A life Lived and Taught: Interview with Aparna Dar

Prof. Aparna Dar Aparna Dar

Aparna Dar is a mathematician and an emeritus professor at the Indian Institute of Technology, Kanpur, with research interests in Topology and Knot Theory. She completed her Ph.D. at the State University of New York at Stony Brook under the guidance of Jeff Cheeger, focusing on aspects of Knot Theory. Since 1989, she has been teaching mathematics at IIT Kanpur.

In this interview, Prof. Dar reflects on her mathematical influences, her doctoral years in US, her views on the ethical responsibilities of the individual, her time at IITK and her longstanding engagement with teaching.

How would you describe your childhood? What were your early interests? And did you always have an inclination towards mathematics?

Aparna Dar: I was born and brought up in Kolkata, even though my parents were both of Kashmiri Pandit origin. My father, *Shri Swaroop Krishna Dar*—an engineer in the Indian Railways—always had distinction in mathematics as a student, and my mother, *Smt. Kiran Dar*, was a gold medal student of economics. However, as I lost my father at the very young age of 12 years, I was brought up by my maternal family in Kolkata.

Yes, mathematics always attracted me very strongly since my childhood, and I was always winning prizes for mathematics in my school days. And since my maternal family was very spiritually inclined, my other childhood interest was reading the works of great spiritual masters like Swami Vivekananda, who has deeply influenced my thinking and personality.

How would you describe your undergraduate years? What led you to join IIT Kanpur for your master's studies? Which courses and individuals had a significant influence on you there?

AD: After completing my schooling, I wanted to continue with higher studies in mathematics, and some family friends suggested that IIT Kanpur was a very good institute to learn mathematics. So I prepared for JEE and got selected in the Mathematics Department of IIT Kanpur in 1975. We had excellent professors in the department, who not only excelled in their work but were also very generous and kind to me as a young student. Among them was *Prof. Krishna Tiwari*, who worked in Algebra, and *Prof. U. B. Tiwari*, who worked in Analysis, amongst many others. Somehow, I got interested to work in Topology and Geometry, and my kind teachers wrote my recommendation letters to go to SUNY Stony Brook, where I started my PhD in mathematics.

How would you describe your time at IIT Kanpur so far, both inside and outside the campus? What changes have you witnessed since your master's studies?

AD: There have been many changes at IIT Kanpur since my student days and up to the present, during which I have been working here as a faculty member.

"My main purpose was to impart the kind of education that Swami Vivekananda's writings talk about, i.e., "Education is to teach students self-confidence in their own abilities, and to learn to think for themselves."

In our student days, the human touch between students and teachers was very strong. We would visit their homes, and they treated us like family members. This was an invaluable gift, as we absorbed a lot of wisdom and maturity from our professors.

When I joined IIT Kanpur in 1989, my main purpose was to impart the kind of education that Swami Vivekananda's writings talk about, i.e., *"Education is to teach students self-confidence in their own abilities, and to learn to think for themselves"*. At the time, many wonderful young students joined me for their master's projects—such as *Harish Seshadri* and *Punita*

45th alumni reunion of Class of 1980 in March 2025. Aparna Dar

Batra—who have today become excellent mathematicians. It was a joy for me to have the opportunity to help these students in their formative years.

Also, I learned a new field of mathematics, a branch of Topology called Knot Theory, and solved an open problem on Kirby's List of Open Problems in Low-Dimensional Topology in 2005. Thereafter, many students wanted to do projects on Knot Theory with me, and they even enjoyed learning it a lot in my courses!

Presently, student numbers have vastly increased, and due to extensive online resources, the human connectivity with faculty has diminished. This is unfortunate, because it is through personal contact alongside the care and wisdom of senior faculty that young students learn the valuable lessons of human life.

How would you describe your time at SUNY Stony Brook? Which areas of mathematics drew your interest during that period?

AD: I was accepted into the Ph.D. program in Mathematics at SUNY Stony Brook in 1980. In those days, Stony Brook was a truly wonderful place to be—both because of the exciting work in Geometry and Topology in the department at the time, and also because of the friendly, cosmopolitan atmosphere of the University.
We formed a close circle of friends at SUNY Stony Brook, and some of us have remained lifelong friends.

What was it like working with Professor Jeff Cheeger during your doctoral studies?

AD: It was very fortunate for me to be accepted by *Professor Jeff Cheeger* as a doctoral student. At the time, he had several Ph.D. students (maybe 4–5), and he kindly accepted me among them. Professor Cheeger is a mathematical genius, but alongside, he is also a very generous and good-hearted professor—a very rare combination, and I feel privileged to have been his doctoral student.

Jeff Cheeger. ©NYU

What was the focus of your doctoral thesis at SUNY Stony Brook?

AD: In the early eighties, Prof Cheeger had solved a famous open problem on the equality of the analytic torsion, and a topological invariant— the Reidemeister Torsion. This path-breaking work was published in the *Annals of Mathematics*. From this, Prof Cheeger began the study of analysis on spaces with singularities, i.e., pseudomanifolds, and was very actively doing path-breaking research in this area. This was the time he accepted me as his doctoral student, so he suggested a problem of extending analytic torsion and the topological Reidemeister Torsion to pseudomanifolds. Though it was challenging, based on the Intersection Homology Theory of *Goresky* and *MacPherson*, it became possible to generalise the analytic torsion to pseudomanifolds, and also define a topological invariant, the Intersection $\mathcal{R}$-Torsion, and to prove equality in some special cases. This work, done over 2-3 years, became my PhD thesis at SUNY Stony Brook.

Do you have interests outside of mathematics—such as philosophy or music? Have these other dimensions helped inspire your work, and if so, in what way?

AD: Apart from mathematics, I am also deeply interested in the spiritual traditions of the East and West. Having read Swami Vivekananda extensively in my childhood and during my student days, I felt the beauty of our ancient Upanishadic culture, which accepts all paths to the Divine as true.

Quoting from the Sanskrit: *"Ekam sad viprā bahudhā vadanti"*—Truth is One, but it manifests in infinitely many names and forms. Thus, every spiritual tradition leads to the realisation of the Transcendental Divine Light. Another beautiful concept in our ancient Vedanta is: *"Vasudhaiva kutumbakam"*—the whole world is one family. Lastly, quoting from Swami Vivekananda is the idea that: *"Service to others is the highest form of worship"*—*"Nara is Nārāyaṇa"*, and similarly, *"Jīva is Śiva"*.

Personally, I am initiated into the ancient Gayatri Mantra, (a prayer for wisdom) from Shantikunj, Haridwar, since the last 25 years or so.

You solved Kirby's open problem in knot theory—namely, whether there exist alternating amphicheiral knots of every even crossing number—with a positive, constructive class of examples. How was the process for you? Did you approach the problem intending to solve it, or did the solution arise more as a realisation along the way?

AD: It all started when I began reading a paper by *Prof. Vaughan Jones* (who discovered the Jones polynomial). The paper is titled *"Hecke Algebra Representations of Braid Groups and Link Polynomials"* and was published in the *Annals of Mathematics*, 1987. In this paper, in the appendix on page 381, Prof. Jones gave a table of all the knots up to crossing number 10, their braid representations, and their polynomials.

It was this table, in the appendix, with which I just began calculating Jones polynomials in terms of their braid representations. In fact, my approach was quite experimental— in that I calculated Jones polynomials of many closed braids, and then tried to see if there was any connection between them.

To my great surprise, I did find a connection, and then I just stumbled upon the solution to the Kirby problem. In this process, I discovered many symmetries and formulas for the Jones polynomials that were quite amazing. Probably many discoveries are made in this manner!

Aparna Dar with her students during a topology course. Aparna Dar

Do your undergraduate students take interest in your work on knot theory?

AD: Actually, undergraduates here at IIT Kanpur have been enjoying knot theory, which I have been teaching to them since 2005. It is full of open problems, and sometimes undergraduates even come up with original insights!

Are there any open problems in knot theory that continue to fascinate you?

AD: Yes, there are many open questions still unknown about the Jones polynomial. For example: is there a nontrivial knot whose Jones polynomial equals 1? Not just me, but a large number of mathematicians have been intrigued by questions like this!

Did your interests in differential geometry ever prompt you to explore theoretical physics or consider working within it?

AD: Though I have had many physics students, my own knowledge of physics is very limited, so I have remained within the domain of mathematics only.

How was your experience at the other institutes where you spent time during your postdoctoral years—for instance, IAS, TIFR, ICTP, and others?

AD: IAS, TIFR, and other such institutions are among the most eminent centres for research in mathematics, and it was a privilege for me to spend time in such citadels of higher learning.

You are also a long-standing member of *Manushi*. What is its focus?

AD: Yes, I have been a member of *Manushi* for more than 25 years, as it engages with the real-life challenges faced by women in Indian society.

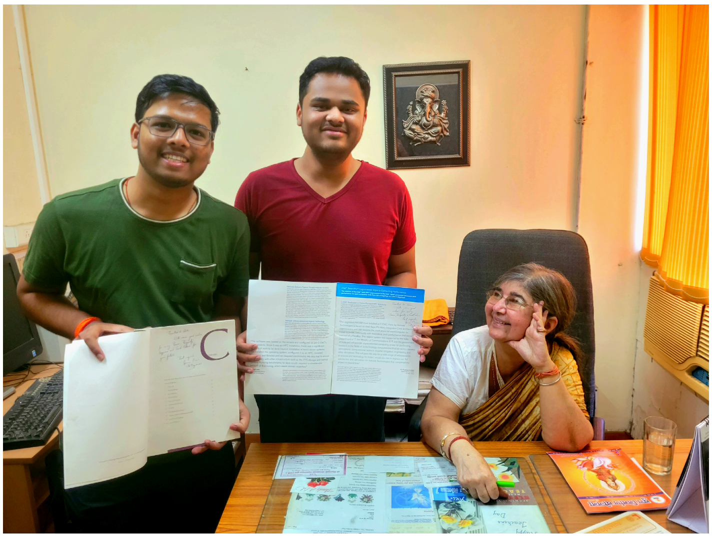
What do you think about the ascetic nature of mathematics? Do you think such a thing exists? How does a career in mathematics—or academics more generally—impact the daily life of a family person?

AD: As I understand it, mathematics began as a language for understanding and describing nature. Thus, in the classical period, mathematics and physics were very closely interrelated. For example, Newton invented calculus as a language and tool to describe his laws of motion, and Einstein used Riemannian geometry to describe his general theory of relativity.

Aparna Dar with her students on the occasion of *Basant Panchami*, 2025. Aparna Dar

Mathematics, being abstract, does possess an ascetic nature. But it also seems to be an innate, inborn talent in some people—something like music. However, many mathematicians, including legendary figures like Euler and Gauss, have led very normal, happy lives, much like other creative individuals.

Do you feel that the works of ancient and pre-colonial Indian mathematicians—such as Āryabhaṭa, Bhāskara, Brahmagupta, and Mādhava—are underrated and insufficiently



Aparna Dar with her students. Aparna Dar

valued in the current state of education in our own country?

AD: Yes. If more people understood Sanskrit, they could translate their works, and I am sure that much advanced mathematics might have been known to Indian mathematicians, but has not yet been discovered.

I do feel that in the ancient and pre-colonial era, Indian mathematicians knew a great deal of mathematics that we are no longer aware of. For example, they had precise knowledge of astronomy, planetary movements, and the exact timings of solar and lunar eclipses. How could they have known all of this without a deep understanding of mathematics?

Thus, I would conjecture that a significant amount of mathematical knowledge existed in that period, but has been lost over time.

Do you think that the lack of Sanskrit literacy today has limited our ability to recover some of these ancient contributions?

AD: Yes, we need people with good knowledge of Sanskrit to search through the Indian mathematics of earlier periods.

Let's talk about education in mathematics in this country. What is your view on the current state of mathematics education in India, especially at the school and college level? Do you feel we are on the right path in cultivating mathematical talent?

AD: Mathematics education in India seems to be doing very well. We have so many young, brilliant mathematicians working in India, and so many institutes like the IISERs and the new IITs. So, I think India is doing very well presently.

How do you approach the challenge of making abstract mathematical concepts accessible to students?

AD: I think we need to provide concrete examples first, and then build up the abstraction through them. This is a principle I have consistently followed in my teaching, and it works well.

What makes a teacher special and different from a researcher—specifically in mathematics?

AD: The teacher who can bring out the best in their student is the one I would consider 'special.' For example, Gauss was the teacher of Riemann, and surely he must have been a wonderful and truly special teacher to have nurtured a brilliant genius like Riemann.

A teacher must derive joy from empowering and serving young students. When this spirit is present, all techniques and methods will follow naturally.

What do you expect from an honest student in your course? What qualities, in your view, help a student go far in mathematics?

AD: I have had many meritorious students who have done really very well. Basically, honesty and integrity of character, and respect for learning and for teachers, take students very far!

What is an academic's duty—particularly as a mathematician—to society? How can one contribute beyond the scope of their research work?

AD: An academician's duty is to pursue their work in a way that benefits society as much as possible.

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Since an academician is a person of learning and wisdom, I believe that, along with teaching the technical and intellectual aspects of their subject, they must also embody integrity of character and conduct in every way. They should stand tall, like a lighthouse—serving as a guide to society in times of difficulty and crisis, such as our modern times.

If *Anveshanā* wanted to inspire young people to pursue abstract thought or explore various forms of mathematics (and of course, beyond), what would you suggest as a starting point?

AD: *Anveshanā* could carry engaging articles on different areas of learning, as well as inspiring examples of creative individuals.

As you are already doing, I feel that *Anveshanā* can interview a wide cross-section of academicians in order to present diverse perspectives from various kinds of thinkers. You may also invite some of the young and brilliant faculty members to write expository articles on their areas of specialisation, so as to make these subjects accessible to students.

Overall, I feel *Anveshanā* can become a source of great inspiration and intellectual interest to many—especially young learners. I extend my heartfelt good wishes to the editors!

This interview was conducted over email correspondence.