



# Reflections on the Teaching of Reading & Writing in STEMM

*An online symposium*

by

Centre for Writing & Pedagogy

&

Mathematics Discipline

School of Interwoven Arts & Sciences

Krea University

Dates: 17–19 January 2025

9:30 AM – 5:30 PM IST



# Coordinators

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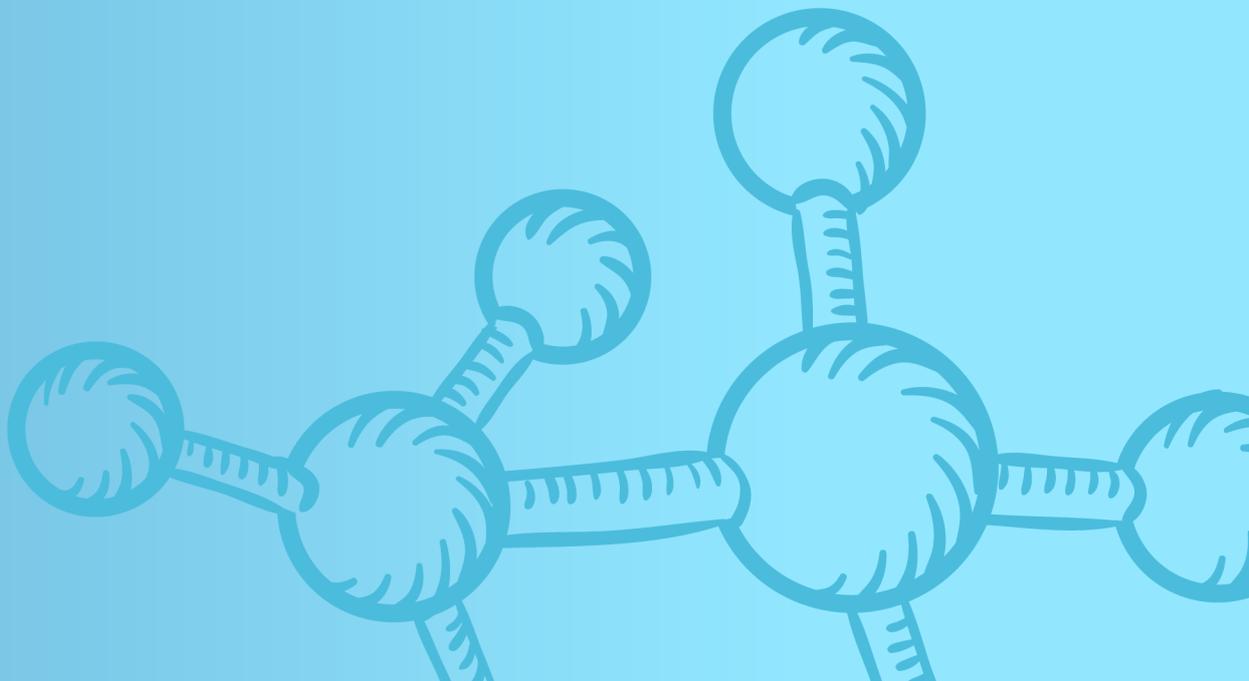
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# Concept Note

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The science, technology, engineering, mathematics, and medicine (STEMM) ecosystem in India is increasingly recognising the importance of teaching its learners and practitioners how to read and write within and across disciplines. For example, in addition to the *National Education Policy* (NEP; 2020) recognising foundational reading and writing skills as “basic learning requirements” (p. 08), the draft *Science, Technology and Innovation Policy* (STIP; 2021) declares an intention to introduce science communication courses at “all levels of education” (p. 44), and the incorporation of science communication skill sets (which presumably include reading and writing in different genres) across different levels of scientific training. Notably, for the STIP, ‘science communication’ is not limited to the transmission of scientific knowledge to non-expert audiences. Instead, the STIP offers a definition of science communication that comprises both science “outreach” and “inreach” (p. 43); while the former constitutes the communication of science to non-expert audiences through science popularisation activities and science journalism, the latter includes communicating scientific findings to expert audiences. In other words, a contemporary learner and practitioner of STEMM would soon be expected to be trained in reading and writing skills that enable one to communicate effectively both within and beyond disciplinary silos.

Policy considerations aside, reading and writing are important for learners & practitioners of STEMM to participate effectively in their disciplines: be it reading literature to identify research questions, reading textbooks as a part of their STEMM education, or to communicate their findings to other practitioners and to members of the public. However, there is evidence indicating STEMM learners and practitioners struggle with these skills. In the context of mathematics education, it has been reported that undergraduate students of mathematics are unable to effectively read their textbooks, and that the difficulties they face in reading and comprehending these textbooks result primarily from the inefficacy of the reading strategies they employ (Shepherd et al., 2009). Thus, in addition to communication skills, training STEMM learners in reading and writing might benefit their engagement with their discipline.

While work on reading strategies that can alleviate challenges such as the one mentioned above is scant, the increased recognition of the importance of science in- and out-reach has propelled several STEM higher-education institutions to instate science writing and communication courses. The scope and curriculum of these courses vary considerably, as do their duration, their target audience, and the expertise required of the instructors. Further, reading and writing practices in all disciplines, including STEM, are being tested and transformed rapidly by generative AI technologies. Before deliberating on the uses and abuses of generative AI in STEM reading and writing contexts, it is imperative to understand the very reading-writing practices that generative AI seeks to intervene in (and perhaps, replace).

Responding to the opportunity posited by these happenings, the Centre for Writing & Pedagogy and the Mathematics Discipline, School of Interwoven Arts and Sciences, Krea University, are hosting an international symposium on ["Reflections on the Teaching of Reading & Writing in STEM"](#).

**This symposium brings together an international cohort of scholars and practitioners from different disciplines to deliberate on reading-writing courses in STEM disciplines as well as courses that focus on reading and writing practices to teach domain knowledge.**

Through the reflections of this cohort, we seek to generate a body of empirical and theoretical knowledge that precipitates critical conversations on curricular & pedagogical aspects of (a) teaching reading and writing skills in STEM and (b) teaching disciplinary knowledge by attending to reading and writing practices within these disciplines.

# Themes & Questions

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Presentations at this symposium explore the following:

## **Curricular and pedagogical reflections on teaching reading and/or writing in STEMM**

What are the curricular and pedagogical choices made by teachers of reading-writing courses in STEMM while designing and executing their courses? What frameworks and intentions guide these choices, and what are the challenges and successes of such courses? How are STEMM-specific reading-writing courses different from such courses in other disciplines, and how is the teaching of reading-writing different from courses seeking to train students in domain knowledge?

## **Sketching the STEMM reading-writing teacher**

Who is the STEMM reading-writing teacher in an Indian context? What makes them take up the teaching of reading and writing in lieu of or in addition to teaching courses in domains of their disciplinary expertise? Do gender, caste, class, sexuality, ability, etc. contribute to who takes up the role of teaching reading-writing in STEMM?

## **Role of reading-writing in domain-specific STEMM knowledge**

How does the teaching of reading-writing precipitate better engagement with disciplinary knowledge?

## **Interdisciplinary reflections & reflections on interdisciplinarity**

What disciplines have a stake in the teaching of reading-writing in STEMM? What is the role, if any, of a STEMM training in the teaching of reading-writing in STEMM? How do approaches from different disciplines, like history, philosophy, literature, and psychology, inform and shape the teaching of writing in STEMM and science education? What are the stakes of evoking 'interdisciplinarity' in discussions on reading-writing in STEMM?

## Empirical investigations into reading and writing in STEMM

What do findings from qualitative or quantitative study of how STEMM learners and practitioners read and write reveal about effective practices, as well as challenges, of teaching reading and writing in STEMM?

## Teaching science communication to STEMM students

What formal and informal methods may be used to teach STEMM students at different stages to effectively communicate their research to the public?

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# Schedule

## Day 1: 17 January 2025

Session	Speaker(s)	Time (IST)
Welcome addresses	Dr Anannya Dasgupta <i>Centre for Writing &amp; Pedagogy, Krea University, Sri City</i>	9.30 AM - 10.20 AM
	Prof KN Raghavan <i>Mathematics Discipline, Krea University, Sri City</i>	
	Prof K VijayRaghavan <i>Former Principal Scientific Adviser to Government of India</i>	
Presentation 1 Hybrid disciplinary spaces: Navigating writing in science education	Dr Sindhu Mathai <i>School of Education, Azim Premji University, Bengaluru</i>	10.25 AM - 11.20 AM
Break: 11.20 AM - 11.30 AM		
Presentation 2 MATH191 - A test ride into mathematical thinking	Dr Soumya Dey <i>Mathematics Discipline, Krea University, Sri City</i>	11.30 AM - 12.25 PM
Presentation 3 Journey of designing a first-year writing curriculum for ESL in engineering	Dr Jooyoung Kim <i>Cognitive and Brain Sciences &amp; Humanities and Social Sciences, Indian Institute of Technology Gandhinagar, Gandhinagar</i>	12.30 PM - 1.25 PM
Lunch Break: 1.25 PM - 2.25 PM		
Presentation 4 Understanding epistemological obstacles in learning interconnections of trigonometric representations	Dr Navaneetha Madaparambu Rajan & Dr Deepa Chari <i>Homi Bhabha Centre for Science Education, Mumbai</i>	2.30 PM - 3.25 PM
Break: 3.25 PM - 3.40 PM		
Keynote address Effective mathematical reading	Prof Lara Alcock, <i>Department of Mathematics Education, Loughborough University, United Kingdom</i>	3.45 PM - 5 PM

# Schedule

## Day 2: 18 January 2025

Session	Speaker(s)	Time (IST)
<b>Introduction to Day 2: 9.30 AM - 9.35 AM</b>		
<b>Presentation 5</b> Why train young scientists to write better for non-scientists?	<b>Dr Somdatta Karak</b> <i>CSIR-Centre for Cellular and Molecular Biology, Hyderabad</i>	9.40 AM - 10.35 AM
<b>Presentation 6</b> What makes computation sing? Interdisciplinarity and innovation in technology education	<b>Achintyaa Sreenath &amp; Prof Kavita Philip</b> <i>University of British Columbia, Canada</i>	10.45 AM - 11.40 AM
<b>Presentation 7</b> Writing as an integral skill: Enhancing analytical and critical thinking through writing pedagogy in energy policy and data science courses	<b>Nivid Desai</b> Writing Studio, Indian Institute of Technology Gandhinagar, Gandhinagar	11.45 AM - 12.40 PM
<b>Lunch Break: 12.45 PM - 2 PM</b>		
<b>Presentation 8</b> Informal paths to training STEM students to write for lay audiences	<b>Dr Shreya Ghosh</b> <i>European Molecular Biology Laboratory, Heidelberg, Germany</i>	2 PM - 2.55 PM
<b>Presentation 9</b> The making of a writing teacher in science and engineering classrooms	<b>Dr Anannya Dasgupta,</b> <i>Centre for Writing and Pedagogy, Krea University, Sri City</i>	3 PM - 3.55 PM
<b>Break: 3.55 PM - 4.05 PM</b>		
<b>Presentation 10</b> Understanding high school students' understanding of reflectional and rotational geometrical transformations and associated symmetries	<b>Saurabh Thakur &amp; Dr Deepa Chari,</b> <i>Homi Bhabha Centre for Science Education, Mumbai</i>	4.05 PM - 5 PM
<b>Closing Remarks: 5 - 5.10 PM</b>		

# Schedule

## Day 3: 19 January 2025 (Open only to speakers)

Session	Facilitator	Time (IST)
<b>Introduction to Day 3: 9.30 AM - 9.40 AM</b>		
<b>Session 1</b> Unpacking the teaching of reading & writing within & across disciplines	<b>Dr Anannya Dasgupta</b> <i>Centre for Writing &amp; Pedagogy, Krea University, Sri City</i>	9.45 AM - 11.15 AM
<b>Break: 11.15 AM - 11.25 AM</b>		
<b>Session 2</b> Classroom as data: Analysing course & teaching materials for pedagogical insights	<b>Prof Madhura Lohokare</b> <i>Centre for Writing Studies, O.P. Jindal Global University, Sonipat</i>	11.25 AM - 12.55 PM
<b>Lunch Break: 12.55 PM - 2.15 PM</b>		
<b>Session 3</b> Mining reflections & interviews for research	<b>Neha Mishra</b> <i>Centre for Writing &amp; Pedagogy, Krea University, Sri City</i>	2.15 PM - 3.45 PM
<b>Break: 3.45 PM - 3.55 PM</b>		
<b>Session 4</b> Structuring & structure in writing	<b>Sayantana Datta,</b> <i>Centre for Writing &amp; Pedagogy, Krea University, Sri City</i> & <b>Dr Vivek Tewary,</b> <i>Mathematics Discipline, Krea University, Sri City</i>	3.55 PM - 5.25 PM
<b>Closing Remarks: 5.25 PM - 5.30 PM</b>		

# People

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## Guests of Honour

### Dr Anannya Dasgupta



Anannya Dasgupta directs the Centre for Writing and Pedagogy at Krea University where she is also Associate Professor of Literature in the Division of Literature and the Arts. Among her publications are single authored essays, such as: *The Feminist De-brahmanising Pedagogy of Writing*, a monograph: *Magical Epistemologies: Forms of Knowledge in Early Modern English Drama*; collection of essays, *Writing In Academia*, co-edited, along with Madhura Lohokare and co-written essays "Something of Our Own to Say" and "Globalising Writing Pedagogy." Her current work is focused on developing writing pedagogies for the Indian classrooms from school to the university level.

### Prof K VijayRaghavan

K VijayRaghavan is the DAE Homi Bhabha Chair Professor at the National Centre for Biological Sciences, Tata Institute of Fundamental Research. From April 2018-April 2022, he served as the Principal Scientific Adviser to the Government of India. Before that, from 2013 to 2018, he was the Secretary of the Department of Biotechnology, Government of India. VijayRaghavan's research interests are in developmental biology, genetics and neurogenetics, on the principles and mechanisms that control the nervous system and muscles during development and how these neuromuscular systems direct specific locomotor behaviours. In addition to continuing his laboratory research interests, VijayRaghavan is studying how sustainable development can be enabled in climate change and the energy crisis. In this context, his focus is on how the university system in India can be empowered to this task and how industry collaboration in research can be enhanced.



### Prof K N Raghavan

K N Raghavan is currently Professor of Mathematics in the School of Interwoven Arts and Sciences at Krea. He moved to Krea recently—in the summer of 2024—from the Institute of Mathematical Sciences (Matscience), where he spent most of his professional career (2001–2024). Raghavan was educated at IIT Delhi and Purdue University and held positions at Michigan State University and Chennai Mathematical Institute before joining Matscience. Raghavan's research interests lie in the area of Representation Theory. He is the co-author with V. Lakshmibai of the monograph in Springer's Encyclopedia of Mathematics series entitled *Standard Monomial Theory, an Invariant Theoretic Approach*. Throughout his tenure at Matscience, Raghavan was involved in various outreach efforts. With physicist colleague Gautam Menon, he started "Science at the Sabha", an annual science outreach event aimed at the general public and held at the Music Academy in Chennai, and ran it for four years 2016–2019, before handing the reins over.



# People

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## Keynote Speaker



### Prof Lara Alcock

Lara Alcock is Professor in the Department of Mathematics Education at Loughborough University in the UK. She has 30 years' experience of teaching undergraduate mathematics. She conducts research on how students think about mathematics, on differences between student and expert thinking, and on educational interventions. Her research focuses on the challenges students encounter as they make the transition to proof, including the reading skills they need in order to understand mathematical texts.

## Speakers



### Dr Navaneetha M R

Navaneetha M R is a postdoctoral fellow at the Homi Bhabha Centre for Science Education, working on the Vigyan Pratibha Project. She earned her PhD in Mathematics from Ariel University, Israel. Her research currently centers on enhancing trigonometry learning at the secondary level, while she also contributes to various research initiatives within the Vigyan Pratibha Project. With 1.5 years of experience teaching undergraduate and postgraduate students, Navaneetha brings a well-rounded approach to her work, combining both research and practical teaching insights. Her expertise lies at the intersection of mathematics education and curriculum development, aiming to make complex mathematical concepts accessible to students. She can be contacted at [navaneetha@hbcse.tifr.res.in](mailto:navaneetha@hbcse.tifr.res.in).

### Nivid Desai

Nivid Desai is the Programme Executive at the Writing Studio, Indian Institute of Technology Gandhinagar. At IITGN, he teaches courses in academic, creative and technical writing at undergraduate, postgraduate and doctoral levels. He also designs and delivers customized in-course writing interventions in collaboration with faculties of science, technology and the humanities. Additionally, he is a member of the Board of Studies at the Department of English, St. Xavier's College (Autonomous), Ahmedabad. Nivid researches at the intersection of writing, education and technology. He has presented and published his research at IIT Delhi, IIT Bombay and BITS Pilani, among others.



# People

## Speakers



### Prof Kavita Philip

Kavita Philip is a historian of science and technology who has written about nineteenth-century environmental knowledge in British India, information technology in post-colonial India, and the intersections of art, science fiction, and social activism with science and technology. She is author of *Civilizing Natures* (2004) and co-editor of five volumes curating new interdisciplinary work in radical history, art, activism, computing, and public policy.

### Achintyaa Sreenath

Achintyaa Sreenath is a graduate student at The University of British Columbia (UBC) pursuing a Master of Arts in Science and Technology Studies (STS) currently in their second year of study. A software engineer by training, Achintyaa has received their Bachelor of Engineering (Honours) in software engineering from the University of Technology Sydney (UTS), Australia.

Achintyaa's research looks at the ways in which technologies inherit and embody social dynamics of power. They are particularly interested in how these dynamics are reconstructed through the rhetoric and deployment of artificial intelligence (AI) technologies, and the material impacts of these reconstructions.



### Dr Somdatta Karak

Somdatta Karak, PhD, is a life scientist turned science communicator. She did her PhD in sensory and motor neuroscience from University of Goettingen, Germany, is an ex-Teach for India fellow and heads science communication and public outreach at CSIR-Centre for Cellular and Molecular Biology (CCMB), Hyderabad. Her work at CCMB focuses on making science accessible and engaging to young people of India. She runs a popular science website called *SciTales by CCMB* where she involves students at CCMB and beyond to create content on science. She also co-leads *Superheroes against Superbugs* – an educational and public engagement initiative for antimicrobial resistance awareness and SciCity Hyderabad – forum that takes science to the cultural spaces of Hyderabad.



### Dr Sindhu Mathai

Sindhu Mathai is an associate professor at the Azim Premji University, Bengaluru. She has taught courses in science education, curriculum studies and research methods to students in the MA Education programme at the School of Education. She has a background in science education, having completed a PhD from the Homi Bhabha Centre for Science Education, Mumbai, in the area of visuospatial reasoning among middle school children. Her recent projects are in the areas of graphical literacy, gender and science, informal science learning, and space-time relationships in the classroom.



# People

## Speakers

### Dr Soumya Dey

Soumya Dey is a mathematician broadly interested in geometry and topology. He has a keen interest in mathematics education at undergraduate and school level.

Dr Dey graduated with a PhD in mathematics from IISER Mohali in 2018, after completing BSc (Hons) in mathematics from St Xavier's College, Kolkata, and MSc in mathematics from RKM Vivekananda University, Belur. Thereafter, he worked as a postdoctoral fellow at IISER Bhopal, the Institute of Mathematical Sciences, Chennai and Chennai Mathematical Institute, Kelambakkam, successively, before joining Krea University in 2022.



As part of his doctoral thesis, Dr Dey computed explicit presentations with finite generating sets for the commutator subgroups of some generalised braid groups. As a postdoc, he started working on mapping class groups of surfaces, singular braid groups, and related infinite groups.

Dr Dey strongly believes that active discussion and collaboration is an indispensable part of doing mathematics, and this culture should be inculcated into undergraduate classrooms. He has co-organised several conferences, workshops and seminars, at both national and international levels, which are aimed at researchers and graduate students. Also, he has been actively involved in math and science outreach activities for students and teachers in schools and colleges.

### Dr Jooyoung Kim

Jooyoung Kim is Assistant Teaching Professor at the Department of Cognitive and Brain Sciences, IIT Gandhinagar (jointly associated with the Department of Humanities and Social Sciences). She received her PhD in linguistics from the University of Delaware, USA, and worked at the university's English Language Institute as a Khbrat program assistant and English-as-a-Second-Language tutor.

Currently, she and her 'Multilingualism and Literacy Lab' (<https://sites.google.com/iitgn.ac.in/MaLL/>) work on multilingual language processing, literacy and education, and academic writing as Instructed Second Language Acquisition, having made over 20 presentations/publications for the last 3 years. She has designed and conducted various writing courses for undergraduate and graduate scholars in engineering and social sciences, such as *Introduction to Writing*, *Writing for Engineering*, *Academic Communication—Explanation and Paraphrasing*, and *Academic Communication—Argumentation and Reasoning*, in addition to linguistics courses on *World Englishes*, *Cognitive Linguistics*, and *The Multilingual Brain*.



# People

## Speakers

### Dr Shreya Ghosh



Shreya Ghosh is a professional science writer and editor with 9+ years of experience in science communication. After completing a PhD in neuroscience from the Tata Institute of Fundamental Research, Mumbai, Shreya joined IndiaBioscience as Program Manager-Science Communication. During her time at IndiaBioscience, Shreya led multiple science-communication-focused initiatives, served as the primary editor for in-house publications, and co-founded the 'Crafting your Career' initiative. In her current role as Communications Editor at European Molecular Biology Laboratory (EMBL), Heidelberg, Germany, she focuses on creating audience-focused informational science content, enhancing the visibility of the institution's research and services and ensuring the quality and accuracy of textual content.

### Dr Anannya Dasgupta

Anannya Dasgupta directs the Centre for Writing and Pedagogy at Krea University where she is also Associate Professor of Literature in the Division of Literature and the Arts. Among her publications are single authored essays, such as: *The Feminist De-brahmanising Pedagogy of Writing*, a monograph: *Magical Epistemologies: Forms of Knowledge in Early Modern English Drama*; collection of essays, *Writing In Academia*, co-edited, along with Madhura Lohokare and co-written essays "Something of Our Own to Say" and "Globalising Writing Pedagogy." Her current work is focused on developing writing pedagogies for the Indian classrooms from school to the university level.



### Saurabh Thakur



Saurabh Thakur is an engineering (IT) graduate and a post-graduate in Elementary Education and is currently pursuing doctoral research work in mathematics education at the Homi Bhabha Centre for Science Education, TIFR, Mumbai. He has been involved in teaching, teacher education, material design and development, and research in school mathematics for over a decade in various capacities with organisations like Teach for India, Azim Premji Foundation for Development, and Tata Institute of Social Sciences. His current work looks at the teaching-learning of geometric transformations at the high school level. He has a passion for nation building and a firm belief that education holds the key to transforming the society as envisioned in India's constitution.

### Dr Deepa Chari

Deepa Chari is a faculty member at the Homi Bhabha Centre for Science Education (HBCSE-TIFR). At HBCSE, Deepa is engaged in research on responsive teaching epistemologies, and instructional and institutional practices enhancing representation of gender and race-ethnic groups in STEM disciplines. Also, Deepa is a coordinator of the national impact program 'Vigyan Pratibha', aimed at student nurture and teacher capacity building in science and mathematics. Through Vigyan Pratibha, she has built sustained interactions with nationwide schools and teacher networks.



# People

## Facilitators for the Writing Workshops

### Dr Anannya Dasgupta



Anannya Dasgupta directs the Centre for Writing and Pedagogy at Krea University where she is also Associate Professor of Literature in the Division of Literature and the Arts. Among her publications are single authored essays, such as: *The Feminist De-brahmanising Pedagogy of Writing*, a monograph: *Magical Epistemologies: Forms of Knowledge in Early Modern English Drama*; collection of essays, *Writing In Academia*, co-edited, along with Madhura Lohokare and co-written essays "Something of Our Own to Say" and "Globalising Writing Pedagogy." Her current work is focused on developing writing pedagogies for the Indian classrooms from school to the university level.

### Prof Madhura Lohokare

Madhura Lohokare teaches at the Centre for Writing Studies, O.P. Jindal University, Sonapat, Haryana. Their doctoral research was an ethnographic investigation of geographies of urban exclusion and their intersections with masculinity and caste in the context of Pune. Their current research interests focus on critical writing pedagogies, interrogating frameworks of care in pedagogy and on articulations between urban modernity and caste privilege.



### Neha Mishra



Trained as a literature scholar, Neha Mishra is Assistant Professor of Practice and Tutoring Coordinator at the Centre for Writing and Pedagogy, Krea University. Before joining Krea-CWP, Neha worked as an editor at the Global Editions division of Pearson Education, NOIDA, where she edited higher education books.

### Sayantana Datta

Sayantana Datta (they/them) is Assistant Professor of Practice at the Centre for Writing & Pedagogy, Krea University, and an independent science journalist and a children's book writer. Initially trained as a neuroscientist, their research and writing now explores intersections of gender, sexuality, caste, health and science. Their work has been recognized by the Laadli Award for Gender Sensitivity in Media and Advertising (2023) and the SAGE-Ashoka Prize for Critical Writing Pedagogies (2024, with Vivek Tewary). Both their children's books, *The Plant Whisperer* and *Grace* (both published by Pratham Books), have been listed in the Parag Honour list (2023 and 2024 respectively). Their research and writing has been funded by grants from the UK Research Initiative's Transforming Education for Sustainable Futures project, the National Association for Science Writers, USA, and the ReFrame Institute of Art and Expression. One can read more about them at [sayantanspins.com](http://sayantanspins.com).



# People

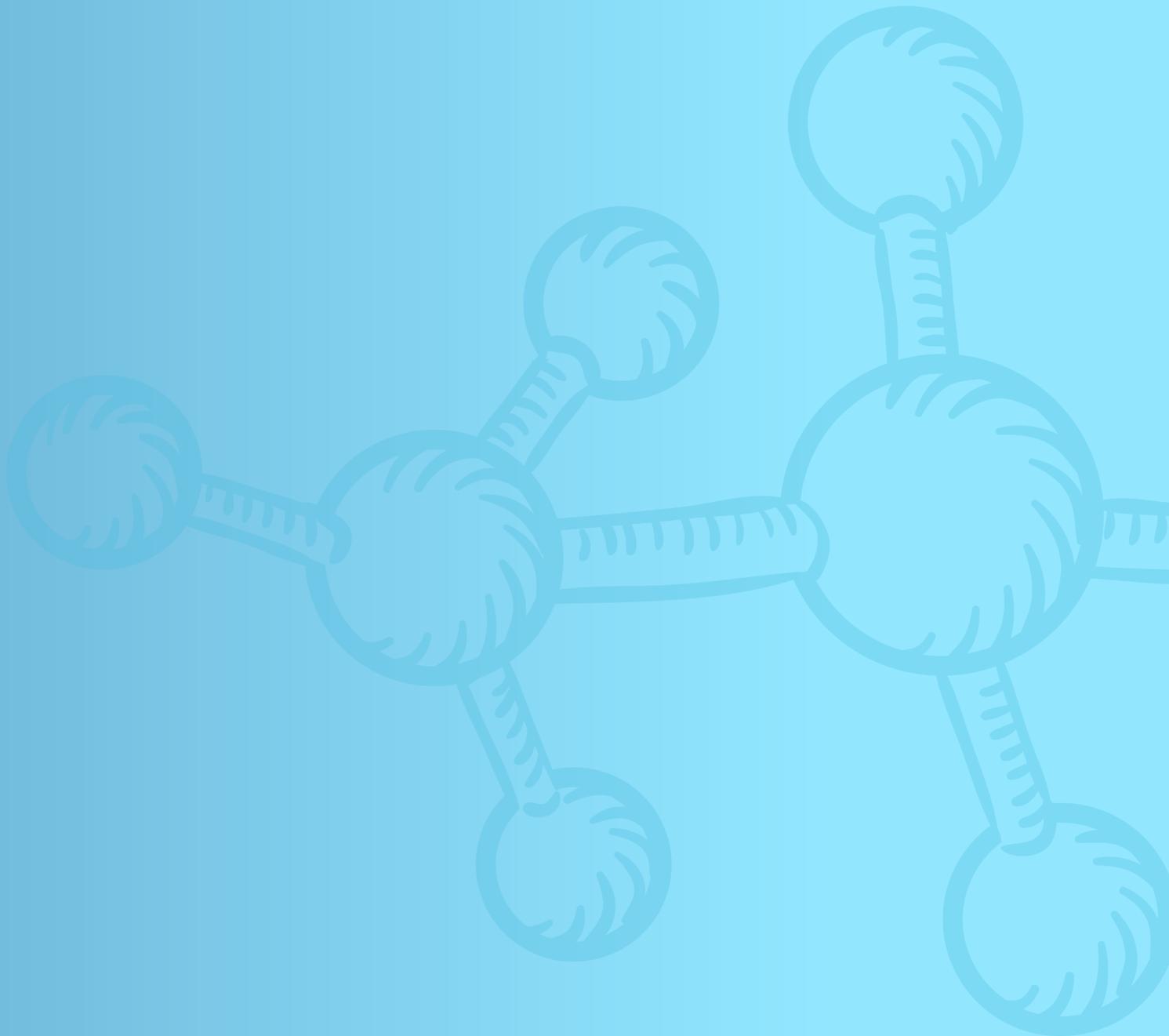
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## Facilitators for the Writing Workshops

### Dr Vivek Tewary



Vivek Tewary is Assistant Professor of Mathematics at the School of Interwoven Arts and Sciences, Krea University working on analysis of partial differential equations. Specifically, he works on the theory of homogenisation — the study of small-scale heterogeneities in physical models; and regularity theory of elliptic and parabolic equations which is about smoothness of solutions in different function spaces. His research is informed by ideas from physics and engineering and he wishes to learn from and work with people in those disciplines. Along with Sayantan Datta, he teaches a writing course in Mathematics. More can be found at [vivektewary.github.io](https://vivektewary.github.io).



# Abstracts

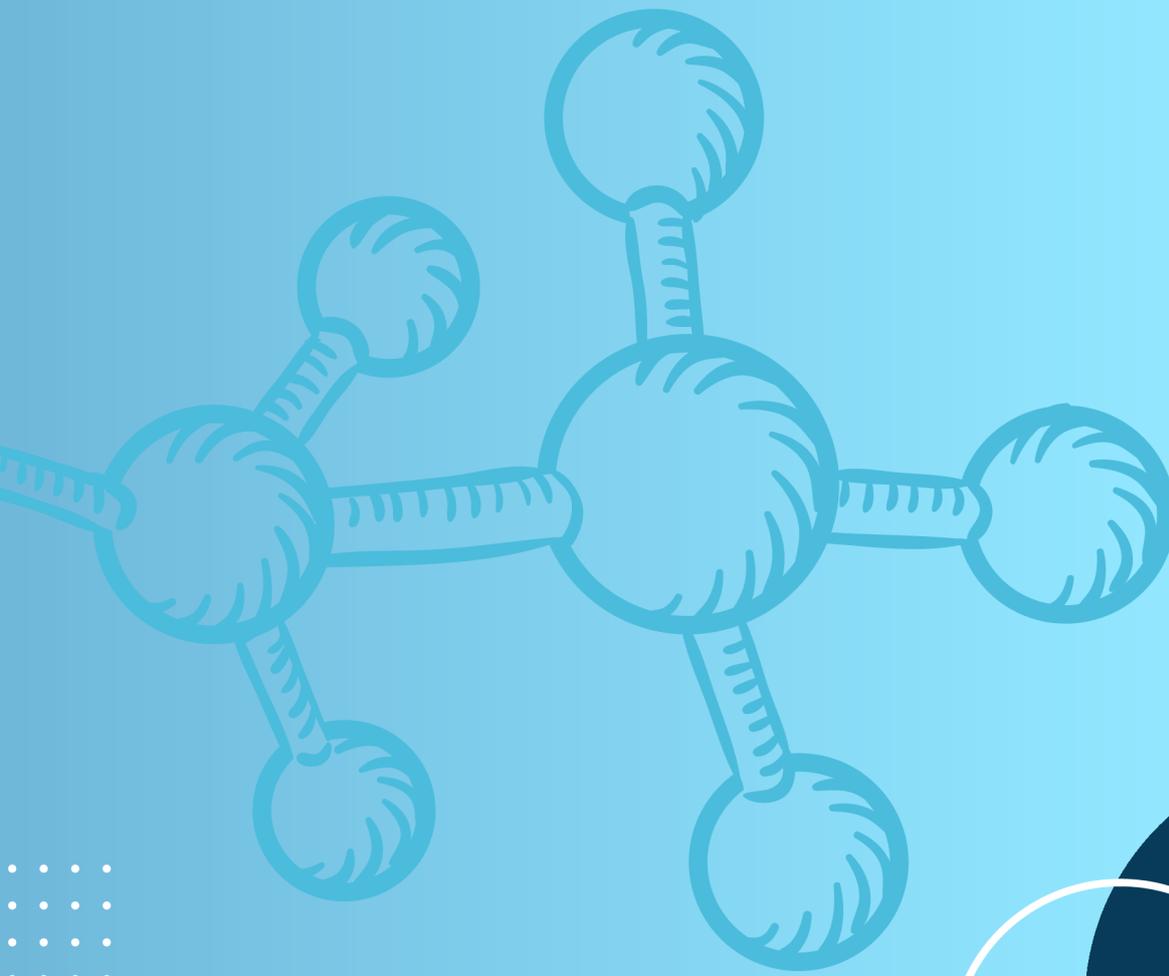
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## Keynote lecture: Effective mathematical reading

**Prof Lara Alcock**

Department of Mathematics Education, Loughborough University

This talk will present a sequence of empirical research studies on expert and novice mathematical reading. In a first study, experts and undergraduates studied purported mathematical proofs while their eye-movements were tracked. We found that experts focused more on the words (rather than the algebra) and shifted their attention in a manner consistent with searching for implicit warrants. In a second, experimental study, undergraduates received self-explanation training or a control activity before reading a mathematical proof and taking a comprehension test. We found that those who had received the training exhibited more expert-like mathematical reading and higher performance in a comprehension test. In a third study, also experimental, undergraduates studied self-explanation training or a control activity in a regular lecture, then read a proof and completed a comprehension test; they also completed a delayed post-test three weeks later. We found that the self-explanation training was effective also in this context. I will discuss implications for teaching effective reading of mathematical text.



## Hybrid disciplinary spaces: Navigating writing in science education

**Dr Sindhu Mathai**

School of Education, Azim Premji University, Bengaluru

Research in science education is highly inter-disciplinary. My work on children's visualisation of human body systems drew upon research in psychology, history and philosophy of science, and human physiology (Mathai, 2006). Hybridity theory (Bhabha, 1997) from postcolonial studies was a meaningful anchor in further work exploring children's understanding of the natural world (Mathai, 2017). Identity construction, and concepts of the habitus, capital and field (Bourdieu, 1977) from Sociology; capabilities and functionings from Economics (Sen, 1999; Mathai, 2018); and conceptions of time from Philosophy (Bergson, 1960) have implications for the pedagogy of science.

An inter-disciplinary understanding has been central to our post-graduate courses in science education at the Azim Premji University, with requirements of reading and writing using multiple conventions. However, the small number of students who return to science education in their post graduate years have a normative understanding of course requirements based on experiences at school and conventional undergraduate education. A typical student views independent work requirements in our courses as 'doing': developing plans for school teaching using curricular artefacts, and 'practical work'. Popular connotations of 'science for all' also allude to tangible practice. My attempts to introduce reading and writing to students started with discussing the literacy practices embedded in science content through innovative curricula such as *Seeds of Science: Roots of Reading* (2023) and *Small Science* (1997–2008). We also have a substantial component of textbook analyses drawing upon conceptual frameworks from the history and philosophy of science. Linking methodological choices within the sub-disciplines of science required confronting multiple metaphysical commitments making science a 'flexible yet durable' discipline.

In the proposed paper, I will illustrate and reflect upon some of the writing struggles students undergo while interpreting the requirements of interdisciplinary approaches. These particularities require open-ness to conceptual frameworks in other disciplines and its bearing on science education; moving away from the fact-value dichotomy; and interpreting the non-linear structure of disciplines over sequence and procedures. Such assignments are essential for students to develop a richer understanding of the nature of science and its complex interpretation compared to how school and college textbooks typically deify it. However, it also presents challenges for students who do not have English language pre-requisites or sense a disconnect from their conventional experience. I will further attempt to characterise typologies of students based on this responsiveness to different disciplines.

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## **MATH191 - A test ride into mathematical thinking**

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We will talk about a first year undergraduate course titled 'Proofs and Ideas - An Introduction to Mathematical Thinking', which I have been teaching at Krea University for the past two years. Within the Krea community, this course is commonly referred to as MATH191, its official course code.

This trimester-long course revolves around two fundamental ideas in mathematics, namely the concepts of an equivalence relation and a partial order on a given set. Starting with the notion of a function, which the students would have already encountered before enrolling in this course, we introduce the definition of a relation on a set as a generalization of a function from the set to itself. Working through a carefully crafted set of examples of relations, we establish the ideas of reflexive, symmetric, and transitive relations, paving the way for equivalence relations to take center stage.

We devote considerable time to helping students understand that defining an equivalence relation on a set is essentially the same as partitioning the set into subsets. As a follow-up, the concept of cardinality of sets is introduced. During tutorial sessions, which are held once every week, students are encouraged to imagine bijective functions between various interesting subsets of the real line and the Euclidean plane, and then precisely write down the explicit formulae. Along the way, the students are exposed to the proof of the Schröder–Bernstein theorem.

The second half of this course begins with the notion of partially ordered sets, emphasizing the difference between symmetric and antisymmetric relations on a set. The course sails through three fundamental examples of partial orders, namely the usual ordering on the real line, divisibility of the natural numbers, and the inclusion relation in the power set of a given set. We wrap up the course by exploring some of the foundational concepts from real analysis and elementary number theory, namely the least upper bound axiom of the real line, the density of rationals in the real line, the unique factorization theorem and the division algorithm.

The course is purposefully designed to gradually increase in complexity, allowing interested students to challenge themselves with progressively harder problems throughout their journey. As the title of the presentation suggests, this course acts as a reality check for students who are considering a math major or a minor, helping them determine if it's the right path for them.

During my presentation, we will dig deeper into the pedagogical elements of this course, informing the audience about specific instances in the course where many students struggle to understand a concept. We will discuss how we rigorously train the students in this course to effectively read and precisely write complex mathematical proofs and ideas. Together, we will advocate for the need to include courses like MATH191 in the undergraduate mathematics curriculum of all universities in the country – courses that prioritize reading and writing in the classroom while imparting domain knowledge.

## **Journey of designing a first-year writing curriculum for ESL in engineering**

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This paper showcases a first-year writing curriculum for an undergraduate engineering program in India, developed over the last four years. Its aim has been twofold: learners' thinking and communication skill improvement in English as a second language (ESL) and providing optimal groundwork for engineering education from the writing in the disciplines (WID) perspective.

Traditional first-year writing classrooms, typically focused on general academic-style essays and critical analyses on intellectually challenging topics, have faced a need for redefinition and reevaluation because of emerging (i) digital literacies (Elola & Oskoz, 2017; McCallum, 2021) and growing interests in (ii) writing across the curriculum, especially, WID (McLeod et al, 1992; Flynn et al., 1997; Hyland, 2008; Kinloch, 2011). Since we viewed general literacy as still valid and essential (e.g., description, narrative, persuasion), we tried to incorporate them smoothly into suitable communication contexts close to new environments of writing education. In addition, another question we tried to solve was, "Which authentic environments should be suitable for our target learners, first-year engineering undergraduates in the Indian context, optimal to their language level, domain-specific knowledge, and prospective styles and genres?"

Our two-semester writing curriculum for engineering students was initially benchmarked by the compulsory writing curricula at CalTech and Harvard University (2020); both engaged incoming undergraduate students in a sequence of two courses, aiming at critical thinking and written proficiency. Adopting them, our core writing curriculum targeted structured thinking and academic rhetorics development, with an extra flavor of ESL. Three key features of our writing curriculum can be summarized as follows: (i) flowing from general to scholarly, (ii) promoting autonomy and cultivating personal voices, with stimulated metacognition, and (iii) engaging authentic science-engineering components that can be transferred to learners' later WID.

First, lessons were directed from general/useful to genre-specific/academic throughout two courses in the first year. For example, the first assignment in the first semester was formal and informal email writing, highly practical in their academic life, coupled with descriptive writing requiring sensory details, strong verbs, and figurative expressions. The focus gradually shifted to source evaluation, expository-argumentative writing, and scientific analysis.

Second, students were invited to self-directed projects engaging their personal experiences. The first semester's assignments include 'email to your friend/relative', 'show what you are passionate about', and 'reflect on a memorable event' with clear expected learning outcomes and rubrics. Even later-stage projects often involved students' personal lives. For example, in a data visualization project, each student recorded their daily routine and analyzed it in tables and charts in the most effective style with relevant categories, values, and text.

Third, reading and in-class activity materials were mostly chosen from digitally accessible news media and popular science outlets. For example, reading for the narrative writing unit included Facebook posts of *Humans of Bombay* and a young Indian scientist's TED talk on Nasik Kumbh Mela, which exposed learners to useful and valuable initiatives. Also, online reading platforms like *Phys.org* and *PressReader* were used to introduce technology magazines, such as *Techlife News* and *Popular Mechanics*, to be used as life-long resources by our students.

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## Understanding epistemological obstacles in learning interconnections of trigonometric representations

**Dr Navaneetha Madaparambu Rajan & Dr Deepa Chari**

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Trigonometric entities such as sine, cosine, etc. can be presented in the form of ratios, unit circle representations, and mathematical functions, and all these forms of representations are also interconnected. Studies have shown that students struggle with the conceptual understanding of trigonometry, particularly in exploring the interconnections of trigonometric representations (Kamber & Takaci, 2017; Orhun, 2001; Weber, 2005). In Indian high-school textbooks, these interconnections, although appear, are not that explicit, and further, often get omitted in the classroom discourses. Students are also seen largely memorizing the trigonometric definitions but can't appreciate the interconnections necessarily. In this paper, we discuss the construction of a diagnostic worksheet developed with a focus on nudging students to think about the interconnections of a few trigonometric entities and present the analysis of the worksheet data.

The research data involved a sample of approximately 100 students of Grade 11 from three schools. All schools were from urban areas following NCERT curricula. The worksheet consists of seven questions focusing on students' conception of trigonometry as ratios, coordinates, or functions and their interconnections. One question was on preparing a concept map which provided a lens to understanding students' overall comprehension of trigonometry.

The questions were informed by our prior textbook analysis of trigonometric chapters in NCERT and selective SCERT textbooks, classroom observations (of Grade 11 mathematics), and feedback from the teachers. Students were requested to solve the worksheet in pairs. After the preliminary analysis of worksheets, a select number of follow-up interviews (in the same pairs) were conducted. The interviews were audio recorded and observation notes were taken.

We observed that students faced difficulties in understanding as well as relating different representations of trigonometry; from the static triangles to the dynamic rotations in the unit circle, and even from the unit circle periodicity to the notion of mappings. For instance, we noticed students' challenges in (a) identifying the  $\cos x$  and  $\sin x$  as coordinates for any angle  $x$  greater than  $90^\circ$ , (b) had seen trigonometric graphs as a separate entity and unable to identify its relation with other representations. Students were also unable to identify the relevance of radian measure. We believe that the limited scope for geometric interpretation and spatial reasoning in the school trigonometry curriculum could be the reasons for students' trigonometric learning difficulties.

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## Why train young scientists to write better for non-scientists?

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In the age of ease of accessing information and where everyone projects themselves to know everything about everything on social media, the lack of actual experts' voices is jarring. This is prominent in the sciences where scientists often complain about the mistakes that journalists might make in covering the scientific details of a process. And, in India where most media houses do not have specialized science journalists, mistakes are common too. Yet, there aren't many avenues where the scientists explain the processes themselves to the non-experts. Students, educators and journalists are the stakeholders that scientists in India want to reach out to. Young scientists, often currently in their doctoral or post-doctoral training, feel strongly about the problem and want to make a difference.

Newspapers, which are best positioned at the moment for offering a forum to the scientists to write that can reach masses, look for experienced writers and consider topics that are new or timely. But most of the time, scientists want to talk about their work because they feel personally invested in it. And, while that might not fulfil the necessities of a newspaper article, these pieces by scientists, if presented well, can provoke newer thoughts and ideas for the readers, can be educational as well as invoke the joy of discovery, the way only a practitioner of science can bring out.

I wish to present my work as an institutional science communicator. I have trained and worked with many young scientists in popular science writing by setting up a website called *SciTales by CCMB*: <https://scitales.ccmb.res.in/>. I will highlight the processes that the variety of these young scientists find useful to become effective writers without going through a formal training. I have gathered these understanding by doing focused discussions with 10 young scientist writers. I will also touch upon tangible examples of how engaging in popular science writing helps the young scientists professionally, journalists who follow our work, and thus, the society at large.

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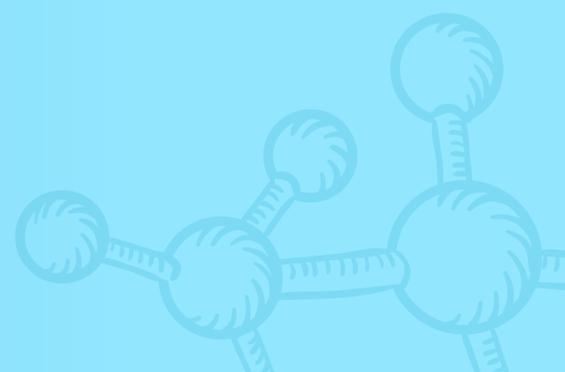
## What makes computation sing? Interdisciplinarity and innovation in technology education

**Achintyaa Sreenath & Prof Kavita Philip**  
University of British Columbia, Vancouver

Launching the iPad in March 2011, Steve Jobs famously placed interdisciplinarity at the heart of technological design, “Technology alone is not enough. It’s technology married with the liberal arts, married with the humanities, that yields the results that makes our hearts sing”. Horace Dediu (2011), in the *Harvard Business Review*, summarized the promise of interdisciplinarity for corporate success: “The lesson the world should take from Apple is that a company needs to become multi-dimensional. It needs to mix the core business with the disruptive innovation. It needs to combine the intellectual with the artistic. It needs to maintain within it the rational and the lunatic” (Dediu, 2011).

In India, what does it mean to combine the rational and the non-rational, or to call for “disruptive innovation”? This paper will examine the hype and reality of the alliance between the liberal arts, humanities, and technology, focusing on Indian software education. We place visionary claims about interdisciplinarity within the larger context of post-colonial informatics and the practical realities of nationalist state planning.

Despite the deeply social nature of engineering, engineering students show a reluctance towards situating their technical texts within any social context (Sarkar et al., 2024). This reluctance reflects a culture within engineering learning that has distanced itself from social realities, focusing on the mathematical element of its training (Crawley et al., 2007). Computer scientist Philip Agre (1995) recalls: “When I was a graduate student in artificial intelligence, the humanities were not held in high regard. They were vague and woolly, they employed impenetrable jargon, and they engaged in meta-level bickering that never decides anything”. Rather than making meta-historical claims about the nature of technological training, we situate interdisciplinarity in the political and social context of Indian software histories. Ajantha Subramanian (2019) argues that caste and engineering are co-constituted through technological rationality. Lilly Irani (2019) shows how interdisciplinarity in Indian software contexts is implicated in the neoliberal shaping of citizens into “entrepreneurial subjects”. In this context, we explore the politics of technological interdisciplinarity, and implications for reading and writing pedagogical strategies.



Our methods are historical and theoretical, while being situated within the co-authors' experiences of education in Indian STEMM spaces. Our discussions are grounded in an inter-generational conversation between the authors about their experiences of reading and writing within science and technology curricula. A. Sreenath, the primary author, draws on their education in software engineering (Manipal, 2018 – 2020; University of Technology Sydney, 2021-2023), and STS (UBC Vancouver, 2023-2025). K. Philip, the second author, brings to bear her education in Physics and Mathematics (Chennai, 1982-85; Iowa 1985-89), and STS (Cornell, 1996), and many years of fieldwork among information professionals and activists during Bangalore's emergence as India's "Silicon Valley." We seek an interdisciplinarity that illuminates the overlap between rationality and its outsides, cautioning against a glib corporate interdisciplinarity that celebrates computation's ongoing penetration into all spheres of life.

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## **Writing as an integral skill: Enhancing analytical and critical thinking through writing pedagogy in energy policy and data science courses**

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This paper examines the integration of writing and reading pedagogy within the eMaster courses "Energy Policy and Regulations" and "Data Science for Decision Making" at IIT Gandhinagar, aimed at enhancing the analytical and critical thinking capabilities of a diverse cohort. Rooted in Electrical Engineering and Computer Science, respectively, these courses introduce modules on technical and narrative writing alongside storytelling to foster comprehensive understanding and communication of complex STEMM concepts. This pedagogical intervention synthesizes two established approaches—Writing Across the Curriculum and Writing in the Discipline—applying them to technology disciplines to embed writing within the core of the subject matter. Rather than treating writing as an external soft skill with learning objectives disconnected from the core skills of the discipline, this approach leverages writing to deepen subject proficiency and solve problems within the discipline.

The curricular design strategically incorporates these elements through targeted assignments and assessments that challenge students to apply technical knowledge in varied writing contexts and vice versa, facilitating a deeper engagement with course content. This intervention equips students with advanced communication skills and enhances their ability to effectively articulate and critique ideas, preparing them for leadership roles in their fields. The impact of this approach is assessed through both qualitative feedback and quantitative performance metrics. This pedagogical innovation demonstrates significant skill development across students, from early-career professionals to senior executives.

## **Informal paths to training STEM students to write for lay audiences**

**Dr Shreya Ghosh**

European Molecular Biology Laboratory (EMBL), Heidelberg

Being able to write about technical topics in a manner that is accessible, logical, engaging, and understandable by non-experts can be a valuable skill for STEM students. It is a prerequisite for communicating science effectively to broad audiences and for participating in many types of science education and public engagement activities. It can also serve as a marker for the student's level of understanding of a STEM topic, as well as their ability to synthesise complex ideas and present them in a simple manner.

Training in this skill – writing about science or mathematics for general audiences – can take formal or informal paths. Formal training can take the form of degree level courses in science communication or individual semester-long credit courses that students can take while pursuing other STEM degrees. However, such formal training can be time consuming, logistically complex, costly to develop, and challenging to design. In addition, access to them is frequently limited to only a small fraction of STEM students.

Therefore, it is important that training in this skill be supplemented by informal training wherever possible. I would like to draw on my own experience as a science communication practitioner to discuss the potential for three different informal approaches towards inculcating this particular skill in STEM students studying at the undergraduate, postgraduate, or doctoral level. The first informal path is through short workshops, either offered by external training providers or developed in-house at universities and research institutions. The second path is through direct mentorship and short traineeships. And the third path consists of science writing clubs and peer-to-peer learning through a shared interest in science communication via the medium of writing. This list is by no means exhaustive, and my hope is that the session would give rise to discussion on further practical approaches to help build capacity in this skill.

## The making of a writing teacher in science and engineering classrooms

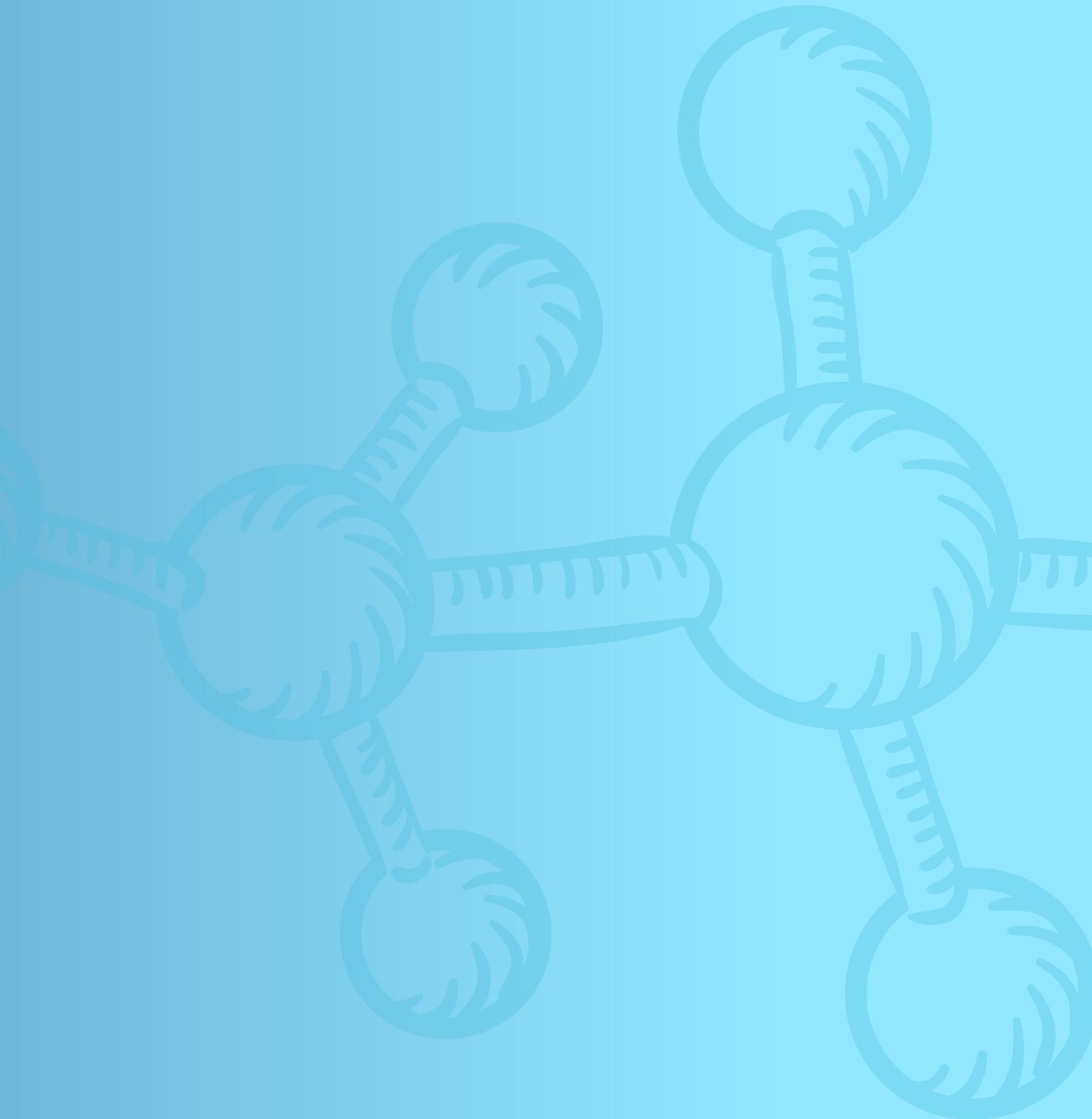
**Dr Anannya Dasgupta**

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This paper is a set of reflections coming from my classroom experience of teaching academic reading and writing to undergraduate and post-graduate students in science and engineering in the United States as well as India. My training as a writing teacher began with teaching the first-year Expository Writing course that I taught over several semesters as a graduate student TA during my doctoral studies in the US. I was usually assigned to teach humanities and arts students, but one semester I was sent over to the science and engineering campus. Looking back, that was the semester I became a writing teacher. Many of my assumptions were challenged, and my teaching methods became more systematic as I was pushed by my students to explain better what it was that I needed them to do and why. I found this set of students more insistent than others on the comprehension of the process of reading and writing as I expected of them. If I was able to provide satisfactory explanations, I saw it reflected in their work more quickly. It was while teaching my science and engineering students that I understood what it meant to de-mystify the process of reading and writing to a step-by-step doable thing. In India, although the science and engineering students who showed up in my writing or literature classes were self-selected and among peers from humanities and social sciences, once again I observed what I had in the US: the science and engineering students responded to a more systematic approach in teaching goals and activities, and often aced the course. This has been true for science students in post-graduate writing classes also. While science students responding well to systematic writing pedagogy is anecdotally true, it is also true that occasionally one hears murmurs of the view that writing in the academic essay form is of not much use to students of science. It is worth pausing on what about it makes it seem like it does not serve their purpose.

In the new pedagogic space of writing centers opening up in Indian universities (and also elsewhere), what the college essay is (or should be) is not always very clear. What to teach in order to teach reading and writing also does not always have a consensus. With a broad mandate to teach reading, writing and critical thinking to improve communication, do writing courses, in the best-case scenario, devise ways to teach skills essential to all disciplines including engineering and the sciences? But what about reading and writing is relevant to science students, in the way they think, read and write? In my experience, student responses in the classroom—what questions they ask, what they resist, where they get stuck, and what helps them—are the best guides to how a writing course can be of use to students, especially those in engineering and science, who by the time they come to college, don't expect to have to write much and certainly not outside their disciplines. As I learned to teach my students in science and engineering, I learned how to let writing curriculum and pedagogy be compelled by the motivation to break down in smaller steps whatever students don't understand.

In this reflection paper, I will map how my methods of teaching reading and writing developed in response to students in science and engineering. In that, particularly, I will dwell on learning how to break-down parts of the writing/reading/thinking process, the function of analogies from science and math to help explain process, and the use of models or templates (picked from the assigned readings or student work in class) as improvised methods that proved particularly helpful.



## **Understanding high school students' understanding of reflectional and rotational geometrical transformations and associated symmetries**

**Saurabh Thakur & Dr Deepa Chari**

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Learning geometric transformations as representing various types of motions has been recommended and included as part of Indian middle school curriculum for some time now. An analysis of the NCERT school textbooks (2006) indicates a lack of stress on important associated ideas such as the perpendicular-bisector relationship between the axis of reflection and a line segment joining an object to its image, considerations for a changing center of rotation, silence about translational and dilational symmetry among others. The depiction of the left-right change in orientation due to reflection in a plane mirror can also be considered as problematic as it raises questions such as the non-occurrence of a top-down inversion.

This study inquires into grade 9 students' reading and writing of mathematical situations involving geometric transformations (reflection about a line, rotation about a point) and their associated symmetry concepts. Students' ideas of shapes as invariances when geometric transformations are applied to them is a key question being answered. Student's interpretations of the parameters involved in these transformations have been investigated thoroughly.

Using a design-based study approach, written assessment tools have been iteratively designed to serve as a diagnostic tool. In the initial stages, qualitative assessments along with focused-group discussions helped explore the prerequisite knowledge and particular challenges that students face in these areas. In later stages, the tool has been recursively fine-tuned to take the form of a standardized set of multiple-choice questions. The fine-tuning is guided by statistical measures such as item-discrimination index.

We argue that translations and rotations are not perceived by students as threats to the integrity (isometry) of a shape but reflections and dilations are. We also argue that students in middle school are not sufficiently exposed to the salient features of reflection and rotation transformations. This can affect students' ability to transition from perceiving geometrical transformations as motions to transformations as mapping of structures as in the reflection and rotation in matrices. We argue towards a holistic geometry curriculum that addresses the four transformations more equitably.

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