Development of Professional Enrichment Programme for the Secondary School Mathematics Teachers

An ABSTRACT of the Thesis submitted to

The Maharaja Sayajirao University of Baroda,Vadodara for the

Degree of DOCTOR of PHILOSOPHY

in Education

Guide:

Prof. Karanam Pushpanadham

Researcher:

A.V. Beena

CENTRE OF ADVANCED STUDY IN EDUCATION (CASE)

DEPARTMENT OF EDUCATIO, FACULTY OF EDUCATION AND PSYCHOLOGY

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA,

VADODARA- 390002

Table of Contents

AN ABSTRACT OF THE THESIS

1. INTRODUCTION

The education system has a tremendous responsibility to transform a child into a fully developed individual. Over the ages, academicians and educationists of the country have been relentlessly working to develop a system of education which can express and promote its social and cultural identity, a system which can fulfill the requirements of the time. Continuously research studies are happening in the education sector for the improvement of the existing system and to establish a system wherein learners can be equipped with the skills necessary to prepare them to face the technological world and to prepare them for the current century's learning and life.

Secondary Education is a bridge between the Primary and Higher Education systems and quality Secondary Education has a very significant role in equipping the learners with the required competency. National Education Policy (NEP)- 2020 and its implementation in its real sense in the secondary education system is expected to bring a paradigm shift. To achieve the objectives laid down by the policy and policymakers, teachers play a vital role. So, empowering them with all skills- generic and content-based is very much essential.

Mathematics as a compulsory subject has been taught in School Education since ancient times. Mathematical skills are crucial for a wide array of analytical, technological, scientific security and economic applications (Emma, 2012). Several efforts have been made through commissions and committees to improve the quality of education in general and mathematics education in specific. National Curriculum Framework -NCF (2005) states that at the secondary stage, students begin to perceive the structure of mathematics as a discipline. Now National Education Policy (NEP)-2020 is also emphasizing Competency Based Education of Mathematics and bringing so much of changes in its Assessment pattern in the secondary level, which is expected to bring desirable changes in Secondary Math education.

Research studies conducted in India reveal that students and teachers face various problems in the process of learning and teaching Mathematics. NCF (2005) highlights the major challenge of learning Mathematics as students' fear towards the subject Mathematics. Learners are unable to

understand the basic concepts of Mathematics due to various reasons. There is a strong teacher component- role of mathematics teacher- to engage a student with a sense of success to boost his/her confidence to prompt him/her to take up further challenges in the subject.

The Position Paper on Teaching of Mathematics (NCERT-2006) by the National Focus Group also talks about the development of a mathematics programme that would ensure that everybody learns mathematics and does not fear it. However, the effectiveness of any such programme depends ultimately on the teacher's professional competencies and status.

In this context, as part of the present study, the researcher closely reviewed the related literature on the following aspects to understand the actual scenario of secondary-level Mathematics Education and the requirement for its improvement in the essential areas.

2. REVIEW OF RELATED LITERATURE

Numerous research studies have been conducted with various objectives and methodologies in the field of Mathematics. The researcher divided the reviewed studies into 4 categories, according to the objectives with which they have been carried out.

1) Studies on Learning Outcomes in Mathematics in School Education.
2) Studies on Difficulties faced by Mathematics teachers.
3) Studies on the Development of Professional Enrichment Programmes in Mathematics and other Subjects.
4) Studies on the Impact of Professional Enrichment Programmes on Mathematics Teachers.

Reviews under the category- 'Studies on Learning Outcomes in Mathematics in School Education'- had been made by the researcher to understand the various factors affecting the learning outcomes in Mathematics in School education. Reviewd studies of Baskaran (1991); Hiebert & Grouws (2007);. Gootenboer & Hemmings (2007); Jaiyeoba & Atanda (2011); Bhagowati (2011); Mahanta (2012); Vijayan (2014) and Michael (2015) pointed out the factors such as poor teaching environment, inadequate self-practice and students' poor background in mathematics etc. effecting the learning outcomes .Majority of the studies recommended teachers to use various methodologies and strategies to facilitate the students' learning out comes, instructional resources should be provided in schools, training programmes for teachers to be

arranged at regular interval and all teachers must make positive use of computers, mathematics teacher should spend extra time for improving students' basic mathematics skills etc. Harefa (2023) found that there is an influence of students' interest in learning on their mathematics learning outcomes.

Studies reviewed on 'Difficulties Faced by Mathematics Teachers' revealed lot of difficulties faced by teachers of mathematics. Ale (1980); Singha et al. (2012) and Sarma & Ahmed (2013) found the common difficulties faced by mathematics teachers as lack of tools to make teaching of mathematics interesting and students' negative attitude and approach towards mathematics learning. . Karalı (2022) revealed that primary school teachers faced many problem areas related to gain density, insufficient lesson hours, central exam-program incompatibility, reading comprehension, associating with daily life, readiness, inadequacy of economy, lack of material, distance education, fear of mathematics, peer pressure and lack of motivation. Anakpua et al. (2023) through the findings of the study: ' Mathematics teachers' perceptions and challenges in using blended learning for optimum mathematics delivery in the post COVID - 19 classrooms' revealed that challenges in using blended learning included lack of ICT compliance, low level of interest in mathematics, time factor, low speed connectivity and poor funding of secondary education. Pokhrel et al. (Aug.2024), concluded that addressing the challenges of teachers requires holistic support, resource enhancement, capacity building, and pedagogical innovation with improving instructional practices, and informing policy for effective mathematics education.

Studies done by Souza et al. (2014); Wagh (1991); Sullivan et al. (2007); McDonald (2009); Kensington- Miller (2013) and Wessels (2014) on 'Development of Professional Enrichment Programmes in Mathematics,' emphasized the need of such enrichment programmes and modules for the effective teaching of the subject mathematics. Such programmes proved helpful in increasing the pedagogical content knowledge of participant teachers and after the implementation of such models, students demonstrated improved learning outcomes. Sulastri et al. (2018) found that six mathematics-training modules satisfied the valid and practice criteria.

The review made on the research done by Ingvarson et al. (2005); Hirst et.al (2009); Watson (2004); Yeasmin (2017); Blank et al. (2008) and Zambo, R. & Zambo, D. (2007) on 'Impact of Professional Enrichment Programmes of Mathematics Teachers' showed that there is a

significant and positive impact of professional enrichment programmes of mathematics teachers in the learning outcomes of students and professional development had an impact on teachers' self- efficacy. Also, the content knowledge increased among the teacher participants, after its implementation. Majority of the studies reported that a creative mathematics teacher using creative teaching methods has great chances to develop in his students' creative characteristics. Ramos-Rodríguez et al. (2022) pointed out the concretion of more specific and robust professional development programs for mathematics teachers.

Though many research studies on Mathematics Education and Mathematics teachers' Professional Enrichment have been conducted, most of the studies have been carried out in foreign countries. Comparatively few studies are being done in India. The researcher observed that in most of the studies reviewed, the teacher's role is very significant in giving the learners a better understanding of the subject. Most of the studies reviewed made recommendations to improve the teaching style and to adopt innovative teaching methodologies to achieve the desirable learning outcomes from secondary Mathematics education.

3. RATIONALE OF THE STUDY

Many of the previous studies and reports explain why mathematics matters, why is it important that we should produce young people who are good at mathematics and why it has become increasingly urgent that we address problems with quality mathematics education.

Studying mathematics stimulates curiosity, promotes creativity and gives children the skills they need for life after school. NCF (2005) states that at the secondary stage only, students can perceive the structure of mathematics and correlate the concepts learned in the primary stage. Focusing on high-quality teaching as the key prerequisite for high-quality education and training, the teacher must provide its learners with the competencies they need to adapt to the globalized complex environments which can be well attained only through quality mathematics education (Caena, 2011).

It is observed that the present mathematics teaching emphasizes mainly memorization and solving problems mechanically through rote learning of formulas and their application through

traditional methods of teaching without giving importance to concept clarification and activities. This has lowered the standards of mathematics education (Gandhi, & Varma, 2007).

These all problems can be solved, and the standard of mathematics education can be improved only through quality mathematics teaching, and that quality can be brought only through good Professional Enrichment Programmes for teachers. Teachers need to be constantly encouraged to analyze themselves and also, they need to introspect about what are they presently doing, whether it is enough for the 21st-century learners, and whether it meets the recommendations and expectations of NCF (2005) and other recommendations made by various commissions for mathematics education in India and also now envisaged by NEP-2020.

The researcher, being in the field of education for the last 21 years - as a mathematics teacher as well as the Principal of a Secondary School- could closely observe the lack of quality teaching in the secondary stage of mathematics in both generic and content-related aspects, resulting into the poor performance of students and hence students slowly losing interest in subject mathematics.

Through the review of related literature made by the researcher, it was clear that in most of the studies, researchers pointed out the need for teachers' training and professional development programmes at regular intervals. National Education Policy (NEP)- 2020 also has made emphasis and now mandatory that teachers must undergo 50 hours of Continuous Professional Development (CPD) in an academic year.

Though many Professional Enrichment Programs and modules have been developed by scholars and academic reformers, mostly abroad and some in India, the researcher observed that very few programs are being developed by focusing the topics which are difficult to understand by the learners or for complex topics at the secondary level.
In this context, the researcher was interested in concentrating on both the generic and content aspects of teaching mathematics, while developing the programme.

The researcher was interested in developing a Professional Enrichment Programme with a strong desire to influence mathematics Education at a secondary stage which in turn will affect the students' learning outcomes. The researcher also had the desire to inculcate and develop the

learners' interest in the subject of mathematics through the programme which is developed for mathematics teachers.

4. STATEMENT OF THE PROBLEM

Development of Professional Enrichment Programme for the Secondary School Mathematics Teachers.

5. OBJECTIVES OF THE STUDY

1) To identify the Professional development needs of Secondary School Mathematics Teachers.
2) To develop a Professional Enrichment Programme (PEP) for Mathematics Teachers of Secondary Schools.
3) To study the effectiveness of the developed programme.

6. EXPLANATION OF THE TERMS

Professional Development Needs: Professional development needs of mathematics teachers include the content and methodological knowledge and skills required for effective mathematics teaching-learning in Secondary School Education.

Professional Enrichment Programme: The term Professional Enrichment programme means a comprehensive, sustained, and intensive approach to improving teacher's effectiveness in raising students' learning outcomes. It is the enrichment training provided to teachers over a period of time to promote their development in all aspects of skill, content and pedagogy that enable them to be professionally competent.

7. DELIMITATION OF THE STUDY

The study was delimited to Class IX and X Mathematics Teachers of CBSE English medium schools of GUJARAT.

8. RESEARCH METHODOLOGY

By focusing the objectives of the research, the researcher adopted the most suitable research methodology, the mixed method- for the study. This methodology involves collecting, analyzing, interpreting and reporting both qualitative and quantitative data. The methodology adopted here proved as the most appropriate one to fulfill the demand of the different phases through which the study was carried out. This methodology helped the researcher to deal with the tool's preparation, techniques used for the data collection and analysis. The researcher focused on the following research questions while proceeding with the current study with an aim to develop a professional enrichment programme for the secondary school mathematics teachers.

9. RESEARCH QUESTIONS

1) How mathematics as a subject is being taught in Secondary Schools?
2) What are the major challenges of Mathematics Teachers?
3) What are the Professional development needs of mathematics teachers at Secondary School level?
4) How do mathematics teachers upgrade their professional competencies?
5) How will the Professional Enrichment Programme (PEP) develop the teaching skills of teachers?
6) What impact does the PEP make on the mathematics learning outcomes of students?

10. RESEARCH DESIGN

With an aim to develop a programme, by considering both generic and content-based needs identified by the researcher during the first phase of the study through the need identification questionnaire-NAQPEMT- and using the other tools like informal interviews, interactions and classroom observations, the researcher felt the need of a strong design for the programme. The reviewed literature, study of the other programmes, teaching modules and programme principles have given a direction to the researcher for the present programme designing and development.

The present study was focused to develop and implement a Professional Enrichment Programme for secondary school Mathematics teachers. The following table explains about the 5 different phases of the study

Table 1: Different Phases of the Study

PHASE	PURPOSE	DESCRIPTION OF THE ACTIVITIES
I	Identifying the Training Needs of Secondary School Mathematics Teachers.	1. Review of various related literature. 2. Interaction with teachers and principals. 3. Development of the tool: Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPEMT). 4. Survey: Administering the NAQPEMT on a sample of 112 secondary school mathematics teachers.
II	Development of the Programme	1. Based on the outcome of the need assessment survey of Phase I, the content of the Professional Enrichment Programme (PEP) was developed.
III	Programme Validation	1. Validation of the programme by collecting the opinions of the experts -Professors, Principals, and experienced teachers of the relevant field.
IV	Implementation of the Programme	1. Physical training session of 62 mathematics teachers at secondary schools. 2. Selected 12 teachers were asked to explore the programme. 3. The programme was implemented on 12 teachers, conveniently selected by the researcher. 4. Online sessions with 12 teachers who implemented the programme.
V	Studying the Effectiveness of the Programme	1. Opinions were collected through feedback form from 62 teachers who attended the training session.

		2. Feedback and opinions were collected from 12 Teachers who implemented the programme. 3. Feedback was collected from students for whom the programme was carried out by the participating teachers. 4. Informal interviews were conducted to study the effectiveness of the programme.

11. POPULATION OF THE STUDY

Mathematics teachers working in the secondary schools constituted the population for the present study

12. SA.MPLE FOR THE STUDY

As the study was conducted in different stages, multi stage sampling technique were used to select the sample for the study. The following table shows the sampling techniques used for the different phases of the study.

T.able 2: Sampling Techniques

PHASE	PURPOSE	SAMPLE & SIZE	SAMPLING TECHNIQUES
I	Identifying the Professional Development Needs.	112 Secondary School Mathematics Teachers.	Random Sampling.
IV	Implementation of the Professional Enrichment Programme	62 Mathematics teachers for the physical training session. 12 Teachers to explore the	Convenience Sampling. Convenience Sampling.

		Modules of the Programme.	
V	Studying the Effectiveness of the Programme	12 Mathematics teachers. 221 Students of Classes 9 &10	Convenience Sampling.

13. RESEARCH TOOLS

The researcher developed the following tools for data collection, development of modules and to check the effectiveness of the developed programme.

Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPEMT):

In Phase I of the study, the researcher developed a questionnaire- Need Assessment Questionnaire for Professional Enrichment of Mathematics Teachers (NAQPEMT) to identify their professional development needs. The questionnaire developed by the researcher contained items with respect to content, methodology, classroom management, ICT resources, assessment practices etc. in order to understand the specific training needs and Professional Enrichment Programme needs of Secondary Section Mathematics Teachers.

Informal Interviews and Interactions:

During the initial phase of this study, the researcher conducted unstructured interviews and lots of interactions with different school Principals and Secondary Section Mathematics teachers to understand the specific areas of problems while teaching Mathematics in Class 9 and 10.

Inputs from such informal discussions gave the researcher a clear understanding and areas to focus while developing the enrichment program. Interactions and informal interviews were again held by the researcher during Phase –IV, the implementation of the developed programme and also during Phase –V while studying the effectiveness of the programme

Classroom Observations and Interactions:

During Phase I (identification of needs), the researcher did the classroom observations of selected mathematics teachers to understand the methodology used in classrooms, the content clarity and the learning outcomes in students, the learning gaps, the assessment practices, technology integration in classrooms and the classroom management skills of mathematics teachers. The researcher interacted with a few mathematics teachers and their principals to understand the training needs.

Also, to study the effectiveness of the implemented PEP, during Phase V, the researcher conducted classroom observations of few teachers who implemented the developed programme. These observations helped the researcher to study the impact of the programme on Teachers' Professional Development.

Feedback Forms:

In phase V, to study the effectiveness of the programme, the researcher used the Feedback Form.

3 types of Feedback Forms were developed by the researcher.

- To collect feedback from the participant teachers who attended the physical and online training sessions.
- To collect feedback from the teachers who implemented the programme.
- To collect feedback from the students at schools where programme was implemented by the participating teachers.

14. DATA COLLECTION PROCEDURE

Since the study was carried out in 5 different phases, the researcher adopted different tools and techniques for the data collection and analysis**.** A brief about the data collection procedure is given below.

Table 3: Data Collection Procedure.

Phases of Study	Data collection Procedure
Phase I: Identification of Professional Development Needs	**Primary Data**: Response to NAQPEMT by Mathematics teachers. Data through Informal Interviews, Interactions and Classroom observations of Mathematics teachers and Principals. **Secondary Data**: Data through review of Reports, Articles and Research Papers.
Phase II: Development of PEP	Inputs and opinions from secondary mathematics teachers and expert professors and principals who had mathematics background. Review of contents of other modules and other professional development programmes.
Phase III: Validation	Informal Interviews, Interactions and Discussion with teachers, experts and experienced professors and principals.
Phase IV: Implementation of PEP	Interaction with participating teachers by conducting offline and online sessions to give training clarity about the programme. Also, continuous discussions and observation of classes.
Phase V: Evaluating the effectiveness of PEP	Feedback and opinions of participating teachers who explored and implemented the programme, feedback from students whom the programme was implemented, data through Informal Interviews, Interactions and Classroom observations.

15. DATA ANALYSIS

Analysis and interpretation of the data gathered for the present study was carried out by the researcher, by keeping the research objectives in mind. Data collected during the various phases of the study by using the mixed methodology were both qualitative and quantitative in nature. The researcher followed the basic statistical analysis steps: collection of data, integration and presentation of data, analyzing the data, interpretation of data and the presentation of results- which were very essential for the research conclusion.

The quantitative data collected were analysed through the descriptive statistical analysis techniques – percentage and mean score calculations. First, the raw data was converted into table form by assigning numerical scores for each response. A 5- point rating scale was adopted in the questionnaire and in the feedback forms to convert the data in quantitative manner. Then the data was explored thoroughly by the researcher to organize the same and to keep the data ready for analysis and interpretation. The qualitative data obtained were analysed through both inferential and narrative analysis methods.

16. MAJOR FINDINGS OF THE STUDY

The following are the major findings of the study.

1. The study revealed that most of the teachers have difficulty in conceptual understanding and explanation of the topics: NUMBER SYSTEMS & TRIANGLES of Class 9 and REAL NUMBERS & TRIANGLES of Class 10 of the NCERT syllabus.
2. It was found from the study that the mathematics teachers have specific professional development needs in the pedagogic areas. These include providing remediation for low achievers; updating knowledge of mathematics-related career opportunities; selecting appropriate instructional strategies and learning new methods of teaching mathematics.
3. The study revealed that mathematics teachers' professional development needs include innovative methods of motivating students to learn mathematics; updating knowledge of applications of mathematics; preparing instructional and learning activities and evaluating students' progress.
4. ICT integration in teaching mathematics was found as a need for professional development for mathematics teachers.

5. Majority of the teachers opined that the programme developed by the researcher was found interesting and insightful for the teachers.
6. Majority of the teachers opined that the Self-learning Modules integrated with Technology helped them to enhance their pedagogical competencies.
7. It was found from the study that the program inputs in terms of content presentation, illustrations, relevance to day-to-day life, current developments in mathematics research, and innovative pedagogies were found interesting and meaningful by the mathematics teachers.
8. The majority of the students have opined that the experiential learning and Art integration in teaching mathematics were interesting and enhancing the concept clarity.
9. The study also revealed that the classroom activities incorporated in the modules and the video content support developed by the researcher were relevant, useful and helpful for the conceptual understanding and competency building in learners.
10. The study revealed that the program developed by the researcher was found effective as perceived by the teachers in terms of content clarity, self-directed learning, relevant activities, incorporation of NEP-2020 aspects, user friendliness and adaptability.
11. It was found from the study that the effectiveness of the program was appreciated by the participant teachers due to its:
    a) Self-explanatory nature
    b) User friendliness
    c) Provided links to many References and Assessment
    d) Well-structured pedagogy and design of each module.
    e) Relevant content and exercises.
    f) Clarity in the content presented.
    g) Outputs in terms of expected learning outcomes.

17. IMPLICATIONS OF THE PRESENT STUDY

The implications emerged from the present study are given below:

1) To ensure the quality in Mathematics education at Secondary level, the opportunities for the continuous professional enrichment program for teachers need to be assured / created.

2) It is necessary for Mathematics teachers of Secondary schools to equip and update them with the latest technologies and technology integrated teaching – learning to meet the demand of 21st century learners.
3) It is important to identify the professional enrichment and development needs of the Secondary Mathematics teachers, time to time, or at a regular interval.
4) Self-learning modules, integrated with technologies can enable the teachers to enhance their competencies and can implement and experiment innovations in real classroom situations, hence enabling the students to improve their performance academically

18. SUGGESTIONS FOR FURTHER RESEARCH

The researcher has made the following suggestions for further research, on the basis of the findings from the present study.

1) Study on development of professional enrichment programme for Secondary Mathematics Teachers by focusing the virtual class room needs.
2) Similar studies to develop enrichment programmes on the other topics of Secondary Mathematics.
3) Comparative studies in terms of Kendriya Vidyalay or other Government Schools' Mathematics teachers' professional development needs and Private Schools Mathematics teachers' professional development needs.
4) Studies on impact of Professional enrichment programmes on school's quality improvement.
5) Studies on development of professional enrichment programmes by focusing the Generic Competencies.
6) Comparative studies on professional development needs of offline and online class rooms of Mathematics.

19. CONCLUSION

The world is changing. Education in general and Mathematics Education in particular will continue to face challenges due to their evolving natures.

At present in India, to bring improvement in mathematics teaching – learning, the focus to be expanded from improvement of individual teacher to the system improvement. India's education sector is eagerly waiting to see the immediate and urgent measures of implementing the recommendation made by National Education Policy (NEP)-2020 to achieve the years' long expectations of the desired reformation and improvement in Education System and quality of teaching – learning, especially in Mathematics Education.

The ultimate aim of any professional enrichment programme for teachers is the learning improvement, academic achievement and competency enhancement of the learners. There is a strong need and scope for self-development, and self-updating by dynamic reading, online browsing, consulting experts, peer discussions and learning on the part of secondary school mathematics teachers. To ensure the quality of mathematics education at the secondary level, continuous professional enrichment opportunities for the teachers are to be created. The present study was done with a hope to make some quality addition in the present mathematics education system.