Professional Development of Mathematics Teachers – Transforming Intangible Pedagogy into Reality

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Abstract: The efficiency and potency of an educational system consecutively lies upon its teachers. Teaching becomes a fulfilling journey that gives an incredible opportunity to mould the impending future of a society. It becomes quite necessary for a teacher to nurture the practice of self-appraisal, improve interactions; develop reflective strategies etc. to steer students towards healthy reflexive skills. The paper highlights the aims of professional development and explores necessity of new pedagogy to connect abstract conjectural of mathematics into reality, considers the efforts that government has made by preparing policies for teacher education in India and provide some strategies for improving professional development of mathematics teachers. Various studies had pointed to the fact that traditional method of teaching is one of the major causes behind students’ poor achievement in mathematics and the improvement can be attained through constructivist approach of teaching.

1. Introduction

Many nations around the world have undertaken wide-ranging reforms of curriculum, instruction, and assessments with the intention of better preparing all children for the higher educational demands of life and work in the 21st century. In the present day students have to know not only the basic reading and arithmetic skills, but also skills that will acknowledge them to face a world that is continually changing. They must be competent to think critically, to analyze, and to make inferences. “Are we sure that our students are getting these?” What are the skills that young people need to be successful in this rapidly changing world and what competencies do teachers need, in turn, to effectively teach those skills to their students? The question that arises from this is, of course, what teacher preparation programs are needed to prepare graduates who are ready to teach well in a 21st century classroom. This question is, however, yet tough to answer with available comparative substantiation.

The world is quickly becoming a different place, and the challenges to individuals and societies enforced by globalization and modernization are widely recognized. Probably the most challenging problem for educators in the coming days is that routine, rule-based, knowledge, which is easiest to teach and to test, is also easiest to digitize, automate and outsource. The issue of 21st century skills is by no means orthogonal to traditional school subjects but, in fact, equally relevant to the latter. In this regard we can take mathematics as an example. Traditionally mathematics is often taught in an abstract mathematical world, using formalism first, removed from authentic contexts, and discouraging to the students that do not see its relevance – for example, students are taught the techniques of arithmetic, then given lots of arithmetic computations to complete; or they are shown how to solve particular types of equations, then given lots of similar equations to solve. On the contrary, in the 21st century, students require to have an comprehensive understanding of the fundamental ideas of mathematics, they need to be able to transform a new condition or problem they face into a form that renders the relevance of mathematics, make the problem open to mathematical treatment, identify and use the relevant mathematical knowledge to solve the problem, and then evaluate the solution in the original problem context. Further, their creativity can be enhanced by formulating unusual solutions, and even new problems with non-standard solutions.

2. Background & Significance of the study

Teaching of mathematics nowadays primarily takes place within a professional framework. On the other hand, mathematics teaching is a complex and demanding process. The complexity is successfully resolved by unfolding continually new techniques or strategies for math teaching and learning suitable to the contemporary context. That way we get a process which has to take place harmoniously within several frameworks. The main frameworks are language frameworks, professional frameworks, methodology frameworks, scientific frameworks, pedagogical frameworks and psychological frameworks. As it is not easy to attain harmony, occasional slip-ups and flaw occur in math teaching which significantly influence the quality of math education. That contemplates negatively on the aims of modern math teaching which calls attention.
to participation of students in independent and research work, developing skills for problem solving and the promotion of creative thinking and innovative skills. Modern math teaching methodology offers various possibilities for solving the above mentioned problem. Through the selection of appropriate problems and through the application of that method a resourceful teacher can prepare students for such work which is very significant to surrounding world of living. Advanced teaching methodology of mathematics offers various possibilities for solving the problem of involving students in independent work, it develops their problem solving skills and build ups their creative thinking procedures and skills. Contemporary math teaching assumes diverse learning activities than traditional method. Emphasis is given to the development of the ability to work independently with a creative approach to math, and on developing conditions for successful application of achieved mathematical knowledge and skill. Students’ independent work on acquiring knowledge of math is achieved largely through the possibility of properly choosing and using teaching tasks. In that way assignments become important measures in forming students systems for basic mathematical knowledge, abilities and practice and support to the enhancement of their mathematical skills and creative thinking.

Teachers have one of the most demanding vocations in the world and in order to fulfill their important roles with distinction, they need training, motivation as well as regular mental, emotional and spiritual regeneration. That educational systems the world over acknowledge the importance of the teacher is often evident by the resources spent on teacher capacity building. However, the issues often have been about building an effective model and mechanism that would develop and enhance the teachers’ capacity and provide them avenues for professional development. Recent studies have identified the need for improved classroom practices in teaching mathematics as a condition for improving K-12 pupil achievement in mathematics (Ball, Hill, &Bass, 2005; Ma, 1999; National Mathematics Advisory Panel, 2008; Stigler & Hiebert, 1999). To improve classroom practices, pre-service methods classes should focus not just on teaching general methods of instruction, but should engage pre-service teachers in learning how to successfully teach subject matter content using highly specific strategies that are specialized to that discipline (Shulman,1987).

'Maths phobia' has become part of major reason for school dropout & inability to cope with Mathematics seems to be a universal phenomenon that many students fear and dread Mathematics.

- Crude methods of assessment that encourage perception of mathematics as mechanical computation.
- Lack of teacher preparation and support in the teaching of mathematics.
- Since the basic objects of Mathematics are abstract, our school curricula has failed to create a stimulated learning space in the mind of learners.
- Our school system have failed to provide contexts in which the learning of Mathematics can take place.
- The present school curriculum gives lesser place to our ‘everyday’ Mathematics. Thus the Mathematics that children learn to do inside and outside our schools remain separate and disconnected.
- The present assessment system in mathematics lead to a tense atmosphere in the classroom as well as in parents. The maths is difficult subject.
- What kind of mathematics curriculum transaction is adequate to meet the needs of achievement in mathematics?
- What modifications to the teacher training curriculum or alternative curricula are needed for making special impacts of learning maths on learners?
- How should pre service/ in service maths curricula be structured?
- How could pre service programme be implemented for higher achievement in mathematics?

Probably, the above leads us to an alternative called Mathematics education.

Mathematics education refers to specialized discipline that sits between mathematics on the one hand, and a range of other disciplines (such as psychology, human development, sociology, philosophy, epistemology, pedagogy, curriculum studies, policy studies and science) from which it draws underpinning research findings and concepts etc. 250 researchers across 60 institutions worldwide who categorized 21st-century skills internationally into four broad categories:

- **Ways of thinking**: Creativity, critical thinking, problem-solving, decision-making and learning
- **Ways of working**: Communication and collaboration
- **Tools for working**: Information and communications technology (ICT) and information literacy
- **Skills for living in the world**: Citizenship, life and career, and personal and social responsibility (Schleicher & Ed., 2012)

To foster these skills a teacher must be trained through continuous professional development programming inside or outside the institution.
Syllabus of mathematics at elementary level are changing. Therefore, as it is essential to modify mathematics curriculum, proper training for teachers is also obligatory, otherwise teaching method will become worthless. At present, in West Bengal, curriculum for mathematics is being thoroughly reviewed for all class to maintain a balance with the prescribed instruction as laid down by the framework of NCERT. In this context the present paper has tried to highlight the importance of professional development for mathematics teachers for making classroom live and innovative to the children.

3. Objectives

This paper aims to
(i) Point towards the traditional method for math-phobia and poor achievement in mathematics and necessitates the new pedagogy of constructivist approach through problem solving method, laboratory method, project method
(ii) Explore the importance of professional development of mathematics teachers for quality elementary mathematics education as hold in RTE, 2009
(iii) Focus on the initiatives / programs for professional development of teachers by government.

4. Methodology

National and International journals, project report, government documents, thesis, proceedings of seminar / conference, article of research work have been used as source of secondary information.

5. Discussion in various aspects –

Scenario of present students’ achievement and major causes- pedagogy in school – lack of laboratory

Elementary education (class I-VIII) is a crucial stage for children as it prepares them for the world of work. It is very essential to provide good quality mathematics education available, accessible and affordable to all our children. To achieve this, there is a need to strengthen the secondary school education by providing opportunities to teachers for improving their professional capabilities/capacities. In majority of the schools, untrained teachers are handling secondary classes. Even the trained teachers are facing lot of challenges to handle classes at secondary stage of school education especially in science and mathematics. As a consequence of this the scenario of mathematics achievement in India remains to be improved from a long way to present situation. As for example, Thakore (1980) found that the students of class V did not have clear concept of fractions. They did not understand the place value of respective figures in decimal fractions. They did not understand addition, subtraction, multiplication and division of decimal fractions. In TIMSS (2003) study India ranked at 46 among 51 countries. Indian students’ score was 392 versus average of 467 for the group. Recent national test results provide continuing documentation of the need to increase the focus on improving student achievement in mathematics. In the year 2014 in the National Achievement Survey (NAS) for class VIII in mathematics conducted by NCERT the average score of 33 states/ UTs was 245 out of 500 with SE of 0.6. Also the mean value of result (out of 100) in mathematics found by them in the year 2012 is given below:

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<thead>
<tr>
<th>Round</th>
<th>Grade III</th>
<th>Grade V</th>
<th>Grade VIII</th>
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<tbody>
<tr>
<td>Round I</td>
<td>58.25</td>
<td>47.45</td>
<td>39.17</td>
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<tr>
<td>Round II</td>
<td>61.88</td>
<td>49.88</td>
<td>42.17</td>
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Also, in that report “Assessing the Impact of Right to Education Act”, done by KPMG & CII, March 2016, it is mentioned that about 19.5%of all the studied children in class two were not able to recognize number upto nine, close to 74% of all the studied children in class three could not do two digit subtraction and close to 74% of all the studied children in class five were not able to do division. To improve quality of learning It is essential to know an accurate picture of the status of learning today (where we are) and a detailed set of goals of what is to be achieved (where do we want to get ). As mentioned by NCERT the higher goals of mathematics teaching and learning is mathematization of the children’s thought process. In this context teachers need professional development to make the classroom lively, attractive, joyful , child friendly through problem solving activities , recreational activities in mathematics , laboratory engagement, project work, activities in mathematics club and library i.e. teachers should appreciate constructivism approach of teaching method instead of traditional method.

Many researchers pointed towards the traditional method of teaching and unappealing curriculum with rude assessment. Some research findings regarding causes behind the low achievement in mathematics are quoted below.
Sharma (1978) conducted a critical study of the achievement in Mathematics by pupils of secondary school with particular reference to the state of Assam. The main objective of the study was to find out the achievement in learning school mathematics and the possible reasons for the low achievement in the same. Some factors responsible for low achievement in mathematics were the imparting of limited knowledge, blind use of rules, heavy syllabus, defective text books and absence of methodical approach of the class room teaching.

Andile and Moses (2006) studied about the factors that contribute to poor performance in mathematics and physical science by using a non-experimental, exploratory and descriptive method. Learners’ and educators’ views were also taken. Results indicated that two factors were identifiable. The first identified to have a direct influence related to teaching strategies, content knowledge, motivation, laboratory use, and non-completion of the syllabus in a year. The second factor, associated with indirect influences, was attributed to the role played by parents in their children’s education, and general language usage together with its understanding in the two subjects.

Harish and Srikanthaswamy (2011) highlighted the need for integrating critical thinking skills in mathematics instruction at the school and college level. Students should be taught to get the habit of thinking mathematically, solving problems scientifically, and reasoning historically, seeing artistically, reading critically and communicating clearly.

Suan (2014) studied the factors that affect underachievement in mathematics. There were three suspected identified factors that will scaffold this study. First is teacher factor, which is compose of mastery of the subject matter, instructional techniques and strategies, classroom management, communication skills, and personality. Second is student factor which include study habits, time management, and attitude and interests towards mathematics. Third is environmental factor such as parents’ values attitudes, classroom settings, and peer group.

In all of these findings it was pointed towards traditional method of teaching as one of the major causes of poor achievement in mathematics. To remove these difficulties in classroom professional development is required. A few research findings are presented to substantiate this thought. Again for enhancement in the achievement in mathematics the research findings stresses on the method of teaching. Some of the findings are mentioned below.

Helen J. Craig, Education Specialist (1998) in his document ‘Teacher Development Making an Impact’, revealed that teacher education can make a difference to student achievement. Teacher education programs can make a difference to student achievement depending on the type of education program and support that is put in place. Specific factors such as the years of teacher training (initial and in service), the teacher’s verbal fluency, subject matter knowledge, having books and materials and knowing how to use them, teacher expectation of pupil performance, time spent on classroom preparation, and frequent monitoring of student progress are all key factors identified in some key research studies that have a positive bearing on the quality of teachers’ performance and, consequently, student achievement.

Addayo (1999) found support for the contention that actively involving student in the learning process through interactive learning leads to improved performance in mathematics. By considering performance in mathematics before and after a 10 week experiment, she found that the two groups of students participating in active learning performed better than the group attending lectures only. In both experimental groups, students solved problems on the background. In addition the one group was given a series of problems which they solved individually, while in the other, students solved the same problems but in a small group of 5.

Fraser, 1984 showed that many women and minority students don’t see the relevance of mathematics to their future lives. This perceived lack of usefulness of mathematics contributes to the high dropout rate. It appears that the implementation of mathematics teaching is far from being successful in achieving its aims.

Makanong (2000) investigated students’ mathematics problem solving processes and to compare the mathematics problem solving processes and achievement levels between students being taught mathematics based on constructivist theory and those being taught mathematics based on traditional teaching on Thailand. The constructivist Teaching Based Model was developed based on a framework of constructivist theory and was composed of three teaching steps: Construction of cognitive conflict; reflection and discussion; and reflection and discussion and conclusion of the results from cognitive restructuring. Lesson plans for constructivist teaching were constructed based on the constructivist Teaching Based Model. Activities in these lesson plan focused on student’s existing knowledge. Collaborative working, real word context, use of manipulative, cognitive conflict, reflective teaching approach and Lash’s translation model. The study is a quasi-experimental research using pre test-post test non-equivalent control group design. Four classes comprising 164 9th–grade students were involved. Students in the experimental group were taught 9th grade algebra based on constructivist teaching and these in the control group were taught based on traditional teaching. Four types
of instrument the mathematics problem solving process test, the mathematics achievement test, the interview task problems and the classroom observation protocol were employed to collect data. Data were analysed quantitatively and qualitatively. The quantitative data indicated no significant differences of mathematics problem solving process and achievement between students in the two treatment group. The qualitative data indicated that constructivist teaching was a promising approach capable getting students more involved in learning mathematics. Students in this study who learned mathematics based on constructivist teaching tried harder, as measured by the interview task problems, than those who learned based on traditional teaching. A variety of institutional methods for teaching algebraic problem solving and applying mathematics to the outside world were explored.

Wenglinsky (2000a), who used multi-level structural equation modelling with data from the US National Assessment of Educational Progress (NAEP) program, found that:
1. Students’ performance was higher when their teacher had majored or minored in the subject they were teaching;
2. Students performed at a higher level if their teacher received professional development in working with different student populations; and
3. Students whose teachers had received professional development in higher-order thinking skills outperform students whose teachers had not.

Findings that were not significant included:
1. Number of years teaching experience;
2. Whether the teacher had obtained a Masters degree or higher; and
3. Time spent on professional development over the last year on classroom management, cooperative learning, on-going forms of assessment, and interdisciplinary instruction.

Hadi, 2002 found that lack of teacher preparation and support to the students in teaching mathematics creates difficulties for suitable teaching-learning process.

Martin L. Abbott, Ph.D. and Jeffrey T. Fouts, Ed.D. (2003) did their research on ‘Constructivist teaching and Student Achievement: The Results of a School-Level Classroom Observation Study in Washington’. The most notable findings in these analyses are the large correlations between the study variables. The negative correlation between school-level family income and student achievement was expected. The large positive correlations between constructivist teaching and student achievement are noteworthy, as is the negative correlation between constructivist teaching and school-level family income. The regression analyses show that constructivist teaching does predict student achievement beyond the effects of school-level family income, albeit with a greatly reduced effect. (Schleicher & Ed., 2012)

A September, 2005 report, A Study of Professional Development for Public School Educators in West Virginia provides a framework for viewing the relationship between professional development, teacher quality, and student achievement in mathematics. The report, prepared by the National Staff Development Council for the Legislative Oversight Commission on Education Accountability, notes that there is conclusive evidence from current research that the single most critical factor in improving student learning is teaching quality.

Kaur and Kaur (2011) studied the effect of concept attainment model of teaching on mathematical achievement of secondary school students. The results indicated that the students achieve a lot after being taught through Bruner’s Concept attainment model. Both the strategies were effective in bringing improvement in the achievement scores at post test level but Bruner’s Concept attainment model was more effective than the traditional method in the teaching of mathematical concepts.

Catherine Lewis (2010) has made an insightful analysis of the impact of such research lessons in Japan. Among nine ways she listed down in which research lessons have an impact, four of these ways are very relevant to the present context:
1. Individual Professional Development: The feedback obtained from observers in a research lesson is a very valuable tool for professional development. Often, young teachers struggle with problems in the classroom that their more experienced colleagues can quickly help them with. The practice of observation and feedback provides an effective way of professional development. Coming from other teachers, this input is likely to be much more effective.
2. Teachers learning to see children: A tremendous impact of Research Lessons is that teachers start to understand how their students think and behave in a classroom. Such an understanding helps developing parameters by which a teacher can judge the status of her class. In Japanese research lessons, data is often collected on student eagerness, student interaction, even aspects like moments of surprise in the students or excitement as evidenced by shining eyes! This understanding is probably the most critical aspect of teaching for understanding and has been largely treated as unimportant in Indian schools. Research lessons help the teacher build this understanding steadily through observation and discussion.
3. Spread of new content and approaches: Research lessons allow for ideas and approaches to be quickly shared among teachers. School principals who have agonized over the fact that staff room interactions are rarely about teaching will notice that research lessons provide an invigorating forum for sharing and discussing ideas and teaching methods.

4. Honouring the Central Role of Teachers: Finally, research lessons put the teacher at the centre of school education, honouring and emphasizing their primary role in ensuring that students learn. While textbooks are useful guides to teaching, the teacher is the best person to judge how much her students are learning and what she needs to do to improve it. Research lessons help focus resources for improvement at the point where they have the most impact: the teachers.


From the above citation and also the importance of quality mathematics education as declared in RTE, 2009 professional development of mathematics teachers become compulsory as one of the main central theme in the present scenario of classroom teaching at elementary level of education, and also for secondary and higher secondary level as they are the future foundation for students. It is also reflected by the new rules and regulations of teacher’s eligibility criteria by NCTE.

6. Meaning of Professional development

Professional development is the advancement of a person in his/her professional role. It includes the prerequisites of constant learning and developing opportunities to extend and widen the scope of professional competence of employees in relation to their role and accountabilities. Prerequisites here refer to the combination of attributes, vs. qualities, skills, knowledge and understanding of ethical principles that underpin the professional practices of employees which enable a person to perform to high standards in a given context and role. Becoming an effective teacher is a continuous process that stretches from pre-service experiences to the end of the advancement professional career. The ultimate beneficiary of professional development is the student though the receiver is the teacher. Professional development for teachers is more than training or classes as it functions as a means to change in their classroom practices. Since NCF 2005 imparts a new curriculum structures across the country it could have a positive impact on teachers’ pedagogical content knowledge as many teachers feel challenged with teaching of curricular subjects due to lack of previous experience with hands-on activities, lack of content knowledge, lack of interest to acquire the resources needed to create appropriate learning environments and lack of confidence. Some characteristics of professional development are discussed here.

(i) Teacher Development is vis-à-vis on the go of Professional Growth and Support

From the age teachers begin any initial preparation or teaching, provision needs to be made for ongoing development of their subject matter knowledge; concrete skills to teach, observe, assess, and reflect; inducement; and career evolution. There also needs to be associations with other teachers and supervisors to help them to solve problems and support each other through conversation, modelling and coaching, and concern with other aspects of school and educational change. Ministries of education and regional office staff have a trustworthiness to provide adequate teaching and learning materials to support the curriculum, sufficient facilities, and ongoing support for the issues that teachers confront.

(ii) Teacher Development Is a Progression alongside a Continuum of Learning

Teacher development is a process, not an incident. It requires change over time and is achieved in phases. The phases are related to teachers’ experience gained in instructional and managing practice over their career. The phases are also interrelated to the degree of services and support a country’s level of economic and political development allows it to provide. Strategies must begin at the teacher level and be aimed at helping each teacher facilitate change in the classroom. Just as the success of each school is the key to overall quality enhancement in the education system, the success of teacher training within the school must be aimed at the success of each teacher to help children learn.

(iii) It Is Important to Create Conditions that Lead to Sustainability

Sustainability of a teacher development program is reinforced where there is long-term connection by stakeholders, plenty institutional capacity, proper incentives and rewards, political solidarity and assurance, and useful phasing out of outside benefactor resources. (Craig, Kraft, & Plessis, 1998)

7. Aims of Professional Development of teachers

Aims of professional development are:
To enrich, promote and empower teachers to be able to get into professional and personal growth of possibilities.

To empower the teachers serving in the higher education segment.

To prepare competent, committed and professionally well qualified teachers who can meet the demands of 21st centuries challenging demands of education systems.

To make available to the ever changing demands of the social system.

To add up more to their knowledge base and to get hold of new skills.

To foster self-confidence and subject knowledge.

To develop positive attitude and proactive qualities.

To build on the collective knowledge and experiences of employees and provide them with opportunities to acquire, practices and adopt new knowledge, thereby enhancing individual, group and organizational learning and capabilities.

To endow teachers with the necessary skills to identify some of the challenges in their classrooms and also to find appropriate solutions.

To guarantee better learning outcomes and offer opportunities for teachers to interact with teacher educator.

To increase the ability to monitor students’ work, in order to provide constructive feedback to students and appropriately redirect teaching. (Gupta, A., 2013)

8. Initiatives / program for teachers for professional development in India

The World Bank in its report has commented that “a high quality and well motivated teaching staff and a supportive professional culture are essential in building excellence” [World Bank, 1994]. Also UNESCO has endorsed the importance of teaching staff and its professional development in higher education by passing a recommendation on the topic at its General Conference in Paris in November 1997.

The professional preparation of teachers has been recognized crucially by Kothari Commission (1964-1966). The Commission recommended the introduction of integrated course of general and professional education in university with greater scope for self-study and discussion and comprehensive program of internship. Based on recommendations of the commission, the National Policy on Education (NPE, 1968) was formulated. National Council for Teacher Education (NCTE) was set up in 1974 by a resolution of Govt. of India. The working of National Council of Education Research and Training (NCERT) was also reviewed. The National Commission on Teachers (1983) studied in depth the problems of teacher education and the status of teachers in society. National Policy of Education (NPE, 1986) opened new vistas in teacher education. As a consequence District Institutes of Teacher Education (DIETs), Colleges of Teacher Education (CTEs) and Institutes of Advanced Study in Education (IASEs) were established across the country. The need for professional development of college teachers was pointed out by the National Policy on Education in 1986. The University Grant Commission (UGC, 1987) proposed to establish Academic Staff College (ASC) throughout the country. “Education has continued to evolve, diversify and extend its coverage since the dawn of history. Every country develops its system of education to express and promote its unique socio-cultural identity and also to meet the challenges of time” these are the words of the National Policy on Education (NPE, 1986). The Yashpal Committee Report (1993) on Learning without Burden recommended that the emphasis in these programmes should be on enabling the trainees to acquire the ability for self-learning and independent thinking. In 1998, National Council for Teacher Education (NCTE) established by Govt. of India for the maintenance of standards and improvement of quality of teacher education in the country, emphasized that every five years, the progress be reviewed. The National Curriculum Framework (NCF, 2005) presents a fresh vision and new discourse on key contemporary education issues. During last decade, National Council of Teacher Education (NCTE) took up a joined hands with the National Assessment and Accreditation Council (NAAC) to foster quality assurance and sustenance and with Distance Education Council (DEC) to ensure integrated development of in-service teacher education under Open and Distance Learning (ODL) mode. In XIth five year plan (2002), one more dimension has been added, i.e. training in Information Technology and E-content development. The UGC has extended scope of training to administrative staff of all categories in colleges and university including UGC staff in XIth plan (2007), (see [MHRD, 2007] and [UGC 2007]). At present in India the UGC has several schemes for upgradation the professional competence of teachers like National Fellowship, research associates, major and minor research projects for teachers.

The Right of Children to Free and Compulsory Education (RTE) Act, 2009 poses major challenges for improving the quality of teachers and for
expanding institutional capacity in States to prepare professionally trained persons for becoming school teachers. Government has initiated steps to revise the existing Centrally Sponsored Scheme of Restructuring and Reorganisation of Teacher Education. Analysis shows that there are 5.23 lakh vacancies of school teachers at the elementary level and the provisions under the RTE Act would lead to additional 11 requirements of around 5.1 lakh teachers. Moreover, around 7.74 lakh teachers are untrained, i.e. they do not possess the prescribed qualification. (Press Information Bureau, Government of India, 2015)

The Teacher Education Bureau under Department of School Education & Literacy, Government of India is focusing on the following main components for improving the quality of teacher education:


2. In-STEP: Capacity Building Program of Teacher Educators: Ministry of Human Resource Development (MHRD) and USAID have formulated the In-STEP programme (India Support to Teacher Education Program) under which 110 teacher educators from the Eastern and North Eastern part of the country have undergone a three month fellowship at Arizona State University with the clear purpose of understanding issues related to teacher education. In addition, the TESS-India is another programme for Teacher Educators with collaboration between Department for International Development (DFID) and Ministry of HRD with UK’s Open University as the implementing agency.

3. The Centrally Sponsored Scheme on Teacher Education (CSSTE) puts emphasis on monitoring of the process and outcome parameters in respect of each level of institution, and for the purpose a comprehensive monitoring mechanism has been developed thereof. Joint Review Mission is a part of this monitoring mechanism. Joint Review Missions consisting of experts in Teacher Education have been sent to 21 States from the year 2012-13 till 2014-15 to ensure effective implementation of the Centrally Sponsored Scheme for Teacher Education.

8.1. New Activities/Initiatives under CSSTE Scheme:

i. Enhanced use of E-Governance in Teacher Education by National Council for Teacher Education (NCTE) for better regulation of the sector.

ii. Accreditation for Teacher Education Institutions (TEIs) by National Council for Teacher Education for better management and improved quality of teacher education.

iii. Mapping of Teacher Education Institutions (TEIs) by NCTE to identify the gap areas for effective future planning.

8.2. Strategies of professional development

The following strategies may be taken up for achieving the above aims:
1. Faculty of SCERTs, IASEs, CTEs and University Education Departments would be concerned as master trainers and adviser for the following activities:
2. Expansion of a network among institutions and individuals of SCERTs/SIEs, IASEs and CTEs and University Education Departments.
3. Make plans for of workshops for content and pedagogy enrichment.
4. Endorsement of a set of indicators and benchmarks to track in-service professional development of teachers and the institutions which organise them.
5. Development of short-term courses for continuous professional development and upload on the websites.
6. Devise open and distance learning (ODL) strategies for concurrent/perennial professional development.
7. To be effective, professional development programmes should be based on curricular and instructional strategies that have a high probability of affecting students’ ability to learn and in turn students’ learning achievement (Joyce and Showers, 2002).

8.3. Alternative Teacher Education Programs Should Be Considered

There are a variety of ways to prepare and support teachers in a variety of environments. Initial preparation of teachers varies greatly across countries. Where they exist, programs have worked well when they have ranged from fifteen days as in the BRAC schools in Bangladesh, twenty-five days in the rural community schools in Egypt, two-year programs in Botswana, three years in Namibia, to the five-year programs as found in some U.S. institutions. Success depends on how the courses are structured and what support accompanies them. Practical training, based on the realities of the classroom and ongoing on-the-job support, is the critical factor in any successful teacher education program. Teachers who have shorter initial programs
tend to require more concentrated follow-up while on the job. Where there is an issue with getting females trained in restricted social regions, mobile teacher training has proved helpful. Distance education, when carefully designed for large numbers of students, appears to be significantly less expensive than traditional residential programs in producing “certified” teachers. Alternative programs such as shorter school-based programs with ongoing mentoring and support should be considered, particularly in education systems with shortages of trained teachers.

8.4. Some suggestions for the growth and Professional development of teachers

Framework of Policies: The University should identify goals and priorities and develop and implement a range of strategies and programs to enhance and build the capacity, skills and professionalism of employees to enable them to contribute effectively to education.

Use of ICT in trainings: Training courses must use ICT extensively. Teachers must shake hand with technology. The affecting factors of technology in teacher education and empowerment of teachers are the most important in technology planning, technical support and community building. Until and unless teachers are in tune with technical advancement in the concerned field they may not be in a position to discharge current information to the student community.

Self-motivated learning: Teachers must be involved in self-motivated learning. The necessary skills and attitudes for learning, especially literacy and numeric skills are the confidence to learn - including a sense of engagement with the education and training system; and willingness and motivation to learn.

Participation in Workshops, Seminars and Conferences: Teachers should actively engage in all educational meetings, workshops, conferences etc. Such participation provides the spaces to teachers to gain exposure to new ideas. The teachers are empowered after attending conferences and they can in turn induce their colleagues to follow new teaching practices.

Academic freedom: Teachers need to be endowed with academic freedom to try and experiment different methods/approaches according to the needs of content and classroom.

Study Leave and Education Support: Study leave may be used to undertake activities like weekly lectures, residential programmes, practical training of subject and application of concerned subject in industries or daily life. The procedure to apply study leave should be simple. Concerned heads/Principals must be authorized to permit the teacher on the basis of his/her achievements. An employee undertaking an approved study leave may be eligible for education support in the form of paid study leave.

Allocation of Funds to meet Professional Development: Professional development programmes like seminars, workshops, job exchange, study visits etc. are important components for development of teacher and in the long run development of an institution. Thus to upgrade institutions for 21st century such plans and budgets for growth of teachers must be encouraged.

National Teacher’s Association: Every teacher must enrol in the National Teacher’s Association as a member. This is a basic requirement to professional development. It gives good support to its members by informing them about conferences, workshops, study programmes, teacher exchange programmes. Through these associations a teacher gets the opportunity to connect with other teachers.

Continuing Professional Development Programme (CPD): The teacher must extend his interaction beyond the institution and meet professionals from different organizations, share experiences, practices, construct new paradigms and prepare for effective classroom interaction. Such programmes will keep the teachers actively involved in monitoring their own development in the work place. These programmes impart teachers with a decision making power to make informed choices, equipping them with skills to impart appropriate knowledge and manage their classroom and understand their role in a broader community.

The Professional Standards for Teaching Mathematics (NCTM) suggests that we shift:

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<tbody>
<tr>
<td>classrooms as mathematical learning, collections of individuals under the control of an communities</td>
<td>repetitive drill and practice</td>
</tr>
<tr>
<td>mathematical tasks that engage students’ repetitive drill and practice interests and intellect</td>
<td>the teacher as the sole authority for right answers</td>
</tr>
<tr>
<td>logical and mathematical evidence as verification</td>
<td>merely memorizing procedures</td>
</tr>
<tr>
<td>mathematical reasoning</td>
<td>trying to “cover” too many topics in too little time at a superficial</td>
</tr>
</tbody>
</table>

Table 2: Professional Standards for Teaching Mathematics
the mathematics being studied and its applications | level
---|---
promoting the investigation and growth of mathematical ideas through classroom discourse | passive absorption of information by students as the teacher lectures
conjecturing, inventing, and problem solving | stressing mechanistic answer-finding
using technology and other tools to pursue mathematical investigations | using only paper-and-pencil to do mathematics
connecting mathematics, its ideas, and its applications and helping students seek connections to previous and developing knowledge | presenting mathematics as a body of isolated concepts and procedures
students working individually, in small groups, and as a whole class | students working individually at desks lined up in neat rows

(Adapted from NCTM Professional Standard for Teaching Mathematics, pp. 1-3)

9. Conclusion

As evidenced in this brief review of the literature related to teaching mathematics, there is a literature basis for a set of best practices for use in teaching mathematics. These recommended practices are summarized in the following chart.

Table 3 Best Practices in use of teaching Mathematics

<table>
<thead>
<tr>
<th>Instructional Element</th>
<th>Recommended Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum Design</td>
<td>✓ Ensure mathematics curriculum is based on challenging content ✓ Clearly identify skills, concepts and knowledge to be mastered ✓ Ensure that the mathematics curriculum is vertically and horizontally articulated</td>
</tr>
<tr>
<td>Professional Development for Teachers</td>
<td>Provide professional development which focuses on: ○ Knowing/understanding</td>
</tr>
</tbody>
</table>

Technology

- Provide professional development on the use of instructional technology tools
- Provide student access to a variety of technology tools
- Integrate the use of technology across all mathematics curricula and courses.

(The Alliance Education, Business and Community for Public School, 2006)

Engagement in mathematics should be expected of all students, and the learning environment should be one where students are actively involved in doing mathematics. Challenging problems should be posed and students should be expected to work on them individually and in groups, sometimes for extended periods of time, and sometimes on unfamiliar topics. They should be encouraged to develop traits and strategies — such as perseverance, cooperative work skills, self-assessment, self-confidence, decision-making, and risk-taking — which will be key to their success in mathematics. (Kurnik, 2008)

Solving a math problem implies some research and development. That is why the teacher has to create the spirit of curiosity in his students, the inclination for independent mental work and to show them ways to new discoveries. A creative mathematics teacher using creative teaching methods has great chances to develop in his students creative characteristics. This would be possible if the teachers are well developed in teaching strategies transforming intangible pedagogy into reality.

10. Bibliography


