B.Ed. Two Year Programme

P.1.3 : Mathematics

Maximum Marks: 100

UNIT 1: Introduction to Mathematical Thinking

(i) Mathematics as study of creating, discerning and generalising patterns: Identifying and analysing abstract patterns, patterns of shapes, patterns of motion, patterns of repeating chance, numerical patterns.

(ii) Understanding Mathematics as a humanly created subject: Creating Mathematical structures: idea of axioms, postulates and proofs, what is a proof? Different methods of proofs: direct proof, indirect proof, counter examples, proof by induction.

(iii) Socio-cultural, economic and political factors in the development of mathematics. Everyday mathematics, multicultural mathematics; its use in decision making, at the workplace, etc.

(iv) Societal beliefs related to 'knowing' and 'doing' mathematics. Critically challenging the sociological beliefs related to mathematical abilities, mathematics confined to arithmetic.

Readings and resources

Bishop, A. J. (1988). The interactions of mathematics education with culture.*Cultural Dynamics*, *1*(2), 145–157.

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics.*For the Learning of Mathematics*, *5*(1), 44–48.

Devlin K. (2011). Introduction to Mathematical thinking.

Ernest, P. (2009). New philosophy of mathematics: Implications for mathematics education. In B. Greer, S. Mukhopadhyay, A. B. Powell, & S. Nelson-Barber (Eds.), *Culturally responsive mathematics education* (pp. 43–64). Routledge.

Gutstein, E. (2007). "And that's just how it starts": Teaching mathematics and developing student agency. *Teachers College Record*, *109*(2), 420–448.

Kazemi, E., &Stipek, D. (2001).Promoting conceptual thinking in four mathematics classrooms.*The Elementary School Journal*, *102*(1), 59–80.

MESE -001(2003).Teaching and Learning Mathematics. IGNOU series

Newman, J. (2003). The World of Mathematics: A Four-Volume Series. Washington Tempus

Sautoy, M. du. (2008). The Story of Maths. UK: BBC Four Documentary. (Also available as a book)

Timothy Gowers (2002). Mathematics: A Very Short Introduction. Oxford University Press

Wheeler D (1983). Mathematisation matters. *For the Learning of Mathematics*, *3*(1).

UNIT 2: Learning Mathematics

(i) Developmental progression in the learning of mathematical concepts- Piaget, Skemp, Bruner and Vygotsky; Fischbein on intuitive thinking

(ii) Processes of dealing with abstractions, particularisation and generalisation. Studying algorithms; what works and how?

(iii) Focus on mathematical processes- Problem solving, problem-posing, patterning, reasoning, abstraction and generalisation; argumentation and justification

(iv) Sociocultural perspectives in mathematics learning- Situated learning; social construction of knowledge; social interaction and community of practice

(v) Historical evolution of concepts –understanding how concepts evolved, power-play in legitimising concepts

Readings

Boaler, J. (2010). *The elephant in the classroom. Helping children love and learn maths.* Souvenir Press Ltd

Boaler, J. & Staples, M. (2005). Transforming students'lives through an equitable mathematics approach: The case of Railsideschool. Available for download on: www.stanford.edu/~joboaler/

Boaler, J. (2013, March). Ability and Mathematics: The mindset revolution that is reshaping education. In *Forum* (Vol. 55, No. 1, pp. 143-52).Symposium Journals.

Burns, M. (2007).*About teaching mathematics: A K–8 resource*, Third Ed. Math Solutions Publications.

Gray, E, &Tall, D (1994). Duality, ambiguity, and flexibility: A "Proceptual" view of simple arithmetic. *Journal for Research in Mathematics Education*, *25*(2), 116-140.

Jackson, K. J., Shahan, E., Gibbons, L., & Cobb, P. (2012).Setting up complex tasks.*Mathematics Teaching in the Middle School*, (January), 1–15.

Skemp, R. (1978). Relational understanding and instrumental understanding. *Arithmetic Teacher26* (3), 1-16.

UNIT 3: How Should we Teach Mathematics?

(i) Culture of learning- Creating dynamic classroom environments; sharing and exploring ideas, encouraging diverse and innovative procedures, using multiple ways to solve problems, making conjectures, seeking generalisations; respecting diverse capabilities; use of context; metacognition

(ii) Role of Communication in classroom- Math talk; building a community of mathematicians in classrooms; constructing mathematical ideas by providing scope for exploration, explanation and evaluation of children's work

(iii) Use of resources, activities, story-telling and technology in initiating mathematical thinking.

(iv) Notions related to mathematical 'ability'; promoting growth mindset, depth versus speed; math anxiety

(v) Teacher's beliefs and knowledge about the nature of mathematics and mathematical learning, teachers'agency in school math reform.

Readings and resources

Ball, D. L., & Bass, H. (2003). Making mathematics reasonable in school.In *A research companion to principles and standards for school mathematics* (pp. 27–44).

Ball. D.L, Hill H.C. & Bass, H.(2005). Knowing mathematics for teaching.*American Educator*.Fall 2005.

Boaler, J. & Humphreys, C. (2005).Connecting mathematical ideas: Middle school video cases to support teaching and learning (Portsmouth, NH, Heinemann).

Boaler, J. (1993). The role of contexts in the mathematics classroom: Do they make mathematics more"real"? *For the Learning of Mathematics, 13*(2), 12–17.

Chapin, O'Connor, & Anderson (2009).*Classroom discussions: Using math talk in elementary classrooms*. Math Solutions.

Cirillo, M. (2009).Ten things to consider when teaching proof.*Mathematics Teacher, 103*(4), 250-257.

Fuller, E., M Rabin, J., &Harel, G. (2011).Intellectual need and problem-free activity in the mathematics classroom.*Jornal Internacional de Estudosem EducaçãoMatemática, 4*(1).

Hiebert, J., Carpenter, T., Fennema, E., Fuson, K., Wearne, D., Murray, H. (1997). *Making Sense: Teaching and learning mathematics with understanding.* Portsmouth, NH: Heinemann.

Kazemi, E. (1998). Discourse that promotes conceptual understanding.*Teaching Children Mathematics, 4*(7), 410- 414.

Knuth, E., Choppin, J., &Bieda, K. (2009). Proof: Examples and beyond. *Mathematics Teaching in the Middle School, 15*(4), 206-211.

Lampert, M. (2001).*Teaching problem and problems for teaching*.Yale University.

Lockhart, P., & Devlin, K. J. (2009).*A mathematician's lament*. New York: Bellevue Literary Press.

Martino, A.M. & Maher, C. (1999). Teacher questioning to promote justification and generalization in mathematics: What research practice has taught us?.*Journal of Mathematical Behavior, 18*(1), 53-78.

NCERT (2012). *Pedagogy of mathematics: Textbook for two year B.Ed. course.* New Delhi: NCERT.

Parish, S. (2014).*Number talks: Helping children build mental math and computation strategies, Grades K-5, Updated with Common Core Connections.* Math Solutions.

Reinhart, S. (2000). Never say anything a kid can say! *Mathematics Teaching in the Middle School, 5*(8), 478-483.

Schifter, D. (2001). Learning to see the invisible. What skills and knowledge are needed in order to engage with students'mathematical ideas? In T. Wood & B. Scott Nelson & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary mathematics*. Mahwah, (pp. 109-134). NJ: Lawrence Erlbaum Associates

Smith & Stein (2011).*Five practices for orchestrating productive mathematics discussions.*

Solomon, Y., & Black, L. (2008). Talking to learn and learning to talk in the mathematics classroom. In N. Mercer & S. Hodgkinson (Eds.), *Exploring talk in school* (pp. 73–90).

TIMSS Videos of mathematics classrooms available at:
http://www.timssvideo.com/videos/Mathematics

Deborah Ball video on eliciting student thinking, MSRI interview of 6th graders. http://www.msri.org/workshops/696/schedules/16544

UNIT 4: Mathematics for Equity and Social Justice

(i) Why teach 'mathematics to all'? –Concerns and challenges

(ii) Issues of gender, class and culture in mathematics learning and achievement - Expectations, attitudes and stereotypes; access to higher mathematics; interrogating the notion of 'achievement gap'; construction of learners'identity in a mathematics classroom

(iii) Addressing the concerns of societal as well as mathematical equity

Readings:

Davis, B. (1995). Why teach mathematics? Mathematics education and enactivist theory. *For the Learning of Mathematics*, *15*(2), 2–9.

Davis, B. (2001). Why teach mathematics to all students? *For the Learning of Mathematics*, *21*(1), 17–24.

Dweck, C.S. (2006). Is math a gift? Beliefs that put females at risk. In W.W.S.J.Ceci (Ed.), *Why Aren't More Women in Science? Top Researchers Debate the Evidence*. American Psychological Association.

Eccles, J & Jacobs, J.E. (1986). Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society*, *11*(21), 367-380.

Greer, B., Mukhopadhyay, S., & Powell, A. B. (Eds.). (2009). *Culturally responsive mathematics education*. Routledge.

Gutstein, E., Lipman, P., Hernandez, P. & de los Reyes, R. (1997). Culturally relevant mathematics teaching in a Mexican American context, *Journal for Research in Mathematics Education*, *28*(6), 709- 737.

Rampal, A., Ramanujam, R. &Saraswathi, L.S. (1999).*Numeracy counts!* and *Zindagikahisaab*(2001). National Literacy Resource Centre, Mussoorie. Available at www.arvindguptatoys.com

Rousseau, C.,&Tate,W. (2003). No time like the present: Reflecting on equity in school mathematics. *Theory Into Practice*, *42*(3).

Schoenfeld,A.(2002).Making mathematics work for all children: Issues of standards, testing and equity. *Educational Researcher,31*(1), 13-25.

Engagement with the Field

An understanding of the relationship between the discipline and a selection of school curriculum will be enhanced through observations and projects to address the following issues: What knowledge is valued? How is mathematics experienced in school settings and how are learner identities constructed? How do communities shape knowledge production and, there, what counts as useful mathematical knowledge? How might scholars and teachers

work with community-based knowledge makers to develop collaborative knowledge resources?

Assignments/Projects

1. Analysis of books, folk games, and other resource materials
2. Observation of children doing everyday math, playing folk games; community numeracy practices
3. Classroom observations and analysis of mathematics classrooms
4. Use and setting up of a mathematics lab
5. Development of manipulatives, games, low-cost activity materials