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## Mathematical Beliefs for Achievement in Mathematics at Elementary School Level

**Pushendra Yadav**, Ph.D. Scholar, Department of Education, University of Delhi, India. E-mail: [pushendra.cie@gmail.com](mailto:pushendra.cie@gmail.com)

**Meenakshi Ingole**, Assistant Professor, Department of Education, University of Delhi, India. E-mail: [meenakshi.ingole21@gmail.com](mailto:meenakshi.ingole21@gmail.com)

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Corresponding Author: Pushendra Yadav, E-mail: [pushendra.cie@gmail.com](mailto:pushendra.cie@gmail.com)

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### ABSTRACT

At elementary level most of the students feel difficulty to solve problems and tasks related to mathematics and they feel mathematics is a very difficult subject in comparison to other school subjects. Reports of ASER-2018 by PRATHAM and NAS-2017 by NCERT show the decline in performance of students in mathematics in terms of learning outcomes at elementary level. There could be various reasons behind this. Many of them have been addressed in NEP-2020. That is why new education policy suggested to change the structure, curriculum and instruction methods at elementary level. But out of all these factors one factor which is less emphasized and less talked about in the educational community is mathematical beliefs at elementary level. These days' western countries are doing significant work on mathematical beliefs at elementary level. Because whatever we think or do is to some extent governed by our beliefs. That's why mathematical beliefs become one important factor out of all possible factors for good achievement in mathematics. Through this review-based research paper, the researcher has tried to throw light on the role of mathematical beliefs at the elementary level. Also, have tried to explain what are mathematical beliefs? How does it affect the mathematical behavior of students and affect their mathematical achievement?

**Keywords:** Mathematical Beliefs, Elementary School Education, Achievement.

### INTRODUCTION

Mahatma Gandhi, the father of the nation, who contributed significantly to India's independence, believed that the beliefs held by someone in their inner self could be clearly seen in their behavior. He strongly believes that one's beliefs may change one's destiny. And many Indian philosophers like Vivekananda, Sri Aurobindo also propound the same types of thoughts about beliefs. In the Indian School education system, we stressed enough on elementary and secondary education over the period from the Secondary Education Commission (1952-54) to National Knowledge Commission (2009). During this time period our Indian school education system went through a significant period of changes. In this period recommendations of NPE-1986 and NCF-2005 were important for improving our School Education. Few years ago, in 2017 a learning outcomes

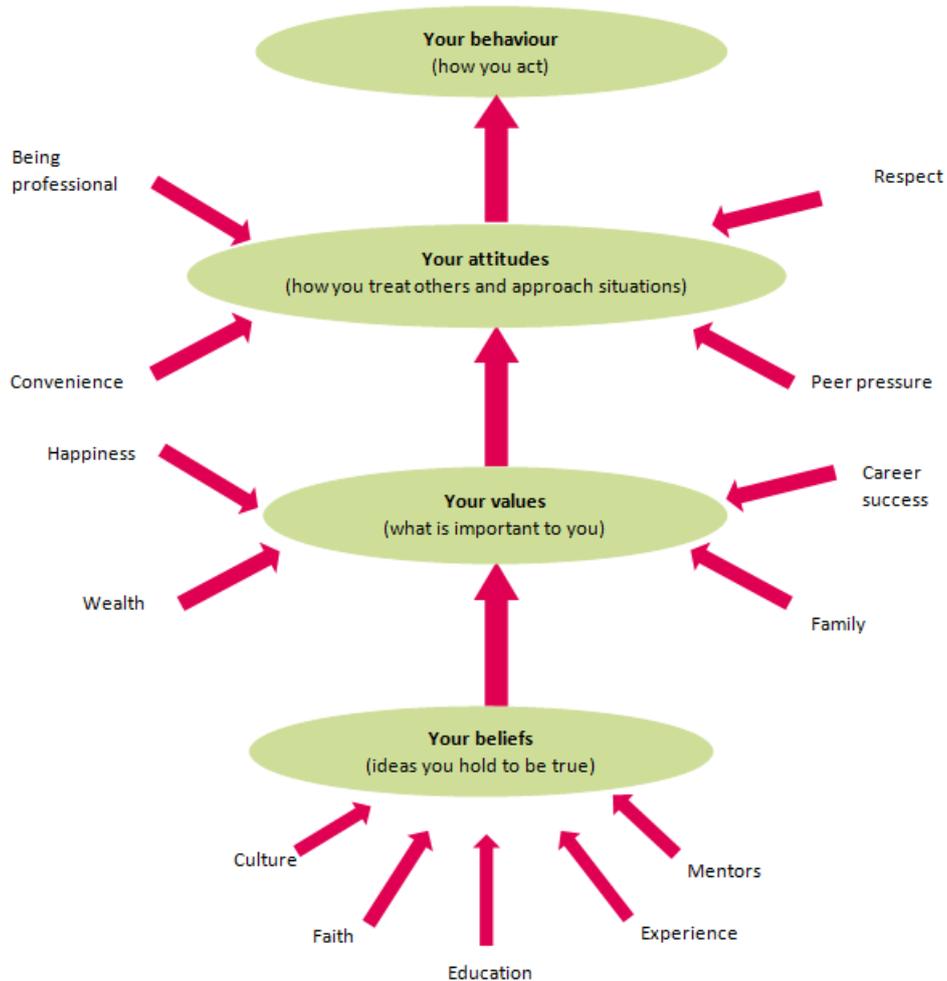
document for the elementary stage was released by the NCERT. And after that we started assessing the performance of school students on the basis of learning outcomes. This document tells us the performance of students in mathematics at elementary level decline in terms of learning outcomes day by day which gives us critical alarming signs about our school education system. ASER report-2018 also gives the same kind of evidence in which LOs in mathematics are quite less in comparison to LOs of other regular subjects at elementary level.

In the last 70 years we have tried to do significant work for the purpose of improvement in mathematics education at elementary level. We have developed several pedagogical resources, instruction methods and spiral curriculum-based books for our students etc. But still, we do not achieve what we want to do. Mathematics is a very important subject and we can say many subjects and disciplines emerge from mathematics and it is the foundation of many subjects so this is our responsibility to provide quality mathematics education to all at elementary level but unfortunately, we are far away from this goal. To take this vision in mind we are moving forward with National Educational Policy-2020. By this policy many important changes have been proposed in the area of elementary education which are reflecting on the ground after a few years. In this era of transformation of the elementary education system of India, we feel few important variables which are important for mathematics achievement at elementary level are still in less discussion. Out of those variables, one important variable is mathematical beliefs. We can say mathematical beliefs are a hidden variable that works in the intersection of affective and cognitive domain.

At elementary level this is very important to take care of how students look into a particular subject? because this is the time where students are actively engaged in their peer groups and a lot of information is perceived from different sources. Many things in terms of peace of information came towards them from all around which is responsible to construct a belief system of an individual. To understand the beliefs about mathematics and its impact on student's mathematics behaviour during a mathematical task several researches have been done in the field of mathematics education which ascertained student's mathematics achievement may be affected by their mathematical beliefs.

### **Beliefs**

According to Bandura (1986) students learning especially at elementary level is affected by its self-regulated behaviour and he emphasized that further students' general behaviour and sense of self-control are influenced by their beliefs. After a few years, Pajares (1992) explained beliefs helps us to understand the reality around us. How do individuals make sense of reality governed by their beliefs? There is no set pattern of making beliefs and there is no standard definition available but Beliefs, attitude and emotions present in one's affective domain (McLeod, 1992). Beliefs include significant cognitive components and are located at the nexus of one's cognitive and emotive domains (De Corte et al., 2002). One's belief system is made up of their beliefs, attitudes, and values (Pajares, 1992). We can say beliefs is included in one's beliefs system which cannot be easily modified. Furthermore, it is more challenging to change a belief the more important it is to a person's sense of self. Even after being presented with a scientifically sound explanation, people nonetheless hold onto ideas that are founded on faulty information. Beliefs are exceedingly challenging to reconstruct since they cannot be assessed directly; instead, they must be inferred from people's comments or actions (Pajares, 1992).



[Diagram 1: Beliefs. Diagram Source: <https://www.iaa.govt.nz/for-advisers/adviser-tools/ethics-toolkit/personal-beliefs-values-attitudes-and-behaviour/>]

### Mathematical Beliefs

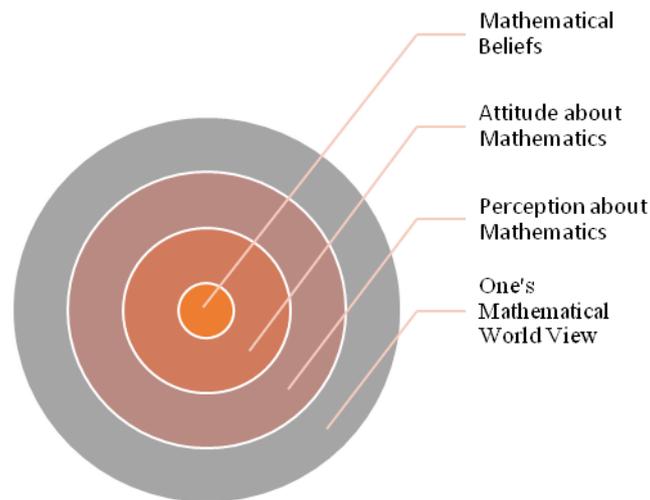
Domain-specific epistemological views are categorized as mathematical beliefs in the literature on mathematics education. One's world view in mathematics, which characterizes how they perceive and approach mathematics, is what one's mathematical beliefs are all about (Schoenfeld 1985). These forms of views were divided into four groups by McLeod (1992): beliefs about mathematics teaching, beliefs in mathematics, beliefs in oneself, and beliefs in the social environment. Using three categories—beliefs about oneself in connection to mathematics, beliefs about mathematics education, and beliefs about the social context—De Corte et al. (2002) further classified mathematical beliefs.

In general, we can say about mathematical beliefs that what students think about mathematics subject? How do they see mathematics as a subject? What kind of assumptions they held regarding mathematics? All these things come together and construct one's mathematical beliefs. In constructions of mathematical beliefs many layers can be included because before starting of childhood students learn so many things from their environment.

National Council of Teachers of Mathematics (N.C.T.M.) principles and Standards-2000 explained students hold some untrue beliefs related to mathematics and these beliefs surely contrast

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with mathematics learning and conceptualization of mathematics. In these documents they deemphasize rote learning for mathematics and promote conceptual understanding by the process of problem solving. N.C.T.M. principles and Standards-2000 proposed students justify their answers with the help of reasoning in a palace of teachers' confirmation of accurate responses. Students must establish links between different mathematical ideas and between mathematical issues and practical applications. Students in this series require more accessible mathematical concepts in order to support their learning for comprehension. If students rely on their non-availing beliefs in this case their understanding may be adversely affected. Further explained Mathematical beliefs are thought to affect how students behave in math, which may have an impact on students' achievement (Schoenfeld, 1992).



[Digram 2: Mathematical Beliefs. Diagram Source: Created by researcher]

## REVIEWS RELATED TO MATHEMATICAL BELIEFS

Since the concept of Mathematical Beliefs is quite new for many researchers and scholars, they have not heard about it before that's why researchers are unable to find any research or study on this variable at Indian repository Shodhganga and Shodhgangotri. Researcher compiled a few studies on mathematical beliefs from western countries from ProQuest, NCTM Journals, Springer, Eric etc. and thoroughly analysed them and also used them for a review for this study.

Yin, Hongbiao. et al., (2020) did study on the impact of Chinese university students' perceptions about mathematics. In this study, the relationship between the mathematics classroom setting at the university and students' conceptions and efficacy of mathematics was investigated. This study's findings supported the mediation function of mathematical beliefs. Findings revealed that students' cohesive concepts and a favourable classroom atmosphere were associated. Russo, J. et al., (2020) conducted a study on primary school teachers' perceptions of difficulty in math classes. The results of this study indicate that 75% of the 93 early Australian elementary teachers who responded to the questionnaire had favorable views about struggle. And the remaining educators have conditionally encouraged views of difficulty. Xenofontos (2017) did a study on Greek-Cypriot elementary school teachers' epistemic attitudes about mathematics. 22 seasoned educators were invited for this reason, and semi-structured interviews were held. Analyses based on thematic data were performed. The results of this study show that mathematical epistemological beliefs can be problematic because they may prevent the emergence of other culturally specific beliefs. Mazlini, et al., (2012) analyzed the relationship between pre-service teachers' conceptual understanding, mathematical experience, and mathematical beliefs. 317 future teachers were chosen at random by researchers from 6 higher education institutions. The test of knowledge framework, the mathematical

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experience questionnaire, and the mathematical beliefs questionnaire were all given out. According to the study's findings, teachers generally have high levels of conceptual understanding and moderate levels of mathematical experience. Niepel, et al., (2018) used the theory of planned behavior (TPB) to look at the students' attitudes and beliefs about math in the classroom. At time-1, 752 pupils were chosen, and at time-2, 514 students. Structural equation modeling was employed for TPB. The results of this study demonstrate that time-1 and control at time-2 had a negative relationship. This work gives us the first longitudinal evidence for the reliability of a model of mathematical attitudes and beliefs that is deeply anchored in TPB. Habok, et al., (2020) attempted to establish a link between motivation and self-related beliefs and academic success in mathematics in their study work. The sample was taken from a comprehensive longitudinal program, and data were gathered at intervals of two years. According to the study's findings, motivational and self-related elements are important for academic success. Francisco (2013) conducted research on high school students' attitudes and actions in math. He emphasized the need for additional research on mathematical beliefs, particularly among students in lower secondary education. He looked explored how high school pupils' arithmetic conduct changed when they were tasked with difficult mathematical problems. The findings of this study indicate that specific educational experiences can change outcomes that are relevant to studies of high school students' mathematics beliefs and behavior.

Guney (2013) performed study on elementary preservice teachers' views and anxiety related to math. He chose 301 pre-service teachers enrolled in an elementary teacher education program for this study, and he gave them two surveys to gauge their attitudes toward mathematics and their level of worry about it. The results of this study demonstrate that educators with strong views about how to teach and learn mathematics experienced less anxiety and had greater self-confidence. Briley (2012) analyzed the relationship between mathematical beliefs, self-efficacy, and the effectiveness of teaching on student teachers. 95 pre-service teachers taking a mathematics content course are included in this study. The findings of this study demonstrate that teachers who have strong mathematical ideas are better at teaching and demonstrate significant confidence while tackling mathematical difficulties. Goldin, Gerald et al. (2011) focuses on the beliefs and engagement structures of mathematical learning and discusses in his study work how emotional and cognitive structures are intertwined with one's beliefs to influence one's mathematical learning and problem-solving. Researchers revealed how beliefs are woven into a person's constructs and affect their activation in this theoretical essay. Jones, Wilkins, Long, et al., (2012) used Blackwell's model of motivation, which is apparent in his research work, is useful in understanding how students' attitudes toward and interests in mathematics connect to their academic performance. The results of this study confirm the reliability of the Blackwell model of motivation. Törner (2002) tried to focus on the essential components of a definition because there is no consensus definition of mathematical beliefs that is available. He researched a few models that are connected to mathematical beliefs in an effort to comprehend their structure. He will be able to differentiate between domain-specific beliefs, subject-specific beliefs, and global beliefs with the aid of this research.

Mason & Scrivani (2004) did a study on improving pupils' mathematical beliefs through intervention. The purpose of this study was to comprehend the students' views about mathematics as they learned about it as well as how those beliefs and associated factors evolved as the learning environment in the classroom changed. For the purpose's fulfillment, 86 fifth-grade students chose and prepared two groups: one for an innovative learning environment, which included 46 children, and the other for a traditional learning environment, which included 40 students. The results of this study show that intervention had a greater impact on students' development of mathematical beliefs than standard education did. Additionally, it helped individuals perform better when tackling arithmetic problems. Szydlik (2000) conducted a study on the conceptual understanding of the limit function and the mathematical beliefs of the 27 university students chosen for the study, and the results revealed that the influence of content beliefs and limit understanding is less pronounced.

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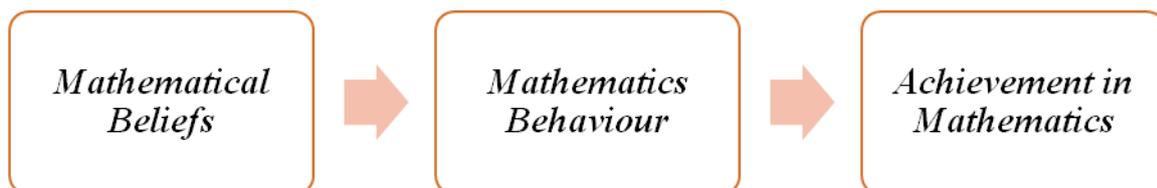
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### Why do we need to study students' Mathematical Beliefs at elementary school level?

In India a lot of research is available related to mathematics subject like related to intervention in mathematics classroom, related to new instruction methods for mathematics and related to mathematics achievement etc. there is dearth research work on mathematical beliefs. On the basis of researches of western countries, we have understood how mathematical beliefs affect one's mathematics behaviour. Many researchers advocate this fact also in India after the recommendation of NCF, 2005 example Mathematization of students' thoughts, new text book for mathematics based on spiral curriculum and new instructions methods and pedagogies etc. we can say these things integrate our elementary education system very well. But many researchers and mathematicians think this is the part of the process which will take time to assimilate into our education system and at the same time we need to take more steps to reform our school education system. Yes, after the intervention of NEP-2020 many things will be changed in the near future. But before NEP-2020 we have started to transform and modify things in the field of mathematics education at elementary level, especially from the last two decades.

We cannot deny the fact that mathematical behaviour towards mathematical problems is very important for meaningful learning. We know mathematical beliefs affect one's mathematical behavior so this is the time when we look into the deep and discover such types of hidden variables which affect mathematical behaviour. We already discussed how one's mathematical behavior affects one's achievement in mathematics? So, studies on mathematical beliefs become important to understand to whole phenomenon of learning in mathematics at elementary level. In order to achieve good and quality mathematics education at elementary level such types of hidden variables may become important in the near future.



[Diagram 3: How mathematical beliefs affect achievement in mathematics? Diagram Source: Created by researcher]

### Suggestions for Elementary School Teachers

Mathematical Beliefs is an important factor for mathematical achievement but unfortunately it is less talked about in the education community around the world. In western Countries they started work on it and research work of Pejares (2002) and Mcleod (1992) took a considerable amount of work on beliefs and mathematical beliefs. NCTM principle and standard-2000 also consider mathematical beliefs as a very important and significant variable for mathematics achievement at elementary level. In India very less research has happened related to mathematics education at elementary level and out of them no research available on Indian thesis repository shodhganga and shodhgangotri related to mathematical beliefs of students at elementary level. So, this is an important question for mathematicians around the world: how are students' beliefs about mathematics constructed? Over years, especially in growing years.

On the behalf of critical review of research related to mathematical beliefs. We have gained some sorts of insight regarding mathematical beliefs. Research shows this is a very important variable for mathematics achievement which is not visible directly. So after reading the different researches related to mathematical beliefs and understanding the zest of all those researches we tried to give a few suggestions which are cited below.

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- i. At elementary level, especially in pre-elementary, teachers need to talk to students very frequently to understand what they are thinking about mathematics and mathematics teaching. If there is any wrong perception in their mind try to modify it in a positive way with the help of examples.
- ii. For teaching mathematics at elementary level teachers will use child-centric pedagogy. In which students get the proper amount of time and confidence to raise their questions which arise in their mind frequently.
- iii. Teachers at elementary level try to teach students through story-telling, role playing and participatory methods so that they start to learn and use mathematics in daily life and make their opinion that mathematics is a very enjoyable subject.
- iv. Since students' beliefs about a particular subject start to construct from their family talks, it is important for school teachers to conduct parent-teacher meetings frequently and give them clear direction to don't do subject bias talk in front of childs. Not doing such types of talk: this subject is difficult and this subject is easy because such types of talks imprint students' minds and that affect their beliefs about a particular subject.
- v. The work of a maths teacher not only gives new information to the students but it is also their duty to construct positive regards about the mathematics subject. If students feel difficulty in a mathematical task. Teachers prepare a list of such students and take extra classes for those. School leaders especially head masters of School take care of this.
- vi. We think at the policy level there is a need for one policy at elementary level which emphasises the development of positive beliefs about Mathematics. And prepare a module for this.
- vii. Curriculum for teachers training programme for elementary level should be changed and Pupil teachers will discover the answer of this question: how do we develop positive mathematical beliefs inside students' minds at elementary level?
- viii. Since the beliefs of students develop with the process of over years it is hard to change quickly therefore more research in this area must happen. Which gives us more clarity on how to deal with the beliefs system of students at elementary level.

## CONCLUSIONS

We conclude that mathematical beliefs are a very significant factor for achievement in mathematics. In India we need to do more research on such types of variables which impact the mathematical achievement of students directly or indirectly. Though mathematical beliefs affect one's mathematical behaviour at any level of education. But Importance of mathematical beliefs at elementary level became more significant because these are the growing years of the students. In these years whatever students take and learn from their surroundings including their family, school, peer group, society etc. imprint their minds easily and that is helpful to construct their beliefs system.

In India at elementary level, we all know the situation of mathematics education not up to the mark. Many documents, policies and surveys advocated this fact. We have to think differently and try to discover more variables which affect mathematics learning and mathematics achievement directly or indirectly with the help of research. We think such types of research are surely helpful to achieve our goal to provide good and quality education to all at elementary level.

## REFERENCE

- ASER (2018). Retrieved on December 6, 2021 from <http://img.asercentre.org/docs/ASER%202018/Release%20Material/aserreport2018.pdf>.
- Bandura, A. (1986). Social foundations of thought and action. Englewood Cliffs, NJ: Prentice Hall.

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- Briley, J. S. (2012). The relationships among mathematics teaching efficacy, mathematics self-efficacy, and mathematical beliefs for elementary pre-service teachers. Retrieved on December 10, 2021 From <https://eric.ed.gov/?id=EJ990482>.
- De Corte, E., Op'tEynde, P., & Verschaffel, L. (2002). Knowing what to believe: The relevance of students' mathematical beliefs for mathematics education. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 297-320). Mahwah, NJ: Erlbaum.
- Francisco, M, J. (2013). The mathematical beliefs and behavior of high school students: Insights from a longitudinal study. *The Journal of Mathematical Behavior*, 32 (3). <https://doi.org/10.1016/j.jmathb.2013.02.012>.
- Goldin, A, Gerald et. al, (2012). Beliefs and engagement structures: behind the affective dimension of mathematical learning. Retrieved on December 10, 2021 from <https://link.springer.com/content/pdf/10.1007/s11858-011-0348-z.pdf>
- Habok, A. et al. (2020). Motivation and self-related beliefs as predictors of academic achievement in reading and mathematics: Structural equation models of longitudinal data, *International Journal of Educational Research*, 103, 101-634. <https://doi.org/10.1016/j.ijer.2020.101634>.
- Haciomeroglu, G. (2013) Mathematics anxiety and mathematical beliefs: what is the relationship in elementary pre-service teachers? Retrieved on December 10, 2021 from <https://eric.ed.gov/?id=EJ1005311>.
- Jones, B.D., Wilkins, J.L.M., Long, M.H. et al. (2012). Testing a motivational model of achievement: How students' mathematical beliefs and interests are related to their achievement. *Eur J Psychol Educ* 27, 1-20. <https://doi.org/10.1007/s10212-011-0062-9>
- Mahatma Gandhi Quotes (2020). Retrieved December 23, 2021 from <https://www.relicsworld.com/gandhi/your-beliefs-become-your-thoughts-your-thoughts-become-your-words-your-words-author-gandhi>
- Mason, L. & Scrivani, L. (2004). Enhancing students' mathematical beliefs: an intervention study, *Learning and Instruction*, 14(2), <https://doi.org/10.1016/j.learninstruc.2004.01.002>.
- Mazlini, A. et al. (2012). Relationship between mathematics beliefs, conceptual knowledge and mathematical experience among pre-service teachers. *Procedia-Social and Behavioral Sciences*, 46, 1714-1719. <https://doi.org/10.1016/j.sbspro.2012.05.366>.
- McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York: Macmillan.
- Muis, K. R. (2004). Personal epistemology and mathematics: A critical review and synthesis of research. *Review of Educational Research*, 74, 317-377.
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author. Retrieved on December 10, 2021 from [https://www.nctm.org/uploadedFiles/Standards\\_and\\_Positions/PSSM\\_ExecutiveSummay.pdf](https://www.nctm.org/uploadedFiles/Standards_and_Positions/PSSM_ExecutiveSummay.pdf).
- NAS (2017). Retrieved on December 6, 2021 From <https://ncert.nic.in/pdf/NAS/src/Uttar%20Pradesh.pdf>
- MHRD, GoI (2020). National Educational Policy (2020).
- MHRD, GoI (2020). National Policy on Education (1968).
- MHRD, GoI (2020). National Policy on Education (1986).
- NCERT, MHRD, GoI (2005). National Curriulum Framework 2005.
- Niepel, C. et al., (2018). Students' beliefs and attitudes toward mathematics across time: A longitudinal examination of the theory of planned behavior, *Learning and Individual Differences*, 63, 24-33, <https://doi.org/10.1016/j.lindif.2018.02.010>.
- Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62, 317-332.

- Russo, J. et al., (2020). Elementary teachers' beliefs on the role of struggle in the mathematics classroom, *The Journal of Mathematical Behavior*, 58, <https://doi.org/10.1016/j.jmathb.2020.100774>.
- Schoenfeld, A. H. (1985). *Mathematical problem solving*. New York: Academic Press.
- Schoenfeld, A. H. (1992). Learning to think mathematically: Problem-solving, metacognition, and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp.334-370). New York: Macmillan.
- Szydlik, J. E. (2000). Mathematical beliefs and conceptual understanding of the limit of a function. *Journal for Research in Mathematics Education*, 31(3), 258–276. <https://doi.org/10.2307/749807>.
- Törner, G. (2002). Mathematical beliefs-a search for a common ground: some theoretical considerations on structuring beliefs, some research questions, and some phenomenological observations. In Leder G.C., Pehkonen E., Törner G. (eds) *Beliefs: A Hidden Variable in Mathematics Education?*. *Mathematics Education Library*, vol 31. Springer, Dordrecht. [https://doi.org/10.1007/0-306-47958-3\\_5](https://doi.org/10.1007/0-306-47958-3_5).
- Yin, Hongbiao. et al., (2020). Linking university mathematics classroom environments to student achievement: The mediation of mathematics beliefs, *Studies in Educational Evaluation*, 66. <https://doi.org/10.1016/j.stueduc.2020.100905>.
- Xenofontos, C. (2017). Greek-Cypriot elementary teachers' epistemological beliefs about mathematics. *Teaching and Teacher Education*, 70, 47-57. <https://doi.org/10.1016/j.tate.2017.11.007>.

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