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INNOVATIVE PRACTICES IN TEACHING MATHEMATICS

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ABSTRACT

Mathematics education is evolving constantly. Though the basic concepts in Mathematics remain the same, new trends and methods of teaching evolve as per the requirement of the changing the socio-cultural and psychological status of the learners. In order to meet the demands of the curriculum and the present century mathematics learners, in this rapidly changing world, it becomes necessary for mathematics teachers to have innovation in classrooms and also to have innovative teaching learning resources with them. Though most of the mathematics teachers are equipped with good content knowledge, innovation is needed in their pedagogical planning and in methodology of teaching. Resources in terms of the best curriculum text books, reference books, etc., are available for teachers, but there is a need for the development of innovative teaching – learning practices and strategies to enhance and enrich the teaching – learning happening in mathematics classrooms. This research paper highlights the need for the development of innovative teaching – learning resources for the present century Mathematics teachers and employing the innovative practices in Mathematics classrooms.

Keywords: Innovative Practices, Mathematics Education, Teaching – Learning Resources, Development of Innovative Strategies.

Introduction

"Destroying any nation does not require the use of atomic bombs or long missiles. It only requires lowering the quality of education... the collapse of education is the collapse of nation" (Sharma, M., 2017, Speaking Tree, TOI). The importance of a good education system for a country is well summarized in the above few lines.

Education system has a tremendous responsibility to transform a child into a fully developed individual. Over the ages, academicians and educationists of the country were relentlessly working to develop a system of education which can express and promote its social and cultural identity, a system which can full fill the requirement of the time. Continuously research studies are happening in education sector for the improvement of the existing system and to establish a system where in learners can be equipped with skills necessary to prepare them to face the technological world and also to prepare them for the current century learning and life. The new National Education Policy (NEP) – 2020 has emerged as a result for the need for such a reform.

Significance of the Study

Mathematics education being an unavoidable or integral part of the curriculum, if structured in the right manner, it can contribute to the progress of our Nation. All available means should be practiced to improve Mathematics education. However, the fact that the majority of students consider Mathematics as a difficult subject to learn, makes it urgent for schools to exploit all resources and strategies to help students understand it (Algani, 2019). Rapid technological advancement also indicates the importance of employing innovative strategies and teaching practices in Mathematics education by integrating technology in the classrooms.

Resources in terms of text books, reference books, good infrastructure, well set Mathematics laboratory, etc., are available for Mathematics teachers in majority of schools and most of the mathematics teachers are well equipped with their content knowledge too. But the variation in the learning outcomes in different students indicates that the quality of methods used in content explanation and the pedagogical planning need change and improvement. Many studies on the related topics are made mostly in Arabian countries, less studies are found in India on developing various strategies for improvement of Mathematics education. The present study is made with a purpose to understand the need of development of innovative teaching – learning resources for quality Mathematics education.

Objectives of the Study

The objectives of the study, based on the above purpose, are as follows

1) To study the different strategies and teaching practices in Mathematics education.
2) To study the need of development of innovative Mathematics teaching – learning resources.

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Methods and Procedure

The study was to investigate the present trends and practices in Mathematics education and to suggest few innovative strategies for Mathematics teachers. Qualitative approach-based on unstructured interviews, discussions and interaction with teachers of 3 different schools and also the observations of their classes-was adopted in the study. Recommendations and findings of previously conducted studies also gave strong foundation for this study and helped in getting an accurate qualitative result for the study. Answers and opinions collected from teachers through the unstructured interviews were analyzed qualitatively to interpret and to formulate the findings.

Reformations in Mathematics Education over the years

Mathematics as a compulsory subject is taught in School Education. Mathematical skills are crucial for a wide array of analytical, technological, scientific security and economic applications (Norris, 2012). Training students to become adept users of Mathematics and to appreciate its usefulness is of paramount importance for the future. Mathematics is not only needed for the understanding of the other Sciences, understanding of a basic level of numeracy is required for all in order to function in an increasingly complex world (Burghes, 2011).

Several efforts have been made through commissions and committees to improve the quality of education in general and Mathematics education in specific. Since last few decades, Mathematics education in school, both at elementary and secondary stage has made remarkable reformation by reforming curriculum, renewing textbooks and changing teaching – learning process. The major reforms in curriculum for all stages of school education came after National Policy on Education (NPE), 1968.The next major change occurred in terms of curriculum and teaching strategies with New Education Policy, 1986 which was subsequently amended in 1992.

National Policy on Education (1986) recommended a common core component in the school curriculum throughout the country. The policy also entrusted National Council of Educational Research and Training (NCERT) with the responsibility of developing the National Curriculum Framework and reviewing the framework at frequent intervals. The National Curriculum Framework (NCF) – 2005, is one of the four National Curriculum Frameworks published in 1975, 1988, 2000 and 2005 by NCERT. With the purpose to make education a joyful experience for children, the recommendations are being made in NCF-2005. It largely focused to provide a curriculum which is not only limited to text books, but to go beyond books and classrooms. More emphasis was made on activity-based learning and for the holistic development of children. ICT based learning was also emphasized in NCF-2005. Mathematics Laboratory activities were made compulsory in the recommendations made by NCF-2005.But in spite of wider spread acceptance of NCF-2005, the situation in majority of class rooms of Mathematics not changed because many teachers failed to translate the ideas mentioned in NCF into class room practices. Position Paper published by NCERT, 2006 by National Focus Group on Teaching of Mathematics also made good recommendations for improving the quality Mathematics education.

Though earlier policies were robust in conception and orientation, they have not delivered the desired results in terms of acceptable outcomes in the education sector. So MHRD felt the need for National Education Policy (NEP) – 2020. NEP-2020 is a much-needed reform specially in this digital era where there is an exploitation of technology, in every field. The emphasis made by NEP-2020 on learning systems like online learning, coding and for the digital courses like Artificial Intelligence, etc., indicates that this new policy has taken care of every step to achieve the goal of holistic education to produce the skillful youth for the country.

Objectives of Teaching Mathematics

The **Central Board of Secondary Education (CBSE)**is a Board of Education for public and private schools, under the Union Government of India, Ministry of Human Resource Development (MHRD) as its Parent Organization. CBSE, in all these years has set a good standard of education in India. With its influential educational policies, now it is one of the most preferred boards in the country. Its effectiveness is reflected on the number of schools affiliating with it each year. It has revised the curriculum and syllabus of Mathematics by considering the objectives laid by NCF-2005. Objectives of teaching Mathematics stated by CBSE are to help learners to:

- Consolidate the Mathematical knowledge and skills acquired;
- Acquire knowledge and understanding, particularly by the way of motivation and visualization of basic concepts, terms, principles and symbols and underlying processes and skills;
- Develop mastery of basic algebraic skills;
- Develop drawing skills;
- Feel the flow of reason while proving a result or solving a problem;
- Apply the Mathematical knowledge and skills to solve real life problems by developing ability to think, analyze and articulate logically;

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- Develop awareness of the need for national integration, protection of environment, observance of small family norms, removal of social barriers, elimination of gender biases;
- Develop necessary skills to work with modern technological devices such as calculators, computers, etc.;
- Develop interest in Mathematics as a problem-solving tool in various fields for its beautiful structures and patterns, etc.;
- Develop reverence and respect towards great Mathematicians for their contributions to the field of Mathematics.

But whether these objectives are achieved in their true sense through present Mathematics education is a million-dollar question. Achieving all the above objectives from a heterogeneous group of students with diversified capabilities is a big task on part of teachers. But to achieve these objectives, acquiring the required skills and practicing appropriate strategies and innovative methods of teaching are very important.

India has made great emphasis on educating all its children since its independence. India, with its strong Mathematical traditions, may be expected by the world to produce excellence in Mathematics (Ramanujam, Subramanian, 2012). But in reality, Mathematics is often referred as the difficult subject and in India, a large number of children fail or drop out before completing the schooling, because they are not able to cope with the demands of the curriculum (Rampal, A. & Subramanian, J., 2012).

Status of Mathematics Teachers

Teacher education institutes are making all the efforts in order to make the student teachers to acquire the skills during their course of training. But after the pre-service program when they enter in the profession, they find the methods of teaching, curricula and various other requirements in schools different from those advocated and implemented in teacher education institutes (NCTE, 2006). There is a need of a systematic mechanism for the academic support for teachers in terms of good resources and also for their professional development.

In many cases, Mathematics is taught by teachers who are not very confident of their Mathematics. Even in cases where qualified teachers teach the subject, their conceptual understanding was seen inadequate (Dewan, H., Batra, N., & Singh, C. I. 2012). Their understanding of the nature of Mathematics and attitude to it and its learning are very different from what is underlined in the NCF-2005 and now in NEP-2020. The lack of ability of teachers in Mathematics is probably the result of their preparation at the School and College level. It may also be because of the inadequate efforts at teachers' preparation and lack of innovative pedagogical and methodological planning. Lack of motivation of teachers also results into poor teaching – learning happening in Mathematics classrooms.

Need of Innovative practices in Mathematics Education

Mathematics is both a practical and theoretical subject. Its aim of teaching at school level being the development of many skills like: Critical Thinking, Problem Solving, Computation, Analytical Thinking, Logical Thinking, Reasoning (inductive and deductive), etc., and also the development of many Life skills too in learners. So, emphasis should be on both rote learning (memorizing the formula, theorem, etc.) and also in applying their meta cognition ability (ability to apply a formula or result in specific problem area).

The curriculum in India at school level, designed by the authorized body like NCERT (for CBSE & other Board) and other state board curriculum, etc., are considered to be the best in comparison with other countries' curriculum. But still students' learning outcomes in mathematics are not up to the expectation. This indicates the lack of strategic planning, innovative practices, innovative pedagogical and methodological planning suitable to the heterogeneous students, on part of teachers. The teachers must develop strategies. Ma'abrah, T. (2018) recommends that teachers should consider presenting the study material in sophisticated and innovative ways. According to Coe, Kristi (2018) there are various ideas that can be exploited and teachers can use innovative and creative ideas to encourage students to study mathematics and most importantly to understand it. It requires reconsidering the nature of the curriculum for mathematics itself, the quality of the methods used in its explanation and finally the extent to which the students accept their content and achieve good results at the end of each semester (Algani, 2019).

Employing different strategies and innovation is very vital in teaching Mathematics. Though teachers talk about their limitations or barriers in employing such strategies in class rooms as: Time barrier (due to the task of completion of entire syllabus during the stipulated time), Lack of motivation, Lack of interest in learners, Lack of professional development programs on innovation or Lack of innovative teaching – learning resources, etc., they must pay attention not only on the syllabus completion but on innovative strategies and creative planning which are proved to be effective for teaching – learning Mathematics.

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The following are few strategies which can be employed in class rooms by teachers for effective Mathematics teaching – learning.

(i) Blended Learning

Learning mathematics can be made easy and attractive if teachers integrate technology in classrooms for today's technology loving learners. Blended learning is a method of teaching that integrates the digital media with traditional teacher led classrooms. This method helps the learners to stay motivated and engaged. Blending Learning is now widely adopted in education with some scholars referring to it as the 'new normal' in course delivery (Dziuban, C., Grahan, C. R., 2018).

(ii) Experiential Learning

Experiential learning is a teaching – learning strategy where in learners learn by doing practically by appreciating the real-world relevance of the subject which helps the students to retain the concepts for a longer period. Such learning by nature, enables the development of a variety of capabilities, such as planning, team work, coping with stressful situations, responsibility and leadership (Davidovitch, N., Yavich, R., Keller, N., 2014).

(iii) Art Integration

Art-Integration is a cross-curricular pedagogical approach that utilizes various aspects and forms of art and culture as the basis for experiencing the learning of concepts across subjects. Art-integrated education, if embedded in classroom transactions, can not only create joyful classrooms, but also can help in imbibing the Indian ethos through integration of Indian art and culture in the teaching - learning process at every level.

Art Integration with mathematics concepts can encourage in demonstration and application of learning in real-life situation by the learners. CBSE has introduced Art – Integrated learning in all its affiliated schools vide circular dated 8th March, 2019.

(iv) Interdisciplinary Approach

It is an approach of curriculum integration which generates an understanding of concepts through different subjects and their connection with the real world. It means combining two or more subjects for enhancing the clarity of a single concept, through activities.

Results and Discussions

Curriculum planning, methods of teaching and pedagogical planning are few important aspects of school education and the quality of school education depends on the quality of these aspects.

NCERT being the curriculum advisor to the Ministry of Human Resource Development (HRD) and considering the important role of NCERT in country's educational activities like development of curriculum, methods of teaching, techniques of evaluation, etc., the researcher has made some suggestions to NCERT and other Policy Makers, based on the findings of the study.

- Along with curriculum, it is necessary to provide a well-structured pedagogical plan and period-wise lesson plans of each chapter for the teachers.The plan must be made mandatory for the teachers to follow.
- At the beginning of each chapter, a concept map to summarize the whole chapter for its overview can be given.
- The period-wise plan must give importance to the following methodological aspects on part of teachers:

1. Every period must start with some warm up activity / activities involving the previous knowledge checking.
2. Swift corrections of the previous day's assignment are very essential in the period itself, with proper positive comments. This every day's practice inculcates a habit in learners to complete their tasks and assignments on time.
3. Specific technology integration, as per the requirement of the chapter / topic to be done. This can be in terms of explaining an abstract concept with the help of a video, etc. Web link / video link and other links for references of related topics need to be provided in order to enhance the concept clarity and to develop the interest of learners in the subject.
4. At the end of every period, quick recapitalization of the learned concepts must be made as a habit.
5. The period must end by assigning some learning activities / practice works on the basis of the learned concepts of the day.

- After completion of the chapter / topic (by using the required number of periods):

1. A comprehensive series of self-assessment questions to be provided to do in class rooms or at home, at the convenience of the learners. (Self-assessment is being emphasized in NEP 2020 also)

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2. Projects based on "Art Integration" and "Experiential Learning" to be assigned by keeping in mind the mandated learning outcomes, from the topics / concepts taught.
3. One period must be utilized for the conduct of a Formative Assessment of the completed chapter.
- On the basis of the results of the Formative Assessment, a diagnostic test with required remedies to be provided to the learners who are in need of the same.

If a Mathematics teacher follows the exact style and the process mentioned above for the teaching of a Mathematics topic, the researcher guarantees the improvement in academic performance of the learners.

Policy makers need to think about lightening the burden of teachers with the heavy task of completing syllabus by removing the repetition of topics in different classes. This will give space for teachers to adopt creativity and innovation in classrooms. This will also make the teaching process interesting and attractive for learners because interest is a powerful motivational process that energizes learning (Harachiewicz, Smith, & Priniski, 2016).

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, for improvement in Mathematics teaching – learning, a system improvement (rather than the improvement of individual teachers) is needed. A system to be framed to engage more mathematicians, mathematics education researchers, etc., to study more about the development strategies which can enhance the quality of works by mathematics teachers. More contributions in this area in terms of developing strategies, practices, resources and professional enrichment program, etc., may solve the existing problems and may help in achieving the quality Mathematics Education.

National Education Policy (NEP) – 2020 has emerged as the result of search for an urgent requirement of reformation in educational practices. It gives a new ray of hope as it talks a lot about teaching career, professionalism and enriching and empowering teachers. It discusses about ensuring Performance Standards of teachers, and also of Teachers Audit or Performance Appraisal as a system. New Policy has also mentioned the need of innovative practices in teaching – learning by integrating technology and other various strategies.

India's education sector is eagerly waiting to see the immediate and urgent measures of implementing the same to achieve the years' long expectations and requirement of the desired improvement in Education System and Quality of teaching – learning, especially in Mathematics.

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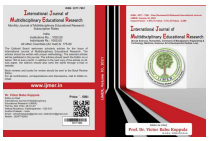
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