implementation of a new training program for all primary and middle school teachers, improving teachers' ethical levels and business qualities, and guaranteeing human resources to promote quality education and the reform and development of rural education.

In August, 2008, China started to prepare and, on July 29, 2010, the *State Medium and Long-Term Educational Reform and Development Planning Outline (2010–2020)* was launched. The major content included 10 aspects: promoting selected units for experiments in quality education, balanced development of compulsory education, vocational education, selecting units for experiments in the construction of lifelong education mechanisms, selecting units for experiments in developing top innovative talents, the entrance examination system, the modern university system, in-depth schooling mechanisms, regional education input safeguard mechanisms, and the provincial government's education integration.

After that, the Ministry of Education and Ministry of Finance implemented *The National-level Training Plan for Primary and Middle School Teachers* (in short *The National Training Plan*), starting from 2010. It mainly includes primary and

middle school backbone teacher training and distance training, training for class advisers, training for primary and middle school subjects that were in short supply or suffering from weaknesses, and other pilot demonstration projects. Based on this document, backbone teachers can be trained, demonstrations can be made, and a set of excellent training courses and teaching resources can be developed and provided, offering powerful support, to teacher professional development. The process included establishing the management of the national teacher training information system, designing the project, making provisions to bid for projects, establishing training standards, building expert databases and a resource library, and developing assessment processes. The outcomes were standardized management and improved quality. By the end of 2013, the national training plan had trained 3500 thousand backbone teachers, of whom 3350 thousand were rural teachers, which accounted for 96% of the total number.

In the two files *Opinions of the Ministry of Education about Enhancing Primary and Middle School Teacher Training (Teacher [2011] No. 1)* and *Opinions of the Ministry of Education's National Development and Reform Commission's Financial Department about Strengthening the Educational Reform (Teacher [2012] No. 13)* launched by the Ministry of Education, the basic ideology and overall mission of the teacher training are specified, and the general requirements are proposed.

In 2012, the Ministry of Education released the *Kindergarten Teachers' Professional Standards, Primary School Teachers' Professional Standards and Middle School Teachers' Professional Standards*, which outline the standards that backbone teachers' training must comply with.

In another document, the *Guidelines and Opinions of the Ministry of Education about Deepening Primary and Middle School Teacher Training and Improving Training Quality (Teacher [2013] No. 6)*, the following are specifically required:

- First, carry out training in accordance with needs; this includes the process of training planning, project design, organization implementation, and quality monitoring.
- Second, enhance practical training, which should take up no less than 50% of teacher training courses; first-class teachers should account for no less than 50% of the trainers' team.
- Third, motivate teachers to take part in the training. By promoting the teachers' selections of topics and training credit management system, teachers can be encouraged and motivated to take part in the program.
- Fourth, utilize information technology, build teachers' online research and study communication, promote school-based research and innovative training modes; use informalization management platforms to enhance the management and supervision of the training process.

18.3.2 National-Level Backbone Teachers' Training

This section illustrates the national-level backbone teachers' training with the example of the National Training Plan (2011) developed by the South China Normal University.

18.3.2.1 Guidance

The national-level backbone teachers' training program aims to encourage high schools to experiment with ideas pertaining to the mathematics curriculum reform and based on modern theories of mathematics education. The aims included the application of new training modes that are targeted, practical and feasible; improve the professional levels of backbone mathematics teachers, along with their teaching ability and the capacity to guide young teachers, and the training of excellent backbone high school mathematics teachers who are ethical, modern in their educational outlooks, and have innovative spirits for the nation.

18.3.2.2 Target of Training

There are several targets that need to be taken into account:

1. Insist on the correct political direction; love the teaching career; establish modern education ideas; establish scientific views about teachers, teaching, quality, and talents; be ethical teachers and uphold vocational ideals.
2. Understand the new curriculum and new textbooks of high school mathematics thoroughly, learn new knowledge, theories, and methods of mathematical education, and expand and optimize the backbone mathematical teachers' professional knowledge structures, so as to promote their professional development.
3. Develop the ability to apply new theories, methods, and measures to the teaching practice, gradually form the distinct teaching style or specialty, and have a strong educational reform consciousness and innovation ability.
4. Through educational scientific research practice, cultivate scientific research ability to undertake important teaching and research and educational reform tasks independently; be able to put forward some significant research topics and practice schemes according to the requirements of the mathematics education reform; and develop the ability to organize, guide, and carry out scientific research and educational reform.
5. Understand the concepts of innovation and reform; be able to play an exemplary role in the field of middle school mathematics teaching, and develop into an educational expert and academic leader of middle school mathematics, step by step.

18.3.2.3 Training Objectives and Methods

The training focuses on excellent senior high school backbone mathematics teachers from across China. The training includes three stages and lasts for about one year. The first stage is mass learning, and this lasts for 15 days; the second stage is post-practice and action study, which lasts for 11 months; and the third stage is achievement exhibition and training summary. The training methods include:

1. Specialist lectures, group communication, collaborative discussions, case teaching, on-the-spot teaching, and problem solving;
2. Emphasis on communication and interaction between the specialists and trainees and among the trainees, to achieve the goals of emotion touching, thought provoking, question generating, and consensus reaching;
3. Linking of specific and general aspects, with deep analysis of specific problems;
4. Working in groups with mathematics education specialists from the School of Mathematical Science of South China Normal University as a community of learning.

18.3.2.4 Training Curriculum (He, 2005)

Module 1: General training

The Basic Education Training and Research Institute of the South China Normal University Cyber Institute is responsible for this module, including comparisons of Chinese and foreign basic education reforms, the professional intelligence of teachers, professional ethics and affective factors for teachers, teaching problems and their solutions, and action research studies.

Module 2: Professional training

Professional training design is based mainly on the following four principles:

1. Learn the new concepts, knowledge, and skills underpinning the senior high school mathematics course reform, and update the educational knowledge and structure.
2. Master the concepts, goals, structure, content, and teaching requirements for implementing the new senior high school mathematics course, and address teachers' problems and questions.
3. Master professional educational scientific research, conduct research in the real context of mathematics teaching, and improve the educational scientific research level.
4. Exchange experiences of education and teaching, improve the level of interaction and cooperation among teachers, promote trainees' teaching reflections, and enhance the professional level of backbone teachers.

The specific courses include the following six categories.

1. Special topics for improving mathematics professional attainment:

- Introduction to the mathematics discipline is taught by three highly regarded professors, Jingxue Yin, Daochun Sun, and Bolian Liu. They mainly introduce the history, thoughts, and methods of the branches of mathematics as well as their own understanding of mathematics, and they expand the trainees' horizons and improve their teaching attainment.
- Mathematical modeling in middle schools: aims at trainees mastering the basic methods of mathematical modeling and improving their ability to use mathematics to solve practical problems.
- Probability and statistics problems: aims to expand trainees' knowledge about probability and statistics and improve their ability to utilize the new teaching materials.
- Research on mathematical problem solving: aims to discuss approaches to middle school mathematical problem solving and develop trainees' abilities to solve mathematical problems.

2. Special topics in mathematics education

- Some common problems domestically and overseas: aims to help trainees to understand the concepts, goals, and content of the mathematics courses of different countries and master the latest news about the development of international mathematics courses.
- Case study of mathematics teaching: disseminates information about the problems, countermeasures, and trend in teaching mathematics from the perspective of international mathematics education and provides the trainees with cases about teaching mathematics under the global vision.
- "Double-base" teaching in Chinese mathematics education: aims to let the trainees master the connotation, contents, changes, and experience of the double-base teaching of mathematics.
- Philosophy and culture of mathematics aims to help the trainees to understand the philosophy of mathematics, comprehend all kinds of mathematics education concepts, understand the essence of mathematics education, and improve their understanding of the culture of mathematics.

3. Special topics in mathematics teaching

The purpose of the special topics is to improve the trainees' skills in mathematics teaching design and enable them to design scientific and reasonable teaching according to the features of the objects, teaching objectives, and environmental conditions.

- Learning and teaching of mathematics concepts and principles: aims to help the trainees master the laws of mathematics concepts and solve standard problems relating to mathematics teaching design (He, 2003, 2004, 2011).

- Examples of mathematics teaching design: aims to solve the inherent problems of algebra teaching and teaching problems of mathematical modeling through the discussion of two cases of national teaching design champions (He & Yao, 2008, 2012).
 - Research on mathematics teaching cases: aims to help trainees to master the basic requirements and implementation processes of case teaching and learn to create mathematics teaching cases step by step.
4. Special topics in mathematics education research
- The purpose of these topics is to improve the teachers' mathematics ability and develop positive attitudes toward educational research and its practical implications.
- How to do mathematics education research involves demonstrating the process of teaching, research, and the growth of secondary school mathematics teachers from the angle of a special-grade middle school mathematics teacher.
 - Research on assessment issues: involves studying and discussing the questions, methods, and experiences of middle school mathematics learning.
5. Special topic on modern education skills
- The goal of Modern Mathematical Teaching Technology is to enable teachers to use modern education skills in their teaching and in developing course materials.
6. Special topic on teaching practice
- Discussion on Issues in Teaching of New Mathematical Courses: The goal is to provide trainees with a platform for interaction between teachers and students and interaction, exchange, and discussion among students, to solve trainees' problems of trainees relating to teaching and learning.
 - Mathematics Teaching Research: The goal is to share experiences, cooperate, exchange, and make common progress.
 - Implementation of Middle School Mathematical Exploration Activity: The goal is to study and discuss the connotation and meaning, characteristics, basic methods, teaching requirements, and cases of mathematical exploration.
 - On-the-Spot Teaching: The goal is to view and emulate the teaching of typical lessons on the spot, develop standard teaching plans, teach and evaluate classroom teaching, and discuss strategies for improvement.
7. Module 3: Studies in the mathematical practice. This module encourages teachers to conduct action research relating to various topics and write papers. These papers are exhibited and reviewed by peers.

18.3.2.5 Examination and Evaluation

1. The project expert team is responsible for evaluating the teaching of the whole training.
2. The research topics are evaluated by the tutors and defense committee.
3. Process evaluation is the main method used to examine the trainees' learning, self-assessment, and peer assessment; evaluation is conducted by the experts and the teacher who is charge of the class based on individuals' learning performances, summaries, and papers. Trainees who pass the examination are awarded the certificate of training completion from the Ministry of Education.

18.3.3 Training the Trainers

The example discussed here is the *Skills Upgrading of Outstanding Front-Line Teachers-Middle School Mathematics* (South China Normal University Cyber Institute), focusing specifically on the *State Training Plan (2014)*.

18.3.3.1 Training Goal

This project is dedicated to the improvement of ideas, methods, and practices of middle school mathematics teachers and their professional quality. The goals are:

1. To help teachers to improve their abilities of training, teaching, organization, and implementation;
2. To understand new developments in domestic and foreign teacher training, learn and understand the theories and methods of modern teacher training, and master the methods of design and planning of teacher training projects and school-based teaching research and training;
3. To expand participants' mathematical horizons, gain insights into the essence of mathematics learning and teaching, thoroughly understand the new curriculum standards and new teaching materials at the Compulsory Education Stage, and expand and optimize the trainees' professional knowledge structure;
4. To improve the trainees' abilities to solve the problems associated with implementing middle school experiments in the mathematics curriculum reform;
5. To exchange, assess, and summarize the experiences of middle school backbone mathematical teachers to prepare them for teacher training according to the national training plan.

18.3.3.2 Training Courses

Module A introduces trainees to the status quo, features, and trends of domestic and international teacher training, the essence of teacher professional development, the *Middle School Teachers' Professional Standards Trial*, and directions in teacher training from a macroscopic view. It also guides trainees to master the design and planning of teacher training projects and school-based teaching research and training. The content is as follows:

- A1. Interpretation of the *Middle School Teachers' Professional Standards Trial*;
- A2. The experiences of international basic education teacher training;
- A3. The modes and methods of teacher training;
- A4. Interpretation of *Guidelines for Strengthening the Reform* and design and organization of teacher training projects;
- A5. Design and organization of school-based teaching research and training;
- A6. The micro-lecture as a teacher training innovation;
- A7. Teachers' moral education.

Module B expands the mathematical horizons of trainees, to develop a thorough understanding of the essence of mathematical teaching, master the theory and technological standard of mathematics teaching design, and improve the professional quality of mathematics educators.

- B1. Analysis of basic mathematical ideas;
- B2. Overall understanding and analysis of content of secondary school mathematical curriculum;
- B3. Mathematics teaching practice;
- B4. Mathematics education methods;
- B5. Research and discussion on improving the effectiveness of middle school lesson observation and evaluation.

Module C introduces trainees to the latest developments in the middle school mathematics course reform, and to solve common problems in the implementation process so as to improve the pertinence, importance, and practice of middle school mathematical teachers' training scheme design.

- C1. In-depth analysis of *Standards for Compulsory Education Stage (2011)*;
- C2. Problems and case analysis (Huang, Li, & He, 2010);
- C3. International teacher education training and case analysis.

Module D addresses the basic methods of teacher training scheme design and prepares middle school backbone mathematics teachers through special reports, case research and discussion, query and reflection, interaction and exchange, and other research and training methods.

- D1. Selection and optimization of content of middle school mathematics teachers training;
- D2. Research on middle school algebraic problems;
- D3. Research on middle school geometric problems.

Module E introduces trainees to methods of effective teacher training and organization and management, through teaching practice, observation, inspection, query and reflection, interaction and exchange, and other research and training methods.

- E1. Research and discussion on middle school mathematics teaching practices;
- E2. Organization and management experience exchanges.

18.3.3.3 Training Methods

1. Expert lectures
Experts introduce relevant advanced ideas, leading theories, and practical experiences in order to expand the trainees' professional perspectives, establish theoretical frameworks, and improve professional quality.
2. Participative training
In this format, trainees participate in training, teaching, and discussions, thus learning and making progress together with other trainees. This training mode is based on five principles: equal participation and mutual cooperation; showing respect for diversity as well as flexible and diverse forms; taking advantage of existing experience to construct knowledge; paying attention to training process; and emphasizing linking theory with practice and combining the concrete with the abstract. The methods commonly used are group discussion, case analysis, watching videos, and interviews.
3. Task-driven approach
The task-driven training mode involves presenting complex and meaningful problem situations. Learners cooperate with each other to solve a series of relevant real teaching problems. This mode mainly consists of the following sections: creating situations; determining problems; independent learning; cooperative learning; and performance evaluation.
4. Case study
In this mode, trainees discuss and exchange new problems and typical cases arising in the experiment of new mathematics curriculum reform in the past ten years, and based on relevant advanced theories.
5. Class observations and evaluations
Trainees visit and evaluate classes in selected schools.

These visits are beneficial as an exchange of ideas and experiences. Evaluations focus on such aspects as teaching objectives, content handling, teaching methods, basic teaching skills, and teaching effects.

6. Field trips

Field trips providing opportunities for trainees to exchange experience with peers and learn from each other, as well as to gain ideas about effective teacher training.

7. Mixed style training

This combines centralized face-to-face instruction and Web-based advanced studies, using online learning platforms. It includes on-site diagnoses and case studies involving practice and observation, situational experiencing to help the trainees to solve problems occurring in mathematics education and teaching practice. A Web-based community has been established in which the trainees can carry out personalized learning, exchange experiences, share results, receive follow-up tutoring, and communicate with each other at the post-training stage.

8. Follow-up and guide

A training service team has been set up to oversee the post-training follow-up exchange between trainers and trainees as well as learners through Web-based platforms for advanced studies. The details are as follows:

- The training organization provides the trainees with the latest information on the plans, schemes, implementation, etc., for training middle school backbone mathematical teachers of all provinces and cities.
- The trainees share their training experiences via network platforms.
- Mentor groups provide the trainees with some latest training resources, solve the problems they encounter, and interact with them;
- During the stage of centralized learning, the trainees are divided into several learning groups, and a South China Normal University Cyber Institute specialist will be assigned to each group as a mentor to build a learning community, so as to provide an institutional guarantee for continuous learning.

18.3.3.4 Assessment and Evaluation

Assessment is based on five aspects: the disciplinary performance, learning results, interactions, design of training scheme and an overall conclusion of the trainee during advanced studies, and by ways of self-evaluation, trainees mutual evaluations, experts' evaluations, and evaluation by the teacher in charge of the class. Those who complete the course requirements receive a Certificate of Completion issued by the Ministry of Education.

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