Dr. Sajna Jaleel
Assistant Professor,
School of Pedagogical Sciences,
Mahatma Gandhi University,
Kottayam.

Bincy Titus
Senior Research Fellow,
School of Pedagogical Sciences,
Mahatma Gandhi University,
Kottayam.

Development of mathematical creativity in India through ages: A historical sketch of Post - Independence period

Sajna Jaleel, Bincy Titus

Abstract
The present paper tries to investigate the historical sketch about the development of Mathematical Creativity in India and analyses its present status. The principles underlying the practice of education in Vedic times are very relevant in developing creativity in all fields, particularly in Mathematics. In this period, the trace of mathematical creativity was seen in sculptures and ancient architectures. As time goes, the educational scenario becomes changed. In the period of British rule, even though, they establish many educational institutions in India, they mainly focused on computational skill in Mathematics. After Independence, the Government of India formulated National Policy on education and according to this policy on education, science and mathematics should be an integral part of general education till the end of the school stage. In the present age, Mathematics is considered as the backbone of science and technology. Mathematical creativity is the essential characteristics of Mathematics that helps for the advancement of scientific inventions and in the advancement of mathematical thinking. Many studies points out the importance of mathematical creativity in the present education system. So it is very relevant to sketch the developmental patterns that occur in Mathematical Creativity. So through the paper, the authors try to sketch the development of Mathematical creativity in the post-Independence period of India.

Keywords: Mathematical Creativity, Historical sketch, Post Independence Period

1. Introduction
It is undeniable that today's education is undergoing severe stress and strain, whatever instruction is imparting in our system of education does not genuinely contribute to the improvement of education of mankind especially the enhancement of inner harmony of human kind. Creativity is the ability to imagine or invert something new. It is not the ability to create out of nothing, but the ability to generate new ideas by combining changing or reapplying existing ideas. Creativity in Mathematics helps students to make sense of the world around them and find meaning in the physical world.

Mathematics is considered as the backbone of science and technology. A sound knowledge of mathematics is accepted to be essential in studying almost every branch of knowledge. It is the gate and key of the science. Teaching of mathematics is integral to the given system of Indian education. As our Prime Minister, Dr. Manmohan Singh commented, "The mathematical community has a duty to find out ways and means to address the shortage of top quality mathematicians in our country. It most reach out to the public particularly in the modern context where mathematics has treated as influence on every kind of human behaviour. I many ways, Mathematics can be regarded as the mother science". (Prime Minister's speech in the 125th Birth Anniversary celebrations of Srinivasan Rumanian at Chennai on December 26, 2011). So the teaching of mathematics is very important for our lives. The students need to develop mathematical ways of seeing, thinking and interpreting the world.

2. Importance of Mathematical Creativity
Mathematics is probably the oldest organized discipline of human knowledge. The process of creating new mathematics is always fascinating. In school and in college, creative and

Correspondence
Dr. Sajna Jaleel
Assistant Professor,
School of Pedagogical Sciences,
Mahatma Gandhi University,
Kottayam.

imaginative thinking in Mathematics should be rated at least as highly as deductive and logical thinking. It plays s vital role in the full cycle of advanced mathematical thinking. Creativity in mathematics helps students to make sense of the world around them. Mathematical creativity is essential for the success of a student in later life. It will help them to improve their productive work as well as their living conditions through mathematical innovations. For future scientific and technological advancement, fostering of mathematical creativity among the students of our school and college is very essential. It ensures the growth in the field of mathematics as a whole. It expresses in generating new concepts and establishing connection between facts of mathematics.

Mathematical creativity has been simply described as discernment or choice (Poincare, 1948). According to him, to create consists is not making combinations and in making those which are useful and which are only a small minority. According to Romey (1970) [15], "Mathematical Creativity is the combination of mathematical ideas, techniques or approaches in a new way". It needs a context in which the individual is prepared by previous experiences for a significant step forward in a new direction. Such preparation occurs through previous activities which form an appropriate environment for creative development.

3. Development of Mathematical Creativity in India on Post-Independence Period

From 1947 to 1968, the Indian Government had adopted the educational policy of pre-independence period with certain modifications. In July 1964, Government of India appointed Kothari Commission and it submitted its report on 1966. This commission holds that education should be related to productivity, should strengthen social and national integration. It emphasizes the importance of science and Mathematics in the curriculum. In 1968, the government of India formulated National Policy on Education and it emphasizes the necessity of talent in diverse fields should be identified and every stimulus and opportunity should be given for its full development. Other important recommendations of NPE (1968) should be (i) science education and research should receive high priority and (ii) science and mathematics should be an integral part of general education till the end of the school stage.

Mathematics is considered as the backbone of science and technology. A sound knowledge of mathematics is accepted to be essential in studying almost every branch of knowledge. Today, what we enjoy in our life is a result of scientific inventions. It is only be possible through the teaching of mathematics. Mathematical creativity is the essential characteristics of mathematics that helps for the advancement of scientific inventions. It plays a vital role in the advancement of mathematical thinking.

Mathematical creativity is the product of and produced by several factors that extent beyond the classroom. Such factors include society, government policies, parents and professional organizations, external authorities which may develop a curriculum and a syllabus for the betterment of mathematical creativity. Thus it can be ensured the growth of mathematics in nature. It does not occur in vaccum. It needs a content in which the individual is prepared by previous experiences for the new direction of development. The performance of students has been a great concern to the society. Different studies show the level of mathematical creativity in the present age.

Some studies analyses the mathematical creativity of different levels of people in society. As a future citizen, many studies focus on the mathematical creativity of students. Salimraj (1998) [16] and George (1994) [5] were tried to analyze the mathematical creativity of students. Both the studies revealed that majority of primary and secondary school students have average level of mathematical creativity and the sub samples possesses significant difference in their mathematical creativity.

Some other studies concentrated on to find the correlates of mathematical creativity. Some of the correlated are intelligence, mathematics achievement and socio-economic status of students. Salimaj (1998) [16] and George (1994) [15] concluded the relationship between some of these correlates with mathematical creativity. Further studies concentrated on different types of intelligences such as multiple intelligence and emotional intelligence in relation to mathematical creativity. George (2000) [6] and Manju (2011) [8] found that there is significant relationship between multiple intelligence and mathematical creativity. Also Sandhya (2011) [17] concentrated on the relationship of emotional intelligence with mathematical creativity. Gakhar (2003) [4] tried to find out the relationship of intelligence, creativity and mathematical achievement with mathematical creativity and found a significant and positive relationship between them. Sholy (2008) [19] concentrated on the factors of mathematical creativity and it was analyzed the effect of some influencing factors of it. The findings of the study revealed that attitude towards mathematics, anxiety in mathematics, self-concept and other factors are related to it. Some studies reflect that there are some vital factors influencing the mathematical creativity. Good education, proper care and provision of the opportunities for creative expression inspire, stimulate and sharpen the creative mind of children. The prime factors influencing the mathematical creativity are learning environment, parental - institutional support, personal motivation, family influence etc. Parents, teachers, siblings and peer groups play a major role in enhancing mathematical creativity of students. Hence they help the child in nourishing and utilizing the creative ability of their students.

Some research works proposed that solid mathematical knowledge is necessary for the development of Mathematical Creativity (Meissner, 2000 [11]; Sheffield, 2009 [18]; Binder, 1996) [2]. Also creative works involve a certain amount of pre –e existinf knowledge and transforms into a new knowledge (Nakakoji, Yamamoto & Ohira, 1999) [12]. On contrary some studies proposed that creative ability contribute to the improvement of mathematical knowledge (Starko, 1994 [21]; Mann, 2005 [9]; Aqui, 2004) [7]. They point out the importance of mathematical creativity in mathematical ability. Sternberg (1999) [22] acknowledged that the essence of Mathematics is to apply knowledge creatively in specific circumstances.

As Mathematics is the study of patterns, relationships and rich interconnected ideas, it is an apt subject for the development of creativity in students. Webster's dictionary (1991) defined "Mathematics is a science of numbers and their operation, interrelations, combinations, generations and abstractions and of space configuration and their structure, measurement, transformations and generalizations". Since Mathematics has the qualities of both art and science, it is an apt subject for developing creative thinking. Some research

works showed that it was possible to promote mathematical creativity in children by providing suitable teaching experiences. Suitable teaching strategies are adopted for the enhancement of mathematical creativity of students in the classroom.

Mathematical language is a wonderful way of communicating ideas. Smith (2004) describes mathematics is a powerful universal language and intellectual toolkit for abstraction, generalization and synthesis. Mathematics is a core subject in our education system. In 1960's Mathematics education developed qualitatively by including the teaching of modern Mathematics in school children. This development become necessary to prepare today's children to face the challenges of future age. It helps children to make sense of their world outside school and helps them to construct a solid foundation for all members of our society. The nation needs to prepare the 'young' people in higher proficiency level. Courant and Robbins (1996) defined "Mathematics is an expression of human mind reflects the active will, the contemplative reason and the desire for aesthetic perfections. Its basic elements are logic and institution analysis and instruction, generality and individuality." Mathematics being so important subject and occupying a central position, it has not been the interest of many students. The gaps are found between aspiration and achievement. Students who discover some of the structures of Mathematics are often impressed by its beauty. Teaching Mathematics is not only concerned with the computational knowledge, but also concerned with the selection of the Mathematical content and communication leading to its understanding and application. So while teaching Mathematics, one should use the teaching methods, strategies, and pedagogic resources that are more fruitful in gaining adequate responses from the students. The Education Commission (1964-66) points out that "In the teaching of Mathematics, emphasis should be more on the understanding of basic principles than on the mechanical teaching of Mathematical computations".

4. Conclusion

When we analyze the history of India, it was seen that during different periods, different mathematics was taught. A century ago, mathematics in upper primary classes involved computation of tasks involving a large amount of numbers, long division, square roots of non-square numbers and so on. This form of curriculum remained in place until the early 1960s, when the implementation of New Maths represented a considerable shift in mathematics curriculum. New topics were included. New forms of thinking mathematically were the part of the syllabus. In that period, there was a declination in the development of mathematical creativity of students. Since 1970s, other reforms have influenced the curriculum, including problem solving where students were expected to be more creative in their thinking. Thus mathematical creativity has a slight improvement in the hands of students. In the 1980s and increasingly, technology has played a role in the curriculum. Students are expected to be far more creative in their thinking, and to deal with much more knowledge and complexity than in the pre- 1960s era.

In past times, mathematics and language were seen as two disparate disciplines. Today, it is seen that in order to learn, appreciate and understand mathematics, students need to learn the language of mathematics. Thus the complex ideas can be easily communicated. Also people use mathematics as a tool for solving problems of every day. It enables people to make sound decisions and judgments and to solve problems. Mathematics has been involved in most creative inventions in modern history.

In conclusion, mathematical creativity is the imaginative, agential, intentional capacity to act upon, and to create with, interplay of a variety of human and mathematical attributes, factors, and conditions. The endeavour to formulate a conceptualization of mathematical creativity bears fruit when it draws on insights from a discussion of questions related to the relationship between creativity and imagination, the nature of mathematics, the significance of mathematical imagination, values and aims which shape the mathematical engagement of pupils and teachers within educational contexts. Today's students are basically bookworms, overburdened by routine and mechanical academic work. The natural curiosity and energy of the students should be diminished. Mithranikethan like educational institutions are considered as the solution for empowering the quality of our present education system. The Government and other educational agencies are concentrated on the foot print of Mithranikethan on the enhancement of quality of education.

5. References

1. Aralas D. Mathematical Creativity and its connection with Mathematical Imagination. In proceedings of the 11th International Congress on Mathematical Education, Mexico, 2008.
2. Binder C. Behavioral fluency: Evolution of a new paradigm. The Bahavior Analyst 1996; 19:163-197. Retrieved from:
   http://www.abainternational.org/TBA.asp
3. Ediger M. Methods in teaching Mathematics. *Edutracks* 2006; (7):2-14.
4. Gakhar S.C. Intellective and non-intellective factors associated with mathematical creativity at the elementary school stage, Journal of All India Association of Educational Research 2003; 15:1-2.
5. George T.T. A study of mathematical creativity of secondary school students in relation to their intelligence and academic achievement. Unpublished M.Phil thesis, University of Kerala, Thiruvananthapuram, 1994.
6. George T.T. Some correlates of mathematical creativity. Unpublished doctoral dissertation, University of Kerala, Thiruvananthapuram, 2000.
7. Hong E, Aqui Y. Cognitive and motivational characteristics of adolescents gifted in Mathematics: Comparisons among students with different types of giftedness. Gifted Child Quarterly 2004; 48:191-201. doi: 10.1177/001698620404800304.
8. Manju V.V. A study of the relationship between multiple intelligence and mathematical creativity of secondary school students. Unpublished M.Ed Dessertation, B.N.V College of Education, University of Kearla, 2011.
9. Mann E. Mathematical Creativity and school Mathematics: Indicators of Mathematical Creativity in middle school students (Doctoral Dissertation). Retrieved from: 2005.
   www.gifted.uconn.edu/siegle/Dissertations/Eric%20Mann.pdf
10. Manoharan J.L. Fostering creativity through problem solving in Mathematics. *Edutracks* 2006; 5(11):11-13.

11. Meissner H. Creativity in Mathematics Education. Paper presented at the meeting of the International Congress on Mathematics Education, Tokyo, Japan, 2000.

12. Nakakoji K, Yamamoto Y, Ohira M. A framework that supports Collectvie Creativity in Design using Visual Images. In E. Edmonds & L. Candy (Eds.), Proceedings of the 3rd conference on Creativity & Cognition, New York: ACM Press. Retrieved from: 1999, 166-173. http://www.informatik.unitrier.dc/~ley/db/conf/candc/candc1999. Html.

13. Pandey R.S. National Policy on Education in India. Allahabad: Horizon Publishers, 1992.

14. PM's speech in the 125th Birth Anniversary Celebrations of Ramanujan at Chennai on December 26, 2011. Government of India: Press Information Bureau. Retrieved from: 15 January 2012. http://pib.nic.in/newsite/PrintRelease.aspx

15. Romey W.D. What is your creative quotient? School science and Mathematics 1970; 70:3-8.

16. Salimraj S. The study of mathematical creativity of primary school pupils in relation to their mathematical achievement and socio- economic status. Unpublished M. Phil thesis, University of Kerala, Thiruvananthapuram, 1998.

17. Sandhya P.S. A study of the relationship between emotional intelligence and mathematical creativity of secondary school students. Unpublished M.Ed Dessertation, B.N.V. College of Education, University of Kearla, 2011.

18. Sheffield L. Developing Mathematical Creativity-Questions may be the answer. In R. Leikin, A. Berman, & B. Koichu (Eds.), Creativity in Mathematics and the Education of Gifted Students. Rotterdam: Sence Publishers, 2009, 87-100.

19. Sholy J. Effect of some environmental factors in mathematical creativity of secondary students of Kerala. Eleventh International Congress on Mathematical education 2008, 6-18.

20. Sriraman B. The characteristics of Mathematical Creativity,the Mathematics educator 2004; 14(1):19-34.

21. Starko J.A. Creativity in the classroom. New York: Longman, 1994.

22. Sternberg R.J. *Handbook of creativity*. New York: Cambridge University Press, 1999.