Roots, Roads, and Reason: Interview with Amit Kuber

Amit Kuber delivering a talk at IITK. Amit Kuber

Amit Kuber is a mathematician and an Associate Professor of Mathematics at the Indian Institute of Technology Kanpur (IITK) since 2016. His research spans combinatorial and order-theoretic methods in representation theory, as well as model-theoretic aspects of K-theory. Having pursued education at the University of Pune, the University of Cambridge, and the University of Manchester, he is also a committed advocate of honest teaching and has been recognised at IIT Kanpur with the Distinguished Teacher Award and the Excellence-in-Teaching Award.

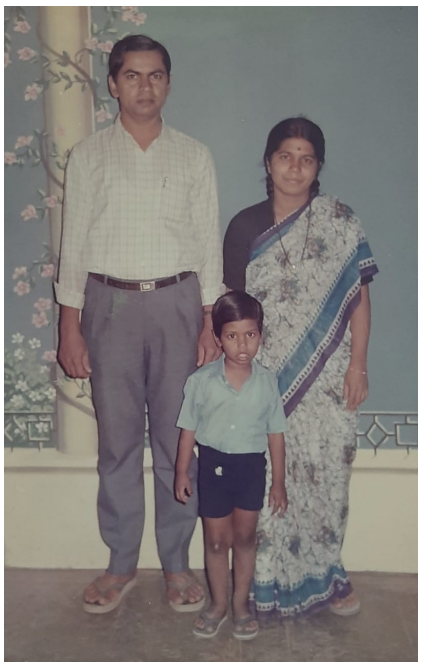
In this conversation with Purnima Tiwari and Aayush Verma for Anveshanā, Prof. Kuber reflects on his childhood and early influences, on discipline as a way of safeguarding curiosity, his mathematics, and on the academic journey that carried him from Pune to Europe and back to India.

Could you tell us a bit about your early life? Where were you born, and what was your childhood like?

Amit Kuber: I was born and brought up in Pune. And until the age of 23, I did not move out of my home. I have a selective memory of certain events. I think my mother (Mrs. Jyoti

Shekhar Kuber) mainly influenced me, but I have also inherited many traits from my father (Mr. Shekhar Digamber Kuber): for example, hard work, no addictions, not getting tired in the office, and the list goes on... Initially, my social interaction was quite a lot, but eventually it declined. At the age of six or seven, playtime decreased considerably. I was more focused on studies.

I remember an incident that happened. My first-grade teacher was very disappointed when she handed over the results to my mother on the last day of school. "He did not do as well as I thought he could," she said. Then my mother looked at the results. I had scored 97%, and she was upset about it: "Why did he lose 3%?" So you can imagine what kind of standards were set. I had scored 100 in the first unit test, and then she expected me to continue the trend. My mother also tells me that I cried once while sitting in a temple because instead of writing "chandra" [moon] in Marathi, I wrote "chandani," which means star. People gathered and thought, "Maybe his exam did not go well". And my mother did not know whether to laugh or cry. I had just missed one word.



Amit Kuber as a child with his parents.
Amit Kuber

Who did you spend the most time with while growing up, and how did that shape your early values and habits?

AK: The person I spent the most time with is my mother. My father is an engineer and was very dedicated to his work. He used to leave home at 7:00 in the morning, but his return time was not fixed every day, so sometimes I saw very little of him in a week. He had a long commute for many years, and because he was so dedicated, that was never an issue for him. As a result, I spent a lot of time with my mother.

She wanted to become a teacher, but she could not. So, whatever students she wanted to nurture, she just had one candidate to fulfill that dream. And she put all her efforts into this. She had prepared for raising a child from a very young age, starting in her 11th grade. When a doctor once visited her college to deliver a talk, she was taking notes. The doctor then spotted her in the audience and said, "You don't need to write so much. I will give you a copy of my book." But she was very dedicated to this.

Most of the things I have learnt, I learnt from her. Our habits are also quite similar. For example, she does not drink tea or coffee because her father did not allow her to. Then she raised me in the same way–I do not drink them either; I never even asked.

Have you never tried a single drop of tea or coffee?

AK: No. I have never tried a single drop of tea. Coffee, I have had, but only as a medicine.

Were you an only child?

AK: I am an only child, yes. It is a nuclear family, just the three of us.

Ages 10–12, what would a typical day in your life look like, including school, and what would you do after coming back home?

Amit Kuber being felicitated by Physicist V.G. Bhide for first position in Maharashtra Talent Search Examination in 2002. Amit Kuber

AK: At the age of 10, I wrote my first state-level scholarship exam. I am not sure if they still exist. My mother asked the teachers, "Will you provide coaching at school?" They said, "What is the point? Nobody gets these scholarships". My mother said, "Let him at least appear for the exam." I stood 6th in the state in that exam. I was showered with appreciation from sectors of society, but not my school. My school was not a good school–neither did they support my endeavours, nor did they celebrate any achievements.

My mother taught me that you should not do anything for appreciation. She also used to say, "If you are doing something, do it well; otherwise, don't do it. If you achieve something, people congratulate you, but you need to get over it and start with something new". The journey has not stopped to this date. I essentially cannot even savour success for a long duration. That was just the beginning. After that, I was mostly focused on doing something extra. School wasn't very challenging. I was always a year ahead in school. For competitive exam preparations, I would often miss school to study with my mother for the whole day, often for 13-14 hours at a stretch. The exam scene in Pune has been extremely competitive. I never said NO to taking on new challenges. I continued like that for several years until I put my foot down for JEE.

Did you not appear for IIT-JEE?

AK: NO! My father wanted me to write the exam. I said I did not want to appear for it because I knew I would crack it, but I did not want to step into an IIT.

"The journey has not stopped to this date. I essentially cannot even savour success for a long duration."

When you decided not to pursue JEE, what alternative path did you choose?

AK: I was interested in learning both science and mathematics. I was also interested in music at that time, but I never looked at music as a career path then, because one needs a guru to make a career. I cannot treat a human being as a supreme lord. On the contrary, academia is more open. I did a three-year Bachelor's in Science at M.E.S. Abasaheb Garware College, Pune. The curriculum did not pose many challenges, and I badly needed a break from the competitive scene.

In the first year, we studied Physics, Chemistry, Mathematics, and Statistics. In the second year, we were required to learn only three subjects, and I considered dropping Physics. Since it was not allowed, I fought for it.

You mean you wanted to drop Physics as one of your subjects?

AK: Yes! The college administration said, "We cannot allow that since it has never been the practice." However, they challenged me to find 12 like-minded students to convince them, and I did exactly that. In fact, now it is a popular choice there.

Kuber in his chemistry lab at home. Amit Kuber

Were you more interested in Chemistry at that stage?

AK: Yes, I was more interested in Chemistry. In fact, I had my own lab. My parents supported me in that way. I would rather not talk about what kind of experiments I have done at home. But let me share that I conducted more than 200 experiments at my home lab starting from the 11th grade. I have a few prized possessions from those days–two silver mirrors (Tollen's reagent) and a gold mirror. In the third year, I had to choose only one subject for my graduation. My Chemistry teachers and especially Statistics teachers were keen to get me in their classes–I

was not interested in the prospect of studying just to earn money. Also, I like exactness and precision, and not approximation, so Statistics did not fascinate me as much. To find time to pursue music, I was naturally pushed towards Mathematics to free lab hours.

Given how much you enjoyed Chemistry and lab work, what eventually made you shift away from it?

AK: Well, let me share the real story. I was a National Talent Search Exam scholar in the 10th grade. I attended the HBCSE training camp after that. When my parents came to pick me up in Mumbai, my mother was scared to see a professor whose face was scarred with chemical burns–this event essentially sealed my fate.

It would have been different if she knew Grothendieck. [Laughter]

Alright, after your Bachelor's, you decided to pursue a Master's in Mathematics.

AK: Yeah, it was a natural progression. I studied at the Department of Mathematics, Pune University.

Looking back, were your professors and peers in Pune supportive of you academically?

AK: Only a few professors supported me, but I was "too much" for most of them! In fact, some of them wanted me to disappear. As a person who asks many questions, I was not welcome in the world of people whose classes are basically spent copying from textbooks. I distinctly remember one course where I learnt the subject by negating everything that was said in the class.

Those who supported had already seen the world. They quickly realized that the university was not suitable for me, and they pushed me in the "right" direction. And people who were there, who were locally trained, did try to sabotage my career as much as possible.

I remember this incident when a group of my friends gave a two-hour-long music concert in the month of January after several weeks of rehearsals. Our program began at 4:30 pm, and there wasn't too much natural light in the big hall with 300 audience members. After two songs, there was a power cut! There was panic everywhere. But I was very calm since, for some weird reason, we were prepared for that situation–we had brought candles, my synthesizer had batteries, and tabla doesn't need power to make sound! I announced, "If you are willing to maintain silence, we can continue with the program." The audience agreed. In candlelight, the chords for the third song filled the ambiance, followed by the lyrics "Main kabhi batalatā nahin, par andhere se dartā hoon main"–it was a wonderful performance! The power was restored

"In candlelight, the chords for the third song filled the ambiance, followed by the lyrics "Main kabhi batalatā nahin, par andhere se dartā hoon main"."

eventually. A few days later, a lecturer taunted, "I really wanted to see how you would react when the power is gone." So that was the level [of contempt]. They were also incentivizing my friends to cut off contact with me. I have gone through this kind of behaviour throughout my life. Now I am used to it. If it is not there, then I would be surprised!

Are you still in touch with anyone from your college days?

AK: Yes, with those who were good to me, not the other ones. I am also in touch with my music teacher, Mrs. Shubhangi Patankar, who has crossed 85.

Please tell us about her. How did you first come into contact with her?

AK: Unfortunately, I studied at Jnana Prabodhini School, a fancy school in Pune, during my 5th grade, amongst the worst experiences there that left me scarred for the rest of my life. That period of 1.5 years, however, did introduce me to three good things in life–good English, Sanskrit, and Music. I appeared for my first exam in vocal Hindustani classical music conducted by Akhil Bharatiya Gandharva Mahavidyalaya as a school pupil. When I left the school, I wanted to continue with music, so I found my music teacher through a friend.

Her teaching method is so amazing that all her students, despite a gap of several years, still remember everything that she has ever taught them. We used to have this fun activity: identify the raag where she would either sing or play a tune while hiding the harmonium. Whenever I visit Pune, we still have a go at that or sing all bandish in succession.

Amit Kuber performing in a musical event. Amit Kuber

So, do you like music? If yes, then what do you listen to?

AK: Yes, I enjoy music with lyrics more than instrumental, like classic or good Bollywood songs and Marathi bhāvgeet. However, once you get into the mood of a raag, words become irrelevant. If I have to pick my favourite raag in Hindustani classical music, then I would say Charukeshi, Puriya Dhanashree, and Marwa. I like the feeling that is accompanied by those thaats. I like dusk-time raags a lot.

Do you also listen to Western Classical Music?

AK: No, not really. I don't understand most of it. I had a musical session with Olivia [Caramello] once–she was my teacher in Cambridge as well as an accomplished pianist. After playing a piece by Beethoven, she asked me, "What emotion does it generate in you?" But I was clueless. Perhaps my emotions are not attuned to Western music.

Kuber with his friends from MSc time. Amit Kuber

After your Master's at Pune University, did you plan to stay in Pune for a PhD? If not, what changed your mind?

AK: Yes. In fact, during my Master's, Prof. Varsha Gejji–my teacher, who was an influential person in changing my career trajectory–asked me, "What do you want to do next?" I responded that I wanted to do a PhD either with her or with Prof. Bhate, my favourite teacher at Pune University. She said, "This is not a suitable place for you. You should go abroad." But I wanted to stay in Pune. After some back and forth, she invited my parents to her home and convinced them to push me to apply abroad. Because of her insistence, and despite the unhappiness at home—on my part and my mother's part—I went ahead with her suggestion. And during my Master's, I applied to only one place–Cambridge–because she had been a postdoc there. I was accepted there as a Master's student for Part III for the academic year 2010-11, instead of for a PhD. Several acquaintances were certain that I would not survive for even two hours abroad, as I had always been under the protective umbrella of my parents. I had stayed outside the city for some time before, but living independently was different. Nevertheless, I spent almost seven years abroad!

Now, we are interested in knowing when you first started feeling a passion for research, and what mathematical problems pulled you in?

AK: As an undergraduate, I was fascinated by the Four Color Theorem and spent hours trying to prove it because I was not happy with Appel and Haken's computer-assisted proof–I also could not get good advice on pursuing Graph Theory. The theorem is a beautiful statement–why should one need computers to prove it? I realized early on that I have a strong

affinity towards Combinatorics. At the other end of the spectrum, while studying Algebraic Topology as part of an Annual Foundation School (AFS) by NBMH, I realized that I also have an affinity towards abstraction and Category Theory.

Though at Pune University, I was mainly focusing on applied subjects, because my favorite teachers taught them. It was Prof. Gejji who introduced me to the world of research, where I worked on the combinatorial aspects of the Runge–Kutta method in numerical analysis. But I was bad at literature survey and discovered my findings in the original paper (by Runge and Kutta) itself. To be honest, I realised the true power of computers and that of the Internet at the age of 23!

At DPMMS, University of Cambridge. Amit Kuber

Later at Cambridge, I was forced to choose the courses that did not require any background, because even though I had a Master's degree from India, it was essentially useless to provide the necessary prerequisites for those courses. But I got a chance to study the flavours of Combinatorics and Category Theory.

All I knew was that I wanted to keep studying–earning was not the immediate goal. My father also taught me, "You should do something that you like, and someone should pay you for it." Reflecting back, after I landed in Cambridge, thanks to my parents' support, my career path was essentially uniquely determined.

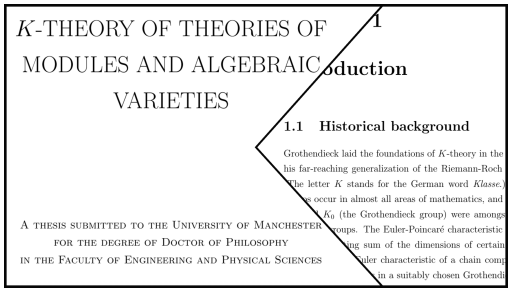
Did you have any mathematical heroes while growing up?

AK: I did not have any heroes while growing up. But Olivia introduced me to Grothendieck. Later, during my PhD at the University of Manchester, he became my main inspiration as a mathematician because of the intuitive depth as well as the variety of subjects he worked on, including Grothendieck categories, Grothendieck topology, and Grothendieck groups. I made sure the first word in my thesis was "Grothendieck", and that the title also contained his name. I had not had a chance to discover him as a person or as a philosopher back then; that happened only later.

In what ways has Alexander Grothendieck influenced your view of mathematics as a way of life? How does this intense focus (like that of Grothendieck) structure a life?

AK: I do not want to compare myself with Grothendieck. But a fascinating thing about him that has influenced me is *mathematics as a way of life*. Let us not call it spirituality, but it is a way of life. I cannot really separate myself as a human being and as a mathematician now–it becomes very difficult.

The precision, the abstraction, the pattern recognition, the connections, the analogies, and then noticing mistakes in little things as a teacher–not just finding but immediately noticing and getting bothered by them—this is all me. It is part and parcel of my life now. Some people find it irritating and hence difficult to talk to me because of that.



Kuber's PhD thesis. On the left, the thesis title and on the right, the first page of the thesis containing 'Grothendieck' in the first line. Amit Kuber

Could you explain Grothendieck's 'Rising Sea' analogy, and what you find most fascinating about it?

AK: Grothendieck's rising sea analogy is about imagining a problem as a hard nut that needs to be cracked. You can take a hammer and a chisel, and strike the nut, and if you are strong and lucky enough, the nut will crack open, but that is just one way of doing mathematics. The other way is you take the nut, and put it into water, let it soak, and then slowly, with time, you rub the shell, and the nut will crack open. You do not have to exert force, but you have to be patient. That is his [Grothendieck] philosophy. Soaking in that liquid is a metaphor for building a theory around the problem–his end goal is to build a theory so strong that the problem becomes a trivial consequence.

He [Aayush] sent me a lecture[1] by Deligne, where he [Deligne] says that in one of Grothendieck's lectures, all the results were very simple, but then at the end he [Grothendieck] had proven something remarkable without anyone ever realizing that it had happened.

You went to the University of Manchester for your PhD. What was your first PhD problem, and how did it shape your way of doing research in mathematics?

> *"Let us not call it spirituality, but it is a way of life. I cannot really separate myself as a human being and as a mathematician."*

AK: The first problem that I was assigned as a PhD student by my supervisor (Mike Prest) was his own conjecture. He told me that he had tried it himself for several years and had not succeeded in proving it. Then he assigned it to another PhD student of his, who proved only a special case, and the general problem remained open. He made a passing comment that he would immediately give a PhD to anyone who solves his conjecture! So he was always skeptical about it, and convinced me

[1] Link to the lecture is at this url.

not to look at the things that did not work while encouraging me to try it myself. I have more or less stuck to that policy for every problem that I work on. He explained the statement of the problem to me, and that was the end. I did not check the literature after that. As a consequence, I was stuck at a point for a long time because I was unaware of a very important lemma called Neumann's lemma, until a friend, Laura [Phillips], told me about it.

The conjecture was essentially motivated by Kontsevich's lecture in Paris, Orsay, in 1995-1996. Two logicians in the audience, Krajíček and Scanlon, observed that the target ring for motivic measures was constructed out of the Grothendieck ring of varieties, which can be essentially understood in a model-theoretic way. The simple reason is that the Grothendieck ring does not utilize the topological structure of varieties. This observation led to the definition of the Grothendieck ring of a model-theoretic structure. My supervisor's conjecture, based on his intuition and expertise in model theory of modules, stated that the Grothendieck ring of a non-zero module is non-trivial. Six months later, I settled his conjecture in the affirmative. In addition, he also made me find generators and relations for such rings.

Kuber with his PhD supervisor, Mike Priest [on the left], and two of Kuber's PhD students in Chennai, December 2025, during a BIRS Workshop on Quivers and Lie Algebra. Amit Kuber

Working under his supervision taught me professionalism, punctuality in responding to emails, and especially improved my English to a level that is acceptable in the UK! His suggestion of not "contaminating" my thoughts by reading failed attempts shaped my idea of doing Mathematics–I do not read a lot, which is both beneficial and problematic. As soon as I understand the problem, I switch off that literature review process. I basically make sure that the problem I am trying to solve has not already been solved, but then I venture out by myself, trying to apply the techniques that I know, rather than trying those that already exist in the literature. People often complain that my papers are very hard to read, because they are not familiar with the techniques that I use. The downside of it is that I miss out on the latest developments. So I am trying to go forward with a balanced view.

Were you introduced to K-Theory by your advisor at Manchester?

AK: No, my advisor did not introduce me to K-Theory. What I worked on was just K_0. Later on, I learned K-Theory with two friends–David Wilding and Laura Phillips, who were my officemates. We started our PhDs on exactly the same day. They were not doing anything

After Kuber's PhD Defense (8 August 2014) at the University of Manchester with Anthony Chiu, Gareth Jones, Harold Simmons, Angus Macintyre, Marcus Tressl, Mike Prest, David Wilding, and Laura Phillips. Amit Kuber

directly related to this topic. Nevertheless, we formed a study group and delivered lectures to each other. Within six months, we had finished a lot of material in K-Theory, essentially around 60 percent of the K-book and some parts of Rosenberg's text. It was a beautiful experience. We gave a public talk at the end of that, which was two hours long.

Wonderful! It is amazing that you learnt it with friends.

AK: I think it is a boring process to learn alone. Dave and I also started a new style of talks, which we termed "double talks". Particularly when there were ideas that ran in parallel, two of us would stand on the stage and take turns speaking, a few sentences at a time. Maybe he would say one sentence about "his side", and then I would add something corresponding to that on "this side", a bit like a *jugalbandi*. We had the chemistry to pull that off–it is not easy with everyone–but it worked really well for us. We also started and ran a seminar series ourselves for several years.

During your PhD, did you miss home?

"I think it is a boring process to learn alone."

AK: Yes, I missed home very much. My parents supported me a lot during that time. Even though I got a full scholarship for my PhD, a large portion of my living and food expenses was borne by my parents. I was living off my parents' support. I wanted to give something back to them by doing something good.

After your PhD, you spent a year in Italy. What was that like, and how did it compare with the later year in the Czech Republic?

AK: Honestly, I was mostly sick, and it was possibly one of the worst years of my life. This was from November 2014 to November 2015. To make it worse, I did not know Italian either. It was very difficult to live there, not just because of the language but also due to water, food, racism, and loneliness.

I was seriously considering coming back to India. During the same year, I already knew I was going to the Czech Republic in 2016. The year in the Czech Republic was much better in terms of people and productivity.

Did you find time to travel around in Europe?

AK: I was very much aware of every single penny that was spent on me. During my PhD, I would walk to my office every day, irrespective of the weather, which was about three and a half kilometers from where I lived, and I never took a bus. I never went anywhere for a leisure trip in the UK, let alone in Europe.

"It was very difficult to live there, not just because of the language but also due to water, food, racism, and loneliness."

After that, I started earning as a postdoctoral researcher. During my year in the Czech Republic, I took my first and only trip to visit a friend in Hungary. My friends visited me from the UK, Italy, and the Czech Republic, and we visited some nearby tourist spots. I generally do not travel without company or reason. I especially dislike going on pre-organised group tours.

Then you joined IIT Kanpur in December of 2016. What were the first courses you taught?

AK: My first teaching experience was a tutorial in Probability and Statistics. The first courses that I taught as a lecturer were Set Theory and Logic, and then Category Theory. I was teaching these two courses simultaneously.

Which new courses have you introduced at IIT Kanpur, starting with Category Theory?

AK: After Category Theory, I taught Topos Theory, then Model Theory, Combinatorics, Algebraic K-theory, and then Representation Theory of Quivers. I have introduced six courses so far, and I wanted to introduce these subjects in the Indian curriculum as soon as possible.

Please share some memories from your teaching days, something that holds importance for you.

AK: There are several I can recall, essentially every time I see somebody's face light up, capturing their "Eureka" moment. It is a pleasure to watch and a great feeling to have. Also, I capture memories of every single course I teach by taking a picture of the survivors on the final day. But one moment that actually made me quite emotional was in 2019. I was teaching this big course, MTH101, and I only had to teach the first half of the semester. I had actually been quite worried about that course even before I started teaching it. I went and stood in that large empty classroom for half an hour, just to imagine what it would look like when it was full of 600 people sitting in front of me. I made attendance compulsory after learning from others' experience with the course, but I also wanted students to attend lectures because they wanted to be present there, not simply because it was compulsory. On the last night of the course, I shared my experiences with the students in my classes in the form of a very long, heartfelt email—it is also available on my website.[2] I got so many responses in that single night, perhaps more than 200. The next day, when I went to class, I got a standing ovation while I was entering, and that was definitely a very emotional moment for me. When I get the opportunity to interact with them in their first semester on campus[3], I want to make them aware of so many pitfalls and roadblocks. A simple mantra to success that I advocate for is to have three meals at regular times every single day. I care and show care.

Survivors of *Representation Theory of Quivers* course by Amit Kuber in Fall 2025 and Thomas Brüstle. Amit Kuber

MTH101A: the journey, 2019. The last day of the course with Kuber and all students. Amit kuber

One student from that class said, "My mother always tells me that you should listen to this person because he cares about you." Making individual connections with students, even

[2] Email is available here.

[3] Kuber's another email titled 'Gotta catch'em young!' sharing a similar message can be read here.

in such a large class, is exactly what I want to achieve–it is difficult, but I put effort into it. Another fond memory is that once, students brought in a cake at the end of the last class. Then there are several emails from students that I have read so far, and those emails highlight that connection. Even if not everybody comes and talks to you, they would know that if they need something, there is somebody they can talk to. I think that feeling of connection is very important for students to not feel alone.

How would you describe Combinatorics and your own way of thinking about it?

"I went and stood in that large empty classroom for half an hour, just to imagine what it would look like when it was full of 600 people sitting in front of me."

AK: I like the study of patterns, which is essentially what you call Combinatorics. However, my students say, "You basically make the definition so vague that anything can come under that umbrella." And to some extent, maybe that is true. I feel Combinatorics is a way of doing Mathematics rather than a subject.

For you, it was that you did not really bother about what would happen next in your career. But there are many students who come to you and ask whether they should go into research or not. Perhaps someone with an undergraduate degree or a master's degree is considering a PhD. What do you typically tell them?

AK: It's a subjective process, and I cannot provide a uniform answer. I think it depends on the answers to the questions that I ask them–say, an algorithm that I follow.

I usually try to make them aware of the pros and cons, as well as the challenges, whether of the corporate world or of the academic world. I also ask them questions about their financial situation to gauge whether they need to earn immediately. When they need to delay further education because the family needs, the best one can do is to tell them to go out, work for a few years, and then come back and try to pursue the same thing that they initially were inclined towards.

I have sometimes seen students who are really strong in mathematics, and I believe they can have good careers in research, but they do not want to. I do sometimes try to push them in that direction, but I am not always successful. Then there are students who are unsure. Sometimes you know that a person probably should not go in this direction, but they still want to.

Occasionally, it is clear that a person is born to do maths. I had a student from the Computer Science branch in my second-year tutorials for Probability and Statistics. It was my first semester of teaching, and I shared an accessible paper in the class. He came to my office, saying he did not understand it. When I dug deeper, he said, "I do not understand how the author thought about the idea." That immediately shows you he is made to do this (research).

Amit Kuber being conferred with Gopal Das Bhandari Memorial Distinguished Teacher Award, IIT Kanpur, on 3 July 2023, by N. R. Narayana Murthy. Amit Kuber

Eventually, he converted to the Maths branch, and now he is doing a PhD in Number Theory. I am happy about that. You cannot have the same answer for everyone. And it is a feeling which I would say I do not want to mechanize; otherwise, AI could take over that job as well. [Laughs]

Should there be a balance between these abstractions and the need for computations?

AK: There should be a balance or synergy between abstraction and concreteness. They complement each other. I definitely do not mind learning something for its own sake. It was the philosophy of Peter Johnstone when he taught Category Theory to us in Cambridge: if you want to learn this subject, do it because you want to learn the subject, not because you want to learn the language. I totally agree with that because it is an insult to the subject.

However, with me, it is like these two weird extremes of mathematics. One is totally abstract, category-theoretic stuff, and the other one is totally concrete–computational stuff. I try to juggle between those two worlds. But this is the artistic aspect of mathematics. People only focus on the scientific aspect, and write "definition, theorem, proof". I always want to write a story.

How do you view an education system where marks become the main focus rather than learning? How does that shape someone's choices?

AK: It feels bad to tell a student, "Now that you are in this class, you have to learn this, just because you want to score." Scoring is not a good motivation for learning anything, because there are other ways of scoring, even if you understand nothing and learn nothing. But learning should be the goal. I can only comment that our education system has not been

"A simple mantra to success that I advocate for is to have three meals at regular times every single day."

successful at inculcating this point of view. At the same time, I am not going to claim that I have solutions for that. It is difficult to do anything at a mass level, especially with our country being the largest in the world in terms of population. We do not motivate people to think independently and ask questions to satisfy their own curiosity. When you are a kid, you succumb to the pressure of the education system. There are many students who cry because of the pressure and loneliness they face in IIT.

But it is a very complex situation. I once read a specific article that explained how school systems were initially developed to create factory workers by training them to do boring tasks for eight hours a day without any curiosity. That is how our education system was built, and we are still continuing with that.

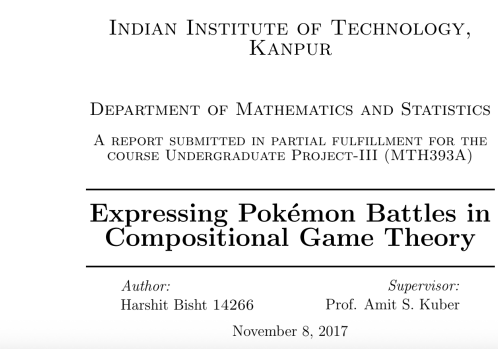
How do you see the balance between teaching and research in an educational institute?

AK: I think that one should do their job very well and fulfill the responsibilities given to them. And everyone should take teaching seriously–I want to emphasize that–irrespective of whether they like it or not, especially in a teaching and research institute, they should do it properly. Now, the definition of "proper" could differ for different people, but I have very strong opinions about that. Teaching is proper if students can get something out of it. One should not think only about oneself and say, "I am delivering my best", but also think about whether it is pitched at too high or too low a level, or whether one is not putting in efforts to convey the ideas, or not making classes interesting enough. In that case, students do not learn. What is important is to convey; the idea should be passed on, and everybody should make efforts in that direction. Now talking of research– It is something that can happen only if all other aspects of your life are in place, but that is not how it works for most people, especially because of the number game (in academia). Unfortunately, our community is forcing people to focus only on research and publishing more, rather than focusing on other things as well. So I would say that I have strong opinions about this, perhaps about this attempt at balancing, and whether it should be done or not. I try to balance things. I know I am only moderately successful on the research front, but I certainly cannot ignore my job of teaching to make up for that.

Lecturing at a CERTEX workshop at IIT Kanpur. Amit Kuber

How do you see the role of AI tools in education today, especially when they can speed things up so much? Do they change how students engage with a subject?

AK: I am actually worried about the future of education with AI being so easily accessible. I do not like the idea of incorporating AI into teaching. Maybe people are focusing on its good aspects, that one can get something done fast. For instance, you can see lots of ads that say you can learn Python, which, in the traditional way, let us say, requires one year, and now here you can learn it in one month. But without romancing with the subject, you do not really develop an intuition for it. Creating a presentation is not just about creating slides–it lacks thought behind what is important and what is not. You actually have to go through that process.



Indian Institute of Technology, Kanpur

Department of Mathematics and Statistics

A report submitted in partial fulfillment for the course Undergraduate Project-III (MTH393A)

Expressing Pokémon Battles in Compositional Game Theory

Author: Harshit Bisht 14266

Supervisor: Prof. Amit S. Kuber

November 8, 2017

A student's report under the supervision of Amit Kuber on Pokémon and Category theory. Amit Kuber

Can you tell us how your student's project connecting category theory to Pokémon came about, and what your own experience with Pokémon has been? Do you enjoy the [Pokémon] game?

AK: Well, Harshit [Bisht], who was my first student at IITK, and I had become good friends by then, and we sometimes used to play Pokémon on the showdown server. When he came across a thesis from Queen Mary University of London that talked about games and monads, we thought, "Okay, can we do something about the game that we both like?" And this is how that project came into existence. Pokémon was really just one very small section at the end of that project, but basically it was about Kleisli categories and how they were used in modelling games. I have played Pokémon with several students here, and participated in Animé society tournaments–I also won a tournament once against seasoned players. It is actually an RPG–a role-playing game–but I do not play that. I like the competitive 6v6 singles random battles format on the Showdown server.

How would you describe your current research to a non-specialised person in the field?

AK: My current research revolves around some combinatorial objects called "quivers" and their "representations". The word "quiver" literally means a bunch of arrows, just as you might have heard in Ramayana and Mahabharata–they are simple-looking yet complex objects and need to be understood through their shadows, which are called representations. In order to understand those shadows, I have to look at some other beautiful pictures–some other quivers–which live above that, and study what properties of those beautiful diagrams above that allow us to get a "good" shadow of the picture that I am interested in.

Alright, what is the origin story of 'Expinfinity', and when did it acquire the meaning 'Exploring Infinity Within'?

AK: I have always been fascinated by the concept of infinity, but the origin story of this name is from 2008. In December that year, I was attending the first-ever Nobel Laureates Conclave in IIIT Allahabad–it was the Indian version of Heidelberg. It was there that I decided to create an email address while toying with the idea of something related to growth faster than infinity, thus expinfinity. The "exp" referred to "exponential" originally, and it did not have the meaning of exploration.

Fast forward 10 years later: on 26 December 2018, I had completed two years of my job. My students had already asked me multiple times by then to create my own website, to which my reply was, "I have not done much in life, what will I write on a website?" But that day, I finally decided to create one. While naming it, I thought about an alternate meaning of the word 'expinfinity,' and this website got its name: "Expinfinity-Exploring Infinity Within". By that time, I had matured quite a lot. The philosophical significance of that phrase is something that I tell a lot of my students–you are looking for answers outside, but the real answers are actually inside you. The current generation is living in so much chaos that they cannot listen to their own inner voice.

Many students learn mathematics through YouTube and social media. Is it easier for them to grasp, and how does that differ from a live classroom?

AK: Nowadays, students ask professors, "Why can't you make your lectures as interesting as Veritasium or 3Blue1Brown?" First of all, they [content creators] put a lot of thought and effort into those videos, and there is an entire production team behind a 15-minute video. They choose a topic to convey an idea that has potential to become popular; they focus on intuition and examples, but often do not go into details and proofs. The purpose is science popularisation, and these features are attractive for students. There is a giant leap from fascination to understanding. Understanding a subject requires romancing with the subject. You have to spend time with it, struggle with it. A readymade solution without struggle cannot be appreciated. True appreciation of a beautiful idea demands struggle. That is how mathematics works because there is no alternative to hard work. Learning is a slow and often boring process. Lecturers can be performers in a limited capacity, and a classroom is not merely a theater.

"But without romancing with the subject, you do not really develop an intuition for it."

How do you choose which students to mentor closely, and how do you tailor your mentoring to each student?

AK: Anyone who approaches me regarding a project, first of all, I try to test whether they are genuinely interested or not; otherwise, there is no point in continuing further–genuine

interest is something beyond the desire to improve their CV. I do not encourage one without a personal interest to pursue something further. I will only have general, limited advice for such people. But if they are passionate about something, show interest, and have potential, then that is the starting point.

Since every student is different, you cannot practically use the same procedure, and since there is no real algorithm, AI certainly cannot replace me on this front! (I would proudly like to say that.)

I spend a lot of time with students. If someone is working with me for a semester-long project, then they have to meet with me for at least three hours per week, where we discuss a variety of topics. Eventually, I understand their strengths and weaknesses. I only need to work on the latter, the things that are holding them back, and that differ for each student.

If a student is too argumentative, then I have to tell them that it is fine if they are doing it with me, but they should not do it everywhere. Sometimes they are too shy, or their communication skills are poor- all of this forms a part of the package. I need to make sure that they feel open to talk to me, and that the connection is strong enough that my words have some impact on them.

"Since every student is different, you cannot practically use the same procedure, and since there is no real algorithm, AI certainly cannot replace me on this front!"

Most of them ask me for a reference letter, and I always write a personalized recommendation from scratch, not by changing the names and qualities in a standard format. I write after recalling their personal interactions with me– some dialogues, or events which indicate something special about them. Every student is different, and so are the challenges they face.

There is a repetitive part in supervision, which becomes quite boring at times, like teaching how to do technical writing and improving communication skills. Even if you end up giving the same talk to a different student, it is essential for their growth.

I strongly believe that focusing on communication and eliminating the misconception from students' brains that mathematics is a solo game are both important. Since the community has to accept and appreciate what you are doing, you have to present your work in an acceptable format. As a result, you should learn how to speak well and how to write well. Your writing should carry your signature, your personality, and convey exactly what you have on your mind. Technical writing, unlike poetry, should not be open to interpretation.

Unfortunately, our education system does not focus on communication. Essay writing is not taken seriously by several high school students, and students interested in science rarely like languages. You have to tell a story. Writing a mathematics paper, delivering a lecture, delivering a seminar- all of it is a story, and that story should be woven around a theme and certain keywords. This is the artistic aspect of mathematics.

Amit Kuber and other participants during the 9th Indian School on Logic and its Applications at IIT Kanpur in 2022. ISLA 2022

To what extent does our current education system allow intellectual independence, and where does it constrain it?

AK: Humans seek validation from others, which comes only when you do something meaningful for a wider audience. Unfortunately, the answer to your question is a resounding "No, it is constrained", which is a fatal flaw in our education system. Why should everybody have to crack the same exam? Is the score of one exam a good indicator of intellect?

The reason is that there is no easy and practical alternative solution. It is not an ideal system but a practical one, the only feasible approach left after eliminating other possibilities, given the scale of population and constraints. So, if you choose to compete in this race, you have to follow certain norms.

Eventually, when you gain independence and when nobody governs your day-to-day activities, you have the choice to skip a lecture if you wish, as you face newfound freedom. And at this point, students tend to do what they want. Unfortunately, our education system does not adequately support or guide them in navigating that freedom in a fruitful manner.

At Anveshanā, we are trying to understand what learning ultimately seeks. So what does 'satisfaction' mean to you in learning and in research?

AK: Research offers the rare opportunity to discover something original, which comes along with a feeling of satisfaction–the joy of discovering something that no one else has known! Most other professions do not offer this opportunity; they might do repetitive work, even creative work, but rarely something entirely new. I personally realized at some point that even though I would like to learn a lot, I have a limited amount of time on this planet. Therefore, I

should learn something, and at some point, I must start using it—applying my knowledge to do something new, and I try to give the same advice to students. You can always find someone who says, "I am learning from this book, I am solving all the exercises from this book and that book", and it never ends. You already accumulate a lot of information as part of the curriculum, and you have to convert it into knowledge as a researcher or a curious learner. This conversion cannot happen unless you process the information, which in turn cannot happen unless you have a concrete goal in mind. The problems you try to tackle guide you through the process and provide a purpose. You cannot be an undergraduate or a postgraduate student throughout your life. What I ask for is to build a strong background and, until then, remain just a student. But once you have laid that foundation, you also become a researcher. Be inquisitive, have a goal, and start reading with that goal in focus–make it a directed effort. Beyond a certain point in your career, your goal should not merely be to read more but to work with purpose.