

## **CHAPTER 2**

### **REVIEW OF RELATED LITERATURE**

#### **2.0 Introduction**

The review of related literature made by the researcher, by focusing the objectives of the present study, is given in this chapter. The review was carried out by the researcher with the motive to provide a strong support to the conceptual framework of the present study. It was done also with an aim to explore the knowledge on various aspects of professional enrichment of teachers. Review was conducted in various phases. Researcher made the review with a prime focus to understand the learning difficulties of students, in mathematics subject. Further the researcher explored the studies conducted on the factors influencing the learning outcomes, difficulties of mathematics teachers, impact of professional enrichment programme of mathematics teachers. Apart from all these, the researcher also reviewed studies on various programmes so far developed for secondary school mathematics teachers.

Researcher explored into studies with the data bases of academic journals and abstracts. Sodhganga was found very useful in searching Indian studies. ResearchGate, Dissertation & Abstract of International studies proved useful in reviewing studies all around the world. Search using citation indexes and bibliographies given by other researchers also proved useful.

Researcher found numerous research studies conducted with different objectives and methodologies in the area of mathematics. The basic formula or key to raise the quality and effectiveness of mathematics education, reported in all research studies is raising the quality and competencies of mathematics teachers through training and professional enrichment and development programmes. The commissions and committees appointed by government and other concerned bodies which are responsible to assure the quality mathematics education at secondary level also emphasize on the preparation and in-service development of educators. The importance of professional development was prominently projected in several committee reports and policy frame works.

Kothari Commission (1964-66) recognized; the professional preparation of teachers as very crucial. National Policy on Education (NPE, 1986) opened new vistas in teacher education. The

need for professional development of teachers was pointed out by the NPE (1986). National Council for Teacher Education (NCTE, 1998) established by Government of India for the maintenance of standards and improvement of quality teacher education in the country emphasized that every five years, the progress be reviewed. During last decade, NCTE 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 (Yeasmin, 2017).

NCF–2005 also presented a new vision and addressed the on- going education issues. It identified the importance of teacher preparation and their professional growth in terms of quality and competencies. The Right of Children to Free and Compulsory Education (RTE) Act, 2009 pointed out the need for expanding institutional capacity of states to overcome the major challenges in preparing professionally trained persons as school teachers, in order to assure the quality of education.

The researcher reviewed the recommendations made after independence of the country by various commissions. All such committees have made recommendations for the quality improvement in education and for the assurance of quality mathematics teachers. National Education Policy (NEP)-2020, also has made strong recommendations for quality mathematics education at all levels, specifically at secondary level. The implementation of the important aspects of NEP-2020 is expected to bring a paradigm shift in the education system of India. The researcher has reviewed each aspect of the policy minutely and has incorporated certain important recommendations made by NEP-2020 while developing the professional enrichment programme for mathematics teachers of secondary level.

The other studies reviewed by the researcher were categorized under 4 broader headings 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 Development of Professional Enrichment Programmes in Mathematics and other subjects.
- 4) Studies on Impact of Professional Enrichment Programmes of Mathematics Teachers.

The reviews of related literature of all the above categories are presented below in details.

## **2.1 Learning Outcomes in Mathematics in School Education**

The review of related literature made under this category was with an aim to understand the current education system and learning outcomes from mathematics education. The reviewed studies were majorly conducted in India and a few in other countries. The review gave an insight to researcher about the various methodologies adopted in the earlier research. The major findings reviewed in these studies helped the researcher to get an understanding of the purpose with which the current study to be focused on.

**Baskaran (1991)** made a study on ‘The Relationship among Achievement Motivation, Attitude towards Problem Solving and Achievement in Mathematics of Standard X Students in Devekottai Educational Districts.’ Stratified sampling technique was adopted to select the sample. Achievement Motivation Inventory Test, Attitude Scale and Achievement Test in Mathematics were used as tools at various levels. Major findings include:

- There is a positive relation between the attitude towards problem solving and achievement in mathematics.
- Urban and Rural students did not differ in their achievement motivation and attitude towards Mathematics, but differ in their mathematics achievement.

**Hiebert & Grouws (2007)** studied ‘The Effects of Classroom Mathematics Teaching on Students’ Learning.’ The objective of the study was to tackle directly the issues of teaching effectiveness which influence the students’ learning outcomes. They first examined why it has been so difficult to establish links between teaching and learning. The two features of classroom teaching they identified for developing students conceptual understanding and mathematical proficiency were (1) explicit attention to connections among ideas, facts and procedures and (2) engagement of students in struggling with important mathematics. They found that most important feature in effective teaching is giving opportunities for student to learn. Teachers should use teaching methodology, strategies, pedagogy, resources, etc. which should be facilitating students’ adequate responses and thus to facilitate in their learning outcomes.

**Gootenboer & Hemmings (2007)** studied ‘Mathematics Performance and the Role Played by Affective and Background Factors’ and examined the factors which contribute to the mathematics performance of a sample of children aged between 8 to 13 years. The study was designed specifically to consider the potency of a number of mathematical affective factors as well as background characteristics (gender, ethnicity and socio-economics status) on students’ mathematics performance. Data was collected by surveying the children and drawing on performance rating from their teachers. The correlation analysis revealed that the relationships between the respective dispositional and background variables with mathematics performance were significant in the direction as predicted. The findings from the logistic regression showed that a combination of these variables was able to appropriately classify students who either were below average or above average performers.

**Jaiyeoba & Atanda (2011)** in their study titled ‘School Quality Factors and Secondary School Students’ Achievement in Mathematics in South Western and North Central Nigeria’ investigated nine school quality factors that were likely to influence students’ achievements in mathematics of the stated region of Nigeria. The study adopted the descriptive survey research design of the ex-post facto type and made use of a sample of 1,014 Mathematics teachers and Principals selected through a multistage sampling procedure. The two tools used were school based Quality Inventory ( $r = 0.89$ ) and school-based Quality Factor Questionnaire ( $r = 0.92$ ). Three hypotheses were tested at 0.05 level of significance. Data collected were analyzed using mean, standard deviation and multiple regressions. The finding of this study affirmed that all the nine school-based quality factors identified, accounted for little proportion of students’ achievement in mathematics. Out of the nine variables, 2 variables that contributed significantly to students’ achievement in mathematics are basic conveniences (toilets and other facilities) and instructional materials. It recommended that instructional resources should be provided in schools.

**Bhagowati (2011)** made a study on ‘Present Scenario of Mathematics and Science Learning in Secondary Schools of Morigaon District,’ through a survey method with the objectives:

1. To study the facilities provided by Government of Assam for the development of science and Mathematics education of secondary schools in Morigaon District.
2. To examine the inadequate knowledge in the subjects raises school drop out on the other hand appreciable knowledge in the subjects boosts up their confidence.

3. To study parents' role on learning the subjects.
4. To study whether the teachers use computers in teaching Mathematics and Science.

Data collection was done through interview and discussion. Students' data collection was done through survey by preparing questionnaire. 300 secondary school students of 10 schools of various locations of the district was the sample. Major findings were:

1. Appointment of qualified teachers led to a boost up in the teaching learning process.
2. The root cause of the mistakes done in secondary level are because of defective teaching in lower level. These mistakes can be reduced if qualified teachers are appointed in lower classes also.
3. Most of teachers in the area are found to be interested in attending training programmes in order to improve their teaching knowledge and skill. Therefore, government must arrange short term training programmes for all the mathematics and science teachers at regular interval of time in every stage.
4. Poor economic condition of the parents and lack of awareness about education influence the teaching learning process, especially in rural and interior areas. Education awareness programmes should be a part of education system of government and poor students must be provided financial help from early stages.
5. Science and Mathematics laboratory is very much important to increase interest in the subjects. So, government must think of it, as an urgent need. The study also recommended:
  - Positive use of computer should be maintained.
  - It should be ensured that all teachers are computer literate. For this purpose, one computer teacher should be appointed in each school and there should be regular computer classes for the students as well as teachers.

**Mahanta (2012)** conducted a study on 'Achievement in Mathematics: Effective of Gender and Positive / Negative Attitude of Students' of class X in Secondary Schools located in District of Nagaon, Assam. Questionnaire containing 50 Questions was prepared with positive and negative implications which were administered to a sample of 500 students, 25 from each school. Data Analysis was done through statistical tools. The finding reveals that (a) most of the Boys and Girls have positive attitude towards mathematics, (b) there exists a slight difference in

achievement in mathematics due to gender (c) there is no difference in achievement in mathematics due to medium of instructions (Assam and English).

**Vijayan (2014)** investigated on ‘Some Correlates of Poor Performance in Mathematics – An Experience from Central School for Tibetans, By Lakkups, Karnataka.’ In this action research, participants were 2 sections of class tenth students – a Total of 40 (23 Boys and 17 Girls). The study combined both quantitative and qualitative research techniques for collecting and interpreting data. Triangulation methodology was incorporated for drawing out appropriate conclusion. The major findings revealed that higher the students’ attitude towards mathematics, greater is the mathematics achievement score. It was also found that attitude towards mathematics is positively and significantly correlated with mathematics base of students, which in turn pointed out the teachers’ role. Teachers should use appropriate strategies to develop a positive attitude in students towards mathematics, then students will automatically start studying mathematics. It also recommended that the concerned teacher should spend at least one period per week (or free time) for improving students’ basic mathematics skills through various methods.

**Michael (2015)** conducted a study on ‘Factors leading to Poor Performance in Mathematics subject in Kibaha Secondary School’ of Tanzania, with the objectives to examine the influence of cultural backgrounds on students’ performance in mathematics, to identify influence of teacher – student’s relationship on student’s performance in Mathematics, determining the nature of school environment where teaching is practiced and to examine influence of school management system on coaching and learning process on mathematics. The study involved 4 secondary schools, 8 mathematics teachers and 60 students. Simple random sampling technique was adopted. Data collection was done through questionnaires, interviews, focus group discussions, observations & documentary review. The findings indicated teaching and learning of mathematics was facing challenges such as poor teaching environment, mathematics departments were not well managed, inadequate self-practice and students’ poor background in mathematics. The researcher recommends teachers to make assessment on the background of their students in to decide teaching methods that can help students perform better in mathematics. Moreover, students also have to put self-efforts and practice in learning mathematics.

**Harefa (2023)** conducted a study on ‘The Relationship between Students’ Interest in Learning and Mathematics Learning Outcomes’. The study was aimed to determine a positive and significant relationship as well as an influence between students' interest in learning and their mathematics learning outcomes. The research method used was quantitative research with a correlational approach. The population consisted of all 65 students of eighth-grade at SMP Negeri 1 Toma. The sampling technique used was total sampling, means the entire population was used as the sample. The tool used was the closed-ended questionnaires and students' mathematics learning outcomes in the form of even semester final exam scores (UKK). Data analysis techniques involved describing the data, correlational analysis, coefficient of determination, and hypothesis testing. The results of this study show that there is a positive and significant relationship between students' interest in learning and their mathematics learning outcomes, and there is also an influence of students' interest in learning on their mathematics learning outcomes. The study concluded that: because students had a sense of enjoyment, interest, and a high desire to learn which they perceived as beneficial and satisfying, students felt comfortable, and were aware of the benefits of learning, and understood the learning objectives, which made them interested and led to an improvement in learning outcomes.

## **2.2 Difficulties Faced by Mathematics Teachers**

Review of related literature made in this category helped the researcher to identify the common difficulties faced by teachers, while teaching the subject mathematics. It also enhanced the researcher’s understanding about the various tools which can be developed and administered for the identification of training needs of the teachers with respect to the current study.

**Ale (1981)** conducted a study on ‘Difficulties facing Mathematics teachers in developing countries’ – a case study of Nigeria. The objective of the study was to determine the major difficulties confronting Mathematics teachers and also to quantify the gravity of these difficulties. Data collected through questionnaire revealed the major difficulties of teachers as: Lack of appropriate knowledge of Mathematics and lack of communication skills, Lack of basic knowledge of the subject and the negative attitude towards the subject, Abstractness of the content in the text book, Lack of teaching aids, Lack of linkages in the topics and hence making the subject irrelevant, Overcrowded classrooms which make classroom environment in conducive for learning, Insufficient time allocation for the subject.

**Singha et al. (2012)** made a study on ‘Various Problems faced by the Students and Teachers in Learning and Teaching Mathematics and their Suggestive Measures.’ The study adopted the descriptive survey design using simple frequency and percentage in analyzing the data. 5 Students and 1 teacher were randomly selected from 5 higher secondary schools of Jorhat District of Assam. The study revealed the following difficulties:

Problems of students: -

Too complex to understand, Not interesting due to lack of applications, Lots of formulae to be memorized, Time consuming (Needs more practices, so its time consuming), Due to lack of practical aware of its applicability, Learning mathematics needs extra coaching which is unaffordable for many students, Students do not get the expected marks and Base of mathematics is not perfectly clear at school level.

Problems faced by teachers:-

Most students come to the classroom with negative attitude towards mathematics, Lack of tools to make teaching of mathematics interesting, Normal time period in schools and colleges to teach mathematics is not sufficient, Many students do not take mathematics willingly; rather they are forced by the parents and Many students try to memorize the mathematical techniques without understanding it.

Suggestive measures mentioned in the study were:

1. Measures should be taken to make Mathematics interesting at school level.
2. Exhibition of mathematical model at school and college level should be conducted.
3. Mathematical quiz should be organized in schools and colleges at regular interval.
4. Regular students’ seminar should be arranged to highlight the importance of mathematics for the career development of the students.
5. Teachers should use the simplest and the most interesting method to teach mathematics by taking examples from daily life.
6. Regular refresher courses should be arranged for the mathematics teachers at district level.

**Sarma & Ahmed (2013)** conducted a study on ‘The Difficulty of Teacher of Learning Mathematics in Under Graduate Level with Special Reference to Guwahati City’ with the objective to find out the problems of teaching and learning mathematics in the under graduate level in the colleges of Guwahati, Assam. For taking up the sample, simple random sampling

without replacement method has been used. 10 colleges having mathematics as subject have been selected and from each college 25 students have been selected at random without replacement. Data has been collected through questionnaire and observations in the experimental classes conducted. Again 25 teachers from selected colleges were also interviewed to collect the necessary data for study. Data analysis was done through statistical method. The major findings and recommendations were:

- Recruitment of mathematics teachers to be done very carefully so that no loophole remains on the part of educators to do away with the fear of mathematics among students.
- While screening and selecting mathematics teachers, emphasis should be more on mathematics teaching skills apart from theoretical knowledge.
- Role of teachers has much significance. They should have updated knowledge and skills to tackle students.

**Karahi (2022)** studied ‘Difficulties Classroom Teachers Encounter in Teaching Mathematics: A Phenomenological Study’. The aim of the research was to identify the difficulties that were faced by classroom teachers in teaching mathematics and to put a current perspective. In the research, phenomenological design from the qualitative research method was applied. Participants were determined by criterion sampling, which is one of the purposive sampling methods. Semi-structured focus group interviews were conducted to determine the opinions of the classroom teachers about the problems they had in teaching mathematics. The participants of the interview were a total of 7 primary school teachers, 4 female and 3 male. Content analysis was used in the analysis of the data. Research findings 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)** conducted a study on ‘ Mathematics teachers’ perceptions and challenges in using blended learning for optimum mathematics delivery in the post COVID - 19 classrooms.’ The study was to examine mathematics teachers’ perceptions and challenges in using blended learning for optimum mathematics delivery in the post Covid-19 classrooms in

Anambra State, Nigeria. Descriptive survey design was adopted. Two research questions and one hypothesis guided the study. The population for the study was 89 mathematics teachers in Awka Education zone of Anambra State. The population was made up of 54 mathematics teachers in urban areas and 35 mathematics teachers in rural areas. A 20-item “Questionnaire for Mathematics Teachers’ Perceptions and Challenges in using Blended Learning for Optimum Mathematics Delivery (QMTPCBLOMD)” was validated by three experts and rated on four Likert scales. Cronbach Alpha was used to establish the reliability co-efficient of the instrument. The Cronbach Alpha reliability co-efficient was estimated at 0.84. Research questions were answered using mean and standard deviation, while the hypothesis was tested using z-test at 0.05 level of significance. The findings of the study showed that both urban and rural mathematics teachers perceived blended learning as the learning process that provided forum for interactive learning, promoted e-learning, fostered collaborative learning experience, incorporated both personalized and group learning, helped to share mathematics information and ideas globally and promoted student-centered learning. 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. There was no significant difference between the mean response of perceptions of urban and rural mathematics teachers in using blended learning for optimum mathematics delivery in the post COVID-19 classrooms. It was recommended among others that both mathematics teachers and students should be ICT compliant and adequate time should be given for teaching of mathematics. Then capacity building workshop on blended learning should be organized for both mathematics teachers and students and government should fund secondary education adequately.

**Pokhrel et al. (Aug.2024)** conducted a study- ‘Exploring Problems and Challenges Faced by Teachers in Teaching Mathematics at Basic Level in Nepal.’ The study was to identify the challenges by teacher when teaching mathematics at the basic level school. The analysis was based on six dimensions of the teachers’ demographic factors, such as gender, age, qualification, experience, training, and school type. The study highlighted the numerous challenges faced by basic-level mathematics teachers, including content delivery, student engagement, resource use, classroom management, assessments, and professional development. The multiple regression value, R square and the adjusted R square value for those variables were found to be 0.469, 0.220, and 0.0792 respectively. Study concluded with the findings: 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.

### **2.3 Development of Professional Enrichment Programmes in Mathematics and other Subjects**

Information gathered through the review of literature on professional enrichment programmes in mathematics and other subjects gave deep insights to the researcher on the earlier developed programmes and the methodologies used for the research. Review of the findings of these studies about the improved learning outcomes, motivated the researcher to carry the present study ahead.

**Wagh (1991)** developed a ‘Multimedia Instructional System for Remedial Purposes for Fractional Numbers.’ 120 students of class VIII consisted the sample for the study. Data collection was done through survey and diagnostic test was used as tool. In the study, the researcher found students making common error in fractional numbers operation, committing common errors in the basic process and cross multiplication.

The Multimedia Instructional System (MIS) and Traditional Instructional System (TIS), both found effective in remedial to improve students’ performance in all computational skills in fractional numbers.

**Sullivan et al. (2007)** conducted a study on ‘Planning and Teaching Mathematics Lessons as a Dynamic and Interactive Process’. They researched actions that teachers can take to improve mathematics learning for all students with particular attention to specific group of students who experience difficulty. After identifying possible barriers to learning, they offered teachers, mathematics lessons structured in a particular way. Teachers’ use of this model, as stated in the findings was “productive and their planning and teaching proved to be dynamic and interactive”.

**McDonald (2009)** made a study on ‘A Model of Teacher Professional Development based on the Principles of Lesson Study.’ This research provided qualitative and empirical data to establish links between ‘teacher knowledge’, ‘teacher practice’ and ‘student learning outcomes’. Study started from 2007, with five teachers and approximately 160 students, the ‘Lesson Study – Principled model of professional development’ provided the teacher participants with on-site, on-

going and reflective learning based on their classroom environment. An experiment design was used “to develop the professional development as an intervention of prevailing teacher practice of which data were collected prior to and after the period of intervention”. A model of teacher change was developed and was useful in making decisions about data collection and analysis. Data sources consisted questionnaires, pre-tests, post-tests, interviews, observations and field notes. Finding of the study showed that “content knowledge and pedagogical content knowledge were increased among the teacher participants and a majority of students demonstrated improved learning outcomes”. The effectiveness of this model was evaluated using Guskey’s (2005) “Five Levels of Professional Development Evaluation”.

**Kensington-Miller (2013)**, the academic developer of Mathematics Education, University of Auckland, New Zealand, conducted various research on Mathematics Education of New Zealand and developed a ‘Professional Development Model for Secondary School Mathematics Teachers: a Peer Mentoring Model.’ The model involving a combination of one-on-one peer mentoring integrated with group peer mentoring was piloted with experienced 11 mathematics teachers of senior students in 10 design schools which were with low socio –economic culture in New Zealand. The investigator organized opportunities for peer mentoring and group meetings for one school year. Throughout the school year, they met eight times for planned Professional Development meetings. Data was collected through questionnaire. At the end of the study, in-depth interviews were being carried out. The interview transcripts were coded and analyzed through an interactive process, “to identify recurrent themes that emerged from the data relevant to the research questions. Finally, using causal networks, the relationships between the codes were made with plausible interpretations of events. The study highlighted the benefits and feasibility of using the model for Professional Development as well as factors that were key for successful implementation. The feature, meeting together as a group, assisting the one-on-one peer mentoring” proved very effective and significant.

**Souza et al. (2014)** conducted a study on ‘Professional Development of Mathematics Teachers Implementing Probabilistic Simulations in Elementary School Classrooms.’ The study states “The inclusion of statistics and probability in the mathematics curriculum has always generated challenges to mathematics teachers. This study was to promote the professional development of such teachers. The researcher had considered two case studies of teachers who focused the

teaching activities on probabilistic simulations. Throughout the planning stage, it was noted they had difficulties and needed different ways to address the topics. Results of the study demonstrated that “the joint elaboration and discussion, within an educational space marked by collaboration, afforded teachers’ greater security when addressing the subject and allowed them to develop new knowledge and ideas on teaching and learning statistics and probability”. In the conclusion it recommended that “a process of professional development should allow teachers to get involved in the identification of problems and aspects that need to be improved in their approaches”.

**Wessels (2014)** developed a professional development programme for ‘Developing Statistical Knowledge for Teaching of Variability’, which focused on: statistical literacy, more specifically on the development of in-service teachers’ awareness and reasoning about variability in multiple trials under uncertainty, and their ability to transfer their understandings to related tasks. Study states, “Variability and uncertainty are key concepts in statistics, but are under-emphasized in many school curricula. These topics formed part of the focus of the intervention. Analysis of post intervention tasks revealed a growth in teachers’ levels of reasoning about variability and their ability to transfer these competencies to related tasks. The results emphasized the value of well-designed learning experiences and rich discussions in teacher professional development programmes in statistical literacy”. The research project had focused on the professional development of mathematics teachers’ statistical thinking and statistical knowledge for the teaching classes 8 to 12. The research was qualitative in nature. 8 workshops in series were offered to 14 volunteer teachers regularly, aiming at their development. The sequence of workshops proved successful and enriched the teachers’ statistical knowledge for teaching and enhanced their statistical thinking.

**Sulastri et al. (2018)** conducted a study and worked on on ‘Developing mathematics training modules to enhance teachers’ content knowledge’. The purpose of the study was to develop six mathematics-training modules concerning the content knowledge of mathematics teachers satisfying the valid and practical criteria. This research employed the research and development approach of Borg and Gall model in ten phases. However, the development in this research was conducted only up to the eighth phase. The results showed that six mathematics-training modules satisfied the valid and practice criteria. The validity was indicated by the conformity of the

materials and concepts for mathematics with teachers' problems, and the curriculum. The practical criteria were based on the conformity of the implementation of the training modules designed; the efficiency, usefulness, and attractiveness as the modules were designed into several parts included the instructions and estimation time; and the legibility and the easy- to use- aspects.

## **2.4 Impact of Professional Enrichment Programmes of Mathematics Teachers**

Review made under the above category was to understand in depth about the impact and effectiveness of the professional enrichment programmes for mathematics teachers, on enhancing the competencies of teachers in the teaching process and also to understand their impacts on the learning outcomes of the learners. The findings of these reviews encouraged the researcher to carry out the present study with a focus to enhance the knowledge, skills and professional competencies of secondary mathematics teachers and to have the improved learning outcomes of the students of secondary classes.

**Ingvarson et al. (2005)** conducted a study on 'Factors Affecting the Impact of Professional Development Programs on Teachers' Knowledge, Practice, Student Outcomes and Efficiency.' It was based on four other studies undertaken through the Australian Government Quality Teacher Programme, designed to enhance teachers' quality. The total data set for the survey study includes 3,250 teachers who had participated in eighty individual professional development activities within these studies. They were surveyed at least 3 months after participating in an activity. To investigate factors affecting impact, a theoretical model was developed on recent research into the characteristics of effective professional development and tested using block-wise regression analysis. One of the main findings from the study was that among all variables, 'in the block of opportunity to learn or process' variable had the largest effect on individual program outcomes.

**Zambo, R. & Zambo, D. (2007)** studied 'The Impact of Professional Development in Mathematics on Teachers Individual and Collective Efficacy.' The participants were 63 teachers of 4<sup>th</sup> – 10<sup>th</sup> Grade who voluntarily participated in the two-week summer professional development workshops on mathematics problem solving. The workshops focused on helping teachers increase their own problem-solving ability as well as improve their classroom problem

solving instruction. 32 teachers were from schools with a low incidence and other 31 from a district with a high incidence of schools labeled underperforming. Group competence and contextual influence, subscales of collective teacher efficacy were measured before and after the workshops using 21 item Likert Scale Collective Efficacy Questionnaire. The major finding of the study was that Professional Development in Mathematics has the potential to affect teachers' personal competence, whether they work at a low or high performing school. It also has the potential to raise the group competence of teachers in underperforming districts when they come together and work as a team.

**Blank et al. (2008)** made analysis of evaluation findings from programs for mathematics and science teachers in 14 states and a report was prepared on the study on 'Does Professional Development Have Effects on Teaching and Learning?' In 2005, the Council of Chief State School Officers (CCSSO) began a study of teacher professional development programmes in Mathematics and Science through a grant from the National Science Foundation. The study was designed to assist education leaders in all states by providing a cross-state analysis of the quality of professional development programs and evaluations using a common rubric developed from research on program effectiveness. CCSSO reviewed evaluation studies from 25 professional development programs for teachers of mathematics and science, from programs nominated by 14 states. The evaluation study reports and papers served as the data sources for the analysis and paper. The reports primarily addressed evaluation findings from professional development activities conducted during the period 2004 through 2007. Following were the several key findings from the study:

- One-third of evaluation studies reported measurable effects of teacher professional development.
- Content focus plus sufficient time plus in-school component equals significant effects.
- Purposeful evaluations yield measurable effects.
- Teacher vs. school-based professional development designs provide differing data on success.
- Include outcome measures in allocation of evaluation resources.
- Plan for use of data systems and experimental designs.

- Link teacher knowledge gains to change in classroom practices.
- Use findings in program decisions.
- Value partnerships for evaluation.

**Hirst et al. (2009)** researched about “Effective CPD in Mathematics Education” with the help of Research Advisory Group of the National Centre for Excellence in the teaching of Mathematics (NCETM). The study investigated 30 CPD (Continuous Professional Development) initiatives representing different models of CPD for teachers of Mathematics, in different locations of England. About 250 teachers in various levels (including Secondary) were involved in these initiatives. 2 teachers from each initiative were interviewed and observed in their classrooms. The full data set comprises responses to questions for organizers, online questionnaire responses etc. Because of the approaches this study adopted, it has been able to provide perspectives and insights that were missing in other research concerning professional development of teachers of mathematics. The study in the conclusion, recommended to encourage and support teachers to try new ideas for teaching and learning mathematics with students and to embed approaches they are beginning to adopt.

**Watson (2014)** conducted a study on ‘The Impact of Professional Development on Mathematics Teachers’ Beliefs and Practices’ which describes the analysis of the implementation of a professional development programme for secondary mathematics teachers in England. The research used a mixed – method multiply case study design with 3 secondary schools. In the qualitative analysis of multiple individual cases, the investigator explored how observational learning processes work, in the context of professional development and the mechanism of which teacher self- efficacy is developed. The major findings of the study revealed that the professional development had an impact on teachers’ self- efficacy. The overall effect was, those who participated in the professional development were more confident in teaching, using the suggested approach as a result of the professional development programme.

**Yeasmin (2017)** conducted a study on “Professional Development of Mathematics Teachers – Transforming Intangible Pedagogy into Reality.’ The study highlighted the aims of professional development and explored necessity of new pedagogy to connect abstract conjectural of mathematics into reality. In the methodology, researcher used government documents, project

reports, national and international journals, articles on research work etc., as source of secondary information. It concluded with the finding that traditional method of teaching is one of the major courses behind students' 'poor achievement' in mathematics and the improvement can be attained through constructivist approach of teaching and to prepare the teachers for the same, they need to be provided with professional development program which focuses on: Knowing / Understanding, Standards, Using standards as a basis for instructional planning. Teaching using best practices, Multiple approaches to assessment, Develop / provide instructional support materials such as curriculum maps and pacing guides and Establish math leadership teams and provide math coaches.

**Ramos-Rodríguez et al. (2022)** conducted a study on: 'Effective Teacher Professional Development Programs, A Case Study Focusing on the Development of Mathematical Modeling Skills'. Study states: A concern in Mathematics Education was the professional development of the teacher and to promote effective training programs. The literature provided principles guiding the design of such programs, which were considered for an instruction intended to strengthen the teacher's practice in relation to the development of mathematical skills. The objective of the work was to study if the designed program was effective, in relation to the impact on the teacher's teaching. It was a case study on a group of in-service teachers focused on the ability of mathematical modeling (MM) and their perspectives of this skill was carried out. This was divided into three moments: before, during, and after the program. The findings show that, before the program, teachers conceived modeling from epistemological, pragmatic and conceptual perspectives; during the program, they focused on the pragmatic and educational perspectives; and at the end of the program, the group was stripped of the pragmatic, epistemological and conceptual perspectives to move towards the educational and socio-critical. They were also able to justify the choice or disassociation of one or more of them. The study pointed towards the concretion of more specific and robust professional development programs for mathematics teachers.

## **2.5 Implications of the Reviews for the Present Study**

Though many research and studies are being conducted on mathematics education and mathematics teacher's professional enrichment, most of the studies have been carried out in foreign countries. Comparatively only few studies were being conducted in India. The researcher

observed that in most of the studies reviewed, teachers' role is very significant in making the learners for the better understanding of the subject. Most of the studies reviewed, made recommendations to improve the teaching style and to adopt innovative teaching methodologies in order to achieve the desirable learning outcomes from secondary mathematics education.

Reviews under the category **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. Baskaran (1991) in the study on 'The Relationship among Achievement Motivation, Attitude towards Problem solving and Achievement in Mathematics of Standard X Students in Devekottai Educational Districts.' revealed the finding that there is a positive relation between both. Hiebert & Grouws (2007) recommended teachers to use various methodologies and strategies to facilitate the students' learning outcomes. Gootenboer & Hemmings (2007) stated that students' background factors have connection in their mathematics performances. Jaiyeoba & Atanda (2011) recommended that instructional resources should be provided in schools. Bhagowati (2011) in the study on 'Present Scenario of Mathematics and Science Learning' mentioned that training programmes for teachers to be arranged at regular interval and all teachers must make positive use of computers. Mahanta (2012) found that the medium of instruction does not affect the students' achievement in Mathematics. Vijayan (2014) recommended that mathematics teacher should spend extra time for improving students' basic mathematics skills. Michael (2015) found teaching and learning of mathematics face challenges such as poor teaching environment, inadequate self-practice and students' poor background in mathematics. Harefa (2023) found that there is a positive and significant relationship between students' interest in learning and their mathematics learning outcomes, and there is also an influence of students' interest in learning on their mathematics learning outcomes.

Studies reviewed under the category: **Difficulties Faced by Mathematics Teachers** revealed lots 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) through the research: 'Difficulties Classroom Teachers Encounter in Teaching Mathematics: A Phenomenological Study' 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), in the study: ‘Exploring Problems and Challenges Faced by Teachers in Teaching Mathematics at Basic Level in Nepal.’ 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.

Professional enrichment programmes for mathematics teachers of any level proved effective and studies reviewed under the category: **Development of Professional Enrichment Programmes in Mathematics** emphasized the need of such enrichment programmes and modules for the effective teaching of the subject mathematics. Souza et al. (2014) who developed a programme of ‘Probabilistic Simulations in Elementary School Classrooms’ recommended that such programmes to be developed in order to allow the teachers to get involved in the identification of problems and aspects that need to be improved in their approaches. Programmes like Multimedia Instructional System for Remedial Purposes for Fractional Numbers by Wagh (1991), ‘Planning and Teaching of Mathematics Lessons’ by Sullivan et al. (2007), ‘Professional Development based on the Principles of Lesson Study’ by McDonald (2009) and ‘A Peer Mentoring Model’ by Kensington- Miller(2013) proved helpful in increasing the pedagogical content knowledge of participant teachers and after the implementation of such models, students demonstrated improved learning outcomes. Wessels (2014) reported that the sequence of professional development workshops proved to be worthwhile for development of teachers’ statistical knowledge for teaching and statistical thinking. Analysis of the results revealed a growth in teachers’ levels of reasoning about variability and their ability to transfer these competencies to related tasks. Sulastri et al. (2018) found that six mathematics-training modules satisfied the valid and practice criteria.

Under the category: **Impact of Professional Enrichment Programmes of Mathematics Teachers**, the review made on the research done by Ingvarson et al. (2005) and Hirst et al. (2009) showed that there is a significant and positive impact of professional enrichment programmes of mathematics teachers in the learning outcomes of students. Watson (2004) had stated in the findings of the study that professional development had an impact on teachers' self-efficacy. Also, the content knowledge increased among the teacher participants, after its implementation. Yeasmin (2017) reported that 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. Blank et al. (2008) made analysis of evaluation findings from programs for Mathematics and Science teachers in 14 states and reported measurable effects of teacher professional development. Zambo, R. & Zambo, D. (2007) stated in the findings that professional development in mathematics has the potential to affect teachers' personal competence, whether they work at a low or high performing school. It also has the potential to raise the group competence of teachers in underperforming districts when they come together and work as a team. Ramos-Rodríguez et al. (2022) pointed out the concretion of more specific and robust professional development programs for mathematics teachers.

Researcher reviewed a total of 29 related studies. The gist of all the reviewed related literature is that success of any education in general and specifically mathematics education depends on the quality and professionalism of teachers. To achieve this, it is very essential to provide opportunities to teachers for improving their capacities. Exposing them towards various professional enrichment programmes is the tool by which policy makers and curriculum reformers' visions for change can be disseminated and conveyed to teachers. The reviewed related studies helped the researcher to conceptualize the present study. Reviewed related literature and their findings paved the way for researcher to expedite further and also to draw many significant implications for the present study. It facilitated the researcher to draw implications in terms of identifying various aspects of developing a professional enrichment programme. The review highlighted the direct relationship between the teachers' competence and students' learning outcomes. The success of all such earlier developed programmes, in terms of improved learning outcomes of learners, motivated the researcher to work with a desire

to enhance the teachers' competence, knowledge, skills, and methodologies of teaching, in a manner to increase the interest of learners in the subject mathematics.

Studies have revealed the need of developing professional enrichment programmes in complex topics of mathematics. Though many research and studies are made abroad, the researcher found the dearth of such modules and programmes developed in India. The researcher being in the field of education, observed the lack of quality teaching in secondary level mathematics due to various reasons. Through the reviewed studies, the researcher understood the different topics so far covered in mathematics by researchers who developed professional enrichment programmes in the past. This provided the researcher to have a framework for the present study.

## **2.6 Conclusion**

Review of the related literature presented under 4 categories mentioned in the chapter, the reviews on the various education policies during post- independence, and also the reviews on the recent NEP-2020, provided the researcher with a good frame work for the present study. The gist of all the related literature reviewed by the researcher was – the quality and the professional competence of the teachers play a vital role in making the education system an impactful one. Quality and the competence of the teachers can be achieved through their continuous professional enrichment programmes. The researcher could draw significant implications from the reviewed studies to conceptualize the present study.

The next chapter presents the details of the research methodologies adopted by the researcher for the present study.