Interview with **Thang Pang Ern**

Conducted by Kartik Nayak

KARTIK Kartik Nayak, interviewer

PANG ERN Thang Pang Ern, Pure Mathematics undergraduate, National University of Singapore

Introductions

KARTIK *After nearly two years, GSEO interviews are finally back. When we first started the series, our goal was simple: to give students around the world access to honest conversations with exceptional people, beyond polished achievements and into the stories, setbacks and ideas that shaped them. We're excited to restart the series with Thang Pang Ern, a Pure Mathematics undergraduate at the National University of Singapore, whose work spans analytic number theory, undergraduate research, teaching, leadership and even contributions to the OEIS, the Online Encyclopedia of Integer Sequences. Whether you're passionate about mathematics, considering research, preparing for university or simply curious about how top students think, we hope this conversation will leave you inspired. Welcome, Thang. Would you like to introduce yourself to the viewers?*

PANG ERN Hi everyone, my name is Thang Pang Ern. I've just finished my second year at the National University of Singapore, where I'm studying Pure Mathematics. In the coming fall semester, I will be an exchange student at the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, and I'm looking forward to life over there. I've done a lot of things in undergrad so far, but I can't think of anything else to mention, so thanks for the introduction.

Falling in Love with Mathematics

KARTIK *Perfect. It's amazing that you're going to be an exchange student as well. So you're primarily studying maths, right? What made you fall in love with Pure Mathematics? And when did you realise that it was something you wanted to pursue, even in university and beyond?*

PANG ERN Firstly, Pure Mathematics is something I initially thought I could pursue in

the long run, but whether I want to do Pure Mathematics after university has become a question mark. I'll come to that later. The first thing I'd like to discuss is how I got so involved in this, and that started when I was about nine or ten years old. Like every other kid, I played computer games like Minecraft and GTA. I think GTA 5 had already come out back then, but I was more into GTA 3 and 4; I didn't really play 5 as a young kid. So, just like any other kid, I played games and had a lot of fun doing it.

But on top of my gaming addiction, I actually had a huge love for mathematics. Back then, I did English, Mathematics, Science and Chinese, and I realised that Mathematics was sort of the only subject (maybe Science as well, but my Science was horrible back in primary school) where getting 100 marks was possible, because it was just working with numbers, and you didn't have to use that much critical thinking back then. I was so intrigued by a lot of the things my teacher told me in mathematics. Sometimes I would just go on Wikipedia to look at random articles, and I would not understand them at all.

When I was eight or nine years old, I actually knew what sigma notation — the summation notation — was. I knew of π when I was eight, and I knew about the Basel problem. The Basel problem is the sum of the reciprocals of the square numbers:

$$1 + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \cdots.$$

This gives you $\pi^2/6$. The other one was another formula for π: the alternating sum of the reciprocals of the odd numbers,

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots,$$

which gives you $\pi/4$. So I knew these kinds of things when I was very, very young.

I was so interested in π and in mathematics in general. I would look things up on Wikipedia and just read random articles. I remember that, even though I knew the summation notation, I was actually quite scared of the integral notation. The integral symbol was something I encountered later. I saw this 'S hook' kind of thing, and it scared me away. I was like, 'Oh, wait. So you do all these crazy kinds of things in mathematics eventually.'

If all my life I had only dealt with solving problems — counting to, let's say, 10 million, and things like that — rather than with all these abstract concepts, then I would really wonder, 'Oh, so that is the real Mathematics?' Whatever I saw on Wikipedia was the crazy, crazy stuff out there that perhaps people are doing nowadays. So I guess that was some of the motivation I had. There were also some websites where I learnt a lot of interesting mathematics. For instance, there's a website called Math is Fun, which had lots of mathematics games and random mathematics articles that were more suitable for the average elementary school student like me back then. That was another avenue. There was also a YouTube channel called Numberphile, which still exists.

I met one of the co-founders of the channel, Matt Parker. He came to Singapore quite recently — I think maybe a month ago — and gave a talk in the city area of Singapore, which was really interesting. I didn't know that he gave talks nowadays, or that he had a YouTube channel called Stand-up Maths; I didn't know him as that kind of person. Back when he did Numberphile with a bunch of other people, I knew him as the guy who made mathematics more accessible. I would watch all these YouTube videos, and there were some videos — I guess even you might have heard of this — about the alternating sum $1-1+1-1+\cdots$, which sums to one-half.

And there's this crazy series:

$$1+2+3+4+\cdots.$$

You get $-1/12$. It's something by Ramanujan, and it's related to the analytic continuation of the Riemann zeta function. As you can tell from our conversation so far, I was really interested in infinite series back then. I watched Numberphile videos, and they were so good because they explain to the average viewer things that I sometimes learnt only in high school or at university level. It's really cool. So that was when I was young.

Then I progressed to secondary school and then junior college — junior college is the equivalent of American high school. I had really good mathematics teachers in junior college. In the Singapore A-Levels, there's the normal level of mathematics that I guess every student takes, and it's so simple.

Even the school examination papers are actually so simple. I realised that my teachers introduced things in class that were outside the curriculum and outside the textbook, and they made mathematics so interesting. That's why I realised that my primary school self was coming back, as I got way more interested in these kinds of abstract ideas again, and it eventually made me decide to major in Pure Mathematics at university. You might wonder why I chose Pure Mathematics, since mathematics is so broad. You can graduate with a mathematics degree with no specialisation, or you can get a specialisation. Currently, we have Pure Mathematics, and we have operations research and data analytics — modelling and those sorts of things. Those are the broad areas, or you can just graduate without a specialisation.

So why did I want the specialisation in Pure Mathematics? Because I realised that the rigour of Pure Mathematics is something you can't get anywhere else. Learning that rigour is what makes me like it, and it also keeps me awake. Every time I wake up, I realise there's some unfinished business I need to do, and I really need to get into the weeds of it and figure out what's going on. But a lot of the time, you face setbacks, because certain things are simply too difficult for you.

KARTIK *Wow, so it started all the way back in primary school. It's a long history, then.*

PANG ERN Yes, from primary school — around 2011 and 2012.

A Life of Competitions

KARTIK *So, quite some time back. Have you ever taken part in any mathematics competitions or Olympiads?*

PANG ERN There are too many mathematics competitions to count, so I'll just talk about some of the interesting experiences. Let's go back to primary school. In 2012, I was in Primary Three. If you do well in mathematics, your teacher will naturally tell you, 'Hey, there's this competition out there.' It was called the National Mathematical Olympiad of Singapore (NMOS). For three years — 2012, 2013 and 2014 — I spent time practising for the competition. An external vendor would come to our class. There were only a few people in our class — I think it was about half of the students, so slightly fewer than 20. We would stay back on a certain day.

Every week, the instructor would work on different questions — mainly brain teasers and puzzles, and number patterns and series. Back then, I was really, really interested in number patterns and series, so I guess that was one of the motivating factors for me to read up on a lot of these different concepts. I still remember some of the questions; I even remember what the book looked like. So that was the NMOS. Fast-forward to 2014: that was when we actually sat for the competition. I can't remember when we sat for the first round.

I was informed that they selected the top 10% of students around Singapore for the second round, and I remember that the second round had only 146 students. So, if you do the maths, about 1,500 people sat for the first round, and I was one of the 146 selected for the second round. That was quite crazy, because back then I didn't really care about getting any award; I just did things for the love of mathematics. If you really love something, you just keep pursuing it, on and on. You can't stop — it's like a train that has gone out of control. You just keep going. I really loved it.

I didn't expect to get into the second round, even though I knew I had probably done somewhat well in the first round. I didn't really care about getting into the second round, because my teacher had mentioned that taking part in this competition was really for exposure: you just see what kinds of questions they can ask in Olympiad competitions. These Olympiad contests are somewhat different from what you would see in your national exams. In Singapore, at the end of our six years of primary school education, we sit for a national exam called the Primary School Leaving Examination (PSLE). There are some similarities, but there are so many other things that are different from PSLE Mathematics.

So it gave us some exposure to the kinds of mathematics you're probably not exposed to in school if you're living an ordinary life. That's what I felt. So I went into the second round of the contest, which I remember was on Saturday, 26 July 2014. You might be wondering how I remember all these random things. I remember 26 July because we had something called the National Education

(NE) Show, which is related to Singapore's birthday on 9 August every year. 2014 was when we celebrated 49 years of independence. 26 July and 9 August are not that far apart, and every Saturday leading up to 9 August, there would be rehearsals at this place in the city area.

You get to see things like army tanks, troops and fighter jets, and eventually fireworks, so there's a lot of celebration. I remember what happened on 26 July: I went to the competition venue first, then I went home, then I went to my primary school, and from there we took a bus down to the city area, where we enjoyed the performance. It was a really long day, because I had so many things going on. So that was the second round of the competition. I realised that a lot of the questions in the second round were pretty difficult. I didn't do any preparation, because I was thinking, 'Well, if I just go in with my current ability, I'll see how it goes.' I didn't really care about anything other than exposure.

In secondary school, there were competitions like the Singapore Mathematical Olympiad (SMO). My life there wasn't really interesting, because in secondary school I was dealing with a lot of academic subjects. Sad to say, I really didn't have that much time for mathematics, let alone Olympiad maths. But I still got some awards here and there, like bronze and silver. In Secondary Two, in 2017, I took part in another competition called the Australian Mathematics Competition (AMC). It caught me off guard, because I didn't look up any past-year papers, so when I received the paper, I didn't really know what it would be like. I just went in without preparing anything.

I remember that the whole competition had 30 questions, arranged in order of difficulty, and that you did not have much time to work on them — well, maybe sufficient time, but not too long. Of the 30 questions, the last five were open-ended, and they increased in difficulty. I only realised that they increased in difficulty when I sat down and flipped through the questions. I remember the first question asked something like, 'What is 2,000 plus 500 plus 16 plus 8?' You think it's so simple, but as you go on, the questions get increasingly harder.

Initially, I spent a lot of time on the early questions, doing them maybe two or three times just to ensure that I got them correct. Then, for the later questions, I didn't have that much time. Usually, the last five questions are the interesting ones, and sad to say, I never got the chance to look at them, because I ran out of time. Having said that, I still got a really nice result for the Australian Mathematics Competition. There were really a lot of things going on. When I went to junior college, from 2020 to 2021, a lot of things happened as well. That was when COVID-19 struck. I still participated in the usual mathematics competitions.

Because of what my junior college life was like, I actually had a lot of time to spend on mathematics, literally because three of the six subjects I took for the A-Levels were mathematics. So I invested a lot of time in mathematics, and I really, really enjoyed it, spending time on Olympiad mathematics and also on some research projects with my friends as part of a competition. I even

participated in the Euclid Contest — there was such a thing back then. Its style was somewhat similar to the Australian Mathematics Competition, but the difference was that the Euclid Contest had proofs, and I looked forward to that kind of thing. Other than that, I also took part in something new, the American Mathematics Competition (AMC).

The starting round of the AMC has 25 questions, all MCQs, and I think each question has five options: A, B, C, D or E. Again, the questions get increasingly harder as you go on. You have 75 minutes to do 25 questions, so on average you should spend about three minutes on each, but it's not evenly distributed, because the early questions are pretty simple. I also remember that if you don't answer a question, you get some number of points; if you get it wrong, you get fewer points; and if you get it correct, you get the most points. I've already forgotten what the distribution was like.

Apparently, in the United States, students can either take part in a contest called MATHCOUNTS or participate in the AMC. If you do well in the AMC, they take the top percentage of students (I don't know what percentage), and those students go on to the American Invitational Mathematics Examination (AIME). That's where they select — I guess tens of thousands, or around ten thousand, people; I don't know. Eventually, they make it to the USA Mathematical Olympiad (USAMO), and then there are team selection tests and so on. After that, they eventually narrow it down to the final six students for the international team at the International Mathematical Olympiad (IMO). I guess that's how the selection works in the US.

But I think that if I had actually gone to the US, I would have been at a total disadvantage, because I found the AMC difficult. I don't see the point of doing questions so fast. Sometimes you won't even have the chance to read the questions from, say, Question 15 onwards — that's probably what happened to me. I didn't get a good score for the AMC in the end, and I actually don't know what the technique for this contest is. Unlike the other contests, I felt the AMC was just pretty strange, and I didn't really enjoy the experience in comparison. But at least I got to try it and really experience it. Some people in the US get close to perfect scores, or even perfect scores, and some of them eventually make it to the IMO and get silver or gold, but I have no idea how people even attempt questions this quickly. Then, when I was serving my national service, there were times when I would just look at random contests, because after high school — after the IMO — there generally aren't contests that cater to university students.

There are things like the MIT Integration Bee and the Putnam. The Putnam is in the US and Canada, I think, and for non-American countries — on the eastern side, and I think in Europe as well — we have the Simon Marais Mathematics Competition (SMMC). Its style is somewhat similar to the Putnam's, and I think the opportunities for university students to take part in competitions are definitely fewer. While serving my national service and since entering university, I have taken part in the IGMO. Back then, it was called the Instagram

Mathematics Olympiad, but the new IGMO is called the International Gamma Mathematical Olympiad. I also took part in another online calculus contest, where I got sixth place out of more than 200 people. I did pretty well, but again, these were all online. I also took part in the International Youth Mathematics Challenge (IYMC), which I think is somewhat recent — it started in 2018 or 2019; I can't remember exactly. I liked some of the questions because they were quite interesting, and there's a section where they ask you to analyse a paper and give you some open-ended questions, which I enjoyed. When I went to university, I took part in the one and only competition available to university students, which is the SMMC I told you about just now. I enjoyed it. I also took part in an integration bee.

So, contest-wise, the in-person contests span my whole mathematical life, from primary school all the way up to now. Really, a lot of things have happened.

KARTIK *Wow, quite a long history. I can relate to you in that sense. I also took part in mathematics competitions from P1 all the way up to JC; JC1 was my last competition, and in fact, it was the IYMC as well. I looked at your profile — I was looking at everything you did, because I'm also a mathematics lover — and saw how you participated in many competitions. I joined the IYMC, and I actually ended up getting first rank in Indonesia in the final round, so it was a pretty big achievement. Do you remember how many points you scored?*

PANG ERN I think it was 24 or 25, somewhere in that range.

KARTIK *Out of 30, right?*

PANG ERN Yes. I didn't do that well in the previous iteration. Perhaps I got 25 out of 30, but unfortunately, with a score of 25 out of 30, you don't come close to getting the top prize.

How Mathematics Is Taught

KARTIK *That is excellent! You have such a long history of joining mathematics competitions. Looking back at everything up to JC, is there anything you would change about the way mathematics is taught in school?*

PANG ERN I need some time for this. How would mathematics be different — what would I change?

KARTIK *Yes, what would you change? Nowadays, when a lot of students think about mathematics, they immediately become scared: it's a lot of numbers and calculations. Is it the way students are taught? Is it something about the content? Is it the way they're exposed to the questions? Is it more about memorising formulas rather than understanding why they're actually used and how they're derived? What would be the number one thing you would change if you had the chance?*

PANG ERN Well, firstly, I think this is maybe applicable to the secondary school context. Say you practise a lot of questions in secondary school maths and apply them when you go on to take your O-Levels — O-Level Mathematics or Additional Mathematics. The good thing is that the techniques are all pretty much the same. There are only certain types of questions they will ask you, and I don't think those would really change. So I don't think this fosters much of a creative thinking process. By comparison, there is a very stark difference between competition mathematics and school mathematics in terms of the kinds of questions you're exposed to. Competition maths exposes you to what we call non-routine problems. It just means: if I give you a non-routine question, can you do it on the spot? What I like to see is people sitting there and fiddling around for a while, and then eventually they might come up with an answer to the problem. But in school mathematics, if you see a question, can you immediately write the solution down? You don't have to think twice about how to solve the problem. You see all those keywords, and you just write it down. That is a bit sad, in my opinion, but unfortunately that's how things are structured. I also realised that in schools, the beauty of mathematics generally isn't really taught. I guess that was the case for me when I was doing mathematics in Singapore.

But I know that in some places around the world — I'll mention at least one — there's a guy on YouTube called Eddie Woo; I think you might have heard of him. Eddie Woo teaches at Cherrybrook Technology High School in Sydney. I've seen many of his videos since I was in Secondary Two, in 2017, and I realised that he spends a lot of time developing students' intuition for solving problems. I feel that this can be done in Singapore, but generally we don't really have the time. We just go straight into the actual content: they throw a bunch of things at you and say, 'Okay, if you see this question, do this; if you see that question, do that.'

But Eddie Woo paints you a very, very nice picture of the whole situation and talks about a lot of mathematical history. It isn't a plain, boring classroom where you just sit down and feel bored; he doesn't teach that way. I don't have the power to change things, but in Singapore, if we spent more time developing students' intuition for solving problems, I think that would be better — especially now, with the role of artificial intelligence in our schools and our societies. To a certain extent, I guess, there are some surveys online that say AI makes you less smart than before. I realise that AI does have its dangers, which is why I try not to rely on it that much. I'll ask it for help a lot of the time, but I definitely won't copy things wholesale all the time, because I have my own style of writing, and I don't want AI to just take over my brain. In the context of schools, I guess students may be using a lot more AI nowadays, especially since around 2023 or 2024. If they become too reliant on it, then what would be the point of learning maths? I don't think students really have the desire to ask AI, 'What's the motivation behind this?' or 'Why do I need to solve this kind of thing in that manner?' I don't think they would, because what they would do is just feed things into ChatGPT or Gemini and expect an

answer: 'Just give me the answer; I don't want to do it.' A lot of things can be changed. But really, mathematics needs to be taught in a way that develops intuition for solving problems. It's not a one-size-fits-all kind of thing. Doing Olympiad mathematics and competitions really exposed me to this, and now I really see that teaching mathematics in this way is better than how mathematics is sometimes taught.

KARTIK *Interesting. So it's more about fostering creativity and, like you said, understanding the motivation behind doing something, rather than just copying the solution and submitting it straight up?*

PANG ERN Yes. To me, motivation is far more important than copying things wholesale from the output you're given. I think that is far more important.

From Junior College to University

KARTIK *I agree 100%, especially because the transition from high school maths to university-level maths is quite a big jump. You need to be able to cope with it and make sure you perform well at university, because you'll be adapting to a new place, you'll probably be living on your own, and you'll have to balance academics as well. With all this, you need to make sure that you can keep doing what you love, especially since you're studying Pure Mathematics at university. On that topic, do you think there's a big difference between high-school-level maths and what you're studying? You're at NUS, which is one of the world's best — a top-10 university. Is there a big difference between what you studied in JC and university maths? What's the difference between Pure Mathematics and your A-Levels?*

PANG ERN Firstly, about NUS's ranking: I think it's first in Asia in the QS rankings, and compared with the whole world, I think it's seventh or eighth, somewhere around there. It's one of the most prestigious universities in the world. To add on, I've met a lot of really good educators and professors who really inspire me in the subject. The QS rankings are based on research — I think they focus primarily on research and not so much on teaching — but I've seen a lot of the work they put out there, and some of it has appeared in really prestigious journals. That's one part.

Going back to the question about the difference between junior college mathematics and university-level maths: the typical Singaporean student does something called H2 Mathematics in junior college. I'm not sure whether the viewers have heard of it.

There are different levels. There is H1 Mathematics, which not many people take in the first place. As for H2 Mathematics, I guess maybe 90-something per cent of students take it; you definitely need that compulsory subject to get somewhere after junior college. H2 Mathematics covers the usual things found in the A-Levels, but there are some differences here and there. I think other

A-Level systems include mechanics and topics like hyperbolic functions, but H2 Mathematics does not. In fact, mechanics was once in our mathematics syllabus, but it was removed. That's the general population. Some students take an additional subject instead of one of their mandatory subjects.

For instance, some students swap a compulsory subject like H2 Chemistry for something else, namely H2 Further Mathematics. In H2 Further Mathematics, we cover introductory university-level content. It is not mainly about proof techniques; proof techniques are something else. Back then, we did induction — it is a proof technique, but the more general proof techniques are covered in H3 Mathematics, which I'll talk about later. Other than induction, we did things like recurrence relations, polar coordinates, further calculus and an introduction to linear algebra. It's quite rigorous, depending on where you go, because the linear algebra taught and examined at the A-Levels is not that difficult, but schools go through way more. That is the difference.

So there's linear algebra, and what else? There's the probability theory part, where we go through other discrete and continuous probability distributions and other statistical tests. In H2 Mathematics, we do the z-test, but in H2 Further Mathematics, if your distribution is unknown or the sample size is small, you sometimes use a t-test. There are also other tests out there, like the χ^2 test and two others whose names I initially forgot: the signed-rank and rank-sum tests. I can't remember them very well because, due to COVID-19, this topic was not tested at the A-Levels, so I didn't spend much time studying it. That's H2 Further Mathematics. In H3 Mathematics, you get an introduction to proof techniques. Induction comes back again, and you have other proof techniques like contradiction, contraposition and so on. That's when you really solve non-routine problems. You do calculus again, for sure, and you do some inequalities and combinatorics. I think there are probably some other nuances here and there in H3 Mathematics. Like I mentioned, the most typical student — the ordinary student who goes into junior college — just does H2 Mathematics and then perhaps proceeds to university. Say you go into a STEM course: maybe computer science or some related engineering field, where you eventually need some level of mathematics. Maybe the most common one over here is data science. I realised that one problem students who go into these majors after junior college have is that they generally struggle with the mathematics content.

This is honestly because of the huge jump from junior college to university. I don't think it's entirely about that, though. Maybe it's partly because you're too used to solving questions with a fixed set of rules and repeating the same story over and over again. The other thing is that, at university level, you do some things that are actually taught in H2 Further Mathematics, or even H3 Mathematics, so people who have done these two subjects at A-Level do have an advantage. If you do calculus, linear algebra, probability, statistics, stochastic processes, numerical analysis and things like these at university level, you have somewhat of an advantage over your peers, because you had some exposure to these subjects in junior college — provided, of course, that during

those few months of break (maybe, for the guys, while they do national service) you spend time revising these things. But I don't really like the fact that junior college H2 Mathematics has a lot of cookie-cutter questions. As I said, it's the kind where you copy and paste a solution that can fit somewhere else. But when I was learning H3 Mathematics, I realised that the questions can get so creative. Fortunately, I already had some preparation from secondary school.

I had encountered concepts like these before. The difference is that in secondary school, I would read on my own and not really have anyone to teach me, but in junior college, when you do H3 Mathematics, you have a teacher; you meet every week, solve problems, have discussions and so on. That's good. You go through topics that are far deeper than what your peers cover in junior college, and the questions are far more intriguing and non-routine. You can't really apply the copy-paste technique anymore, because, as people say, you must have seen the question somewhere before and have some experience with it.

You can say the same thing about H2 Mathematics, but for H3 Mathematics, even if you have seen a question before, you still need some skill to apply that technique. It's not something that is totally magic. That's what I'm saying. So I guess the difference between H2 and H3 Mathematics is really crazy, and the jump from junior college to university involves so many differences. It's also really about the rigour that is instilled when you are trained in mathematics. I can bring up some examples. Take calculus. In an introductory course, you're taught the formal definition of a limit, called the ε-δ definition.

People generally struggle with this because they see a whole lot of quantifiers, such as 'for all' and 'there exists', and they're like, 'Wait, what is going on?' But if you draw things out and apply the definition to simpler things you have seen before, you realise that the definition actually makes sense. I think you'll be all the more appreciative of what these mathematical concepts teach you, because they are beautiful, and that is what makes mathematics special. If you really see this at a deeper level, you'll appreciate mathematics even more. So that's calculus. Linear algebra is the same: we do some proofs. In fact, I was a teaching assistant at NUS for two semesters. I taught an introductory linear algebra course as a tutor, not the main lecturer, and I realised that students generally have issues with proving things.

That's why I developed an intuition for proving things. In exams, you have computational questions and proof questions. I don't spend much time on computational questions, because the formula is right there. If you want me to explain personally, I can, but I don't think it's useful to spend that much time on taking the dot product of two vectors, applying Gram–Schmidt and so on. I could just show you the answers to the Gram–Schmidt process; it's better that way. It's better if I spend more time teaching you the intuition behind the proof questions. I feel that time is better spent that way. So I realised that the jump from JC to university level is really big. The questions you see and the kinds of things you do — a lot of things are different.

Advice to a Younger Self

KARTIK *So I gather from what you've said that H3 Mathematics helped you a lot at university. Interesting. If you could turn back time, go back to JC and give advice to yourself before you entered university, is there anything you would want to say?*

PANG ERN I think it's not really a major thing, but back in junior college, I realised how education is shaped. I had this discussion with my friends before: it is carved out for you. There is a very neat path from primary school to junior college that is carved out for you, and we just walk along it, but suddenly, at the end, it becomes somewhat obscure. That obscurity comes when university begins, because at university level, if you make a mistake, you're kind of at a dead end. But when you're in junior college and you make a mistake, you realise that at the end of the day you can still come back and pull through, because the end goal is the A-Levels.

But at university level, what is your end goal? Different people have different end goals at the end of the day: maybe starting a family, getting a degree, having a house and so on. These goals can be a mix and match of different things. My point is that in junior college, we generally have this idea that you just take your A-Levels, do well, get a scholarship, go to university, do well, get a job, and that's it. But there are a lot of question marks along this path itself. So, if I could turn back time and go back to junior college, what would I tell myself?

I would just tell myself, 'Hey, there are actually other opportunities out there in the world; you shouldn't just stick to academia.' Back then, I was so interested in Pure Mathematics research, and I thought I would do Pure Mathematics and spend so much time on it, and eventually I would publish papers, get tenure and so on. You become a professor whom the world knows for your work in some groundbreaking area — probably some undiscovered area of mathematics, who knows? That is the ambition some of us might have: some crazy thing that perhaps only applies if you're like Terence Tao. That's the exceptional case, but too bad — I don't think that many people are exceptional cases.

So if I could tell my junior college self something, it would be that you shouldn't spend that much time focusing on one thing; you should branch out into thinking about other aspects of life. I should think about family — eventually starting a family is one thing. The other thing is career aspirations: you shouldn't just stick to one thing, because there are many, many other things for you to try. I guess it's a pretty short answer, but that's all I have to say.

KARTIK *Fair enough, because you were pretty interested in mathematics. And now you think that in JC, you could have looked beyond it at other things and discovered a bit more when you had the time?*

PANG ERN Yes — discovering in the sense that I shouldn't just look at solving mathematics

problems for school, but at what else I can do with mathematics beyond this kind of academic work, so that I could prepare earlier.

KARTIK *I see, thank you. That's extremely good advice, and fair enough; I understand what you're saying. One last question for you before we end this interview: finish this sentence. I'll give you two blanks; just fill them in. Actually, there are some other questions, about the NUS Mathematics Society, the OEIS, that kind of thing. We can continue with those. Do you have a little extra time now?*

PANG ERN I have a few more hours to spare.

Contributing to the OEIS

KARTIK *Sure, then we can go ahead. As mentioned, you've contributed sequences to the OEIS as an undergraduate. What was that experience like, and how does it feel knowing that your work is being used by mathematicians worldwide? Could you also introduce the OEIS to our viewers?*

PANG ERN Let me just go to my CV — that's where I save all my things. I'm looking at my CV now, and I have a section on my contributions to the OEIS. The OEIS is the Online Encyclopedia of Integer Sequences. I think it was set up by one person, Neil Sloane, a pretty long time ago. Some history — I'm looking at the Wikipedia page: in 1965, he began collecting integer sequences on file cards, which were later transferred to computer punch cards. As the years went by, the OEIS became an online website where people could publish sequences. How it works is that you create an account and then publish a sequence.

Then a lot of people in the community will talk to you about it, in the sense that they may make some edits, and you have to wait a while before, I think, Sloane actually publishes it for you. Maybe someone else can publish too, but in my experience, Neil Sloane has been the one publishing all my sequences. The good thing is when you want to search for a sequence. Right now, I've just keyed in the sequence 1, 4, 9, 16, 25. As you know, these are the square numbers. If I key it into the OEIS, they tell me that most likely I'm talking about this sequence. They display 207 results, by the way.

In order of relevance, you're most likely searching for A000290, the sequence of square numbers. They tell you a lot of things, like the comments. For instance, one of the comments says that any square number is the sum of two consecutive triangular numbers. I didn't know this fact. Then they tell you a lot of other things: references, formulas and so on. It's really, really long. It's a really good online repository. I use it a lot, and it has helped me in some of my research, including when I put my preprints on arXiv or publish some of them. So what have I contributed to the OEIS? I think my contributions mainly started in January this year. In fact, my CV mentions two contributions in January, one in February, one in April and one in May.

Currently, I have three other edits pending with the OEIS editors, so that's still in progress. Let me give one example of what I contributed: the sequence A392834. This is joint work with a friend called Gerard. The sequence has a pretty long description. It is the time taken to get m people from one side of a bridge to the other, where

(a) the only flashlight must be carried when crossing;
(b) at most three people may cross at the same time;
(c) a group crosses at the speed of its slowest member; and
(d) the k^{th} person requires k seconds to cross the bridge.

We developed this sequence of numbers as part of a research project we did together. As for how some of the sequences might be used, so far I haven't seen anyone use my contributions.

So far, I have only had three contributions. The other two contributions I published were comments on sequences, so it's not that I contributed a new sequence to the OEIS. As for the sequences I did contribute, so far I don't think anyone has made use of them, but perhaps in the near future we might see some new things, because, if you think about it, the OEIS has hundreds of thousands of sequences, and there are so many things out there around the world. So I guess we might have to wait.

KARTIK *So it's basically a collection of all the different types of sequences that people can think of.*

PANG ERN But obviously you need to think of meaningful ones. If you think of a random sequence of numbers — say, 104, 264, 201, 219,000 — it doesn't make sense, right? If there were really some meaning to it, then sure, you could publish it in the OEIS, but you need to state its significance and give some examples of where it pops up.

KARTIK *Interesting. And did you do this while you were studying at NUS in your first year?*

PANG ERN I actually did this in the second semester of my second year.

KARTIK *Oh, so it was pretty recent, then.*

PANG ERN Yes. During that period, I spent a lot of time thinking about what I could put up there that some people might use. I was also invested in the idea that surely there must be something I have that others haven't thought of. And sure enough, I did publish some sequences out there.

Leading the NUS Mathematics Society

KARTIK *Interesting. While you were at NUS, I've read that you were the president of the NUS Mathematics Society. Could you talk a little about the activities you did? And what*

was probably the biggest takeaway from being president?

PANG ERN In the NUS Mathematics Society, I started out as a project director in my first year, and in my second year, I became the president. For some background: when I was a project director, I did a lot of things alongside the other project director, a friend named Ryan. Together, we secured speakers for talks and organised contests like Sudoku and other problem-solving contests, mainly involving Olympiad mathematics and university-level material. One was called ProbleMATHic. We did a lot of crazy things together when I was a project director. When I became the president of the Mathematics Society, I realised that the roles of project director and president are very, very different. As a project director, you do a lot of the groundwork, such as planning things.

To some extent, I really enjoyed doing those kinds of things, because I really love mathematics. But as president, you spend way less time on them, because what you spend time on is managing the different departments. We had a workshops group, people in charge of logistics and people in charge of projects as well, so that's what I did. We did far more things in my second year than in my first. Being president really taught me a lot. The first thing is that it's true you spend less time doing things, but you spend more time telling people what to do. The other thing is that you really get a lot of opportunities.

As a society, we are connected to the NUS Department of Mathematics, as well as to the governing body of the mathematical community in Singapore, the Singapore Mathematical Society (SMS), so we get some opportunities from both. Sometimes they need student volunteers to do something, such as serving as ushers, or they have events we can attend and listen to. In fact, in my freshman year, I got invited to the NUS Faculty of Science anniversary dinner. I can't remember the exact number of years — maybe it was around 120 years or something. We went, and I was invited as part of the NUS Mathematics Society to attend this dinner, so it was a good opportunity.

Then, as president, the good thing was that we collaborated with other student societies at NUS, such as the NUS Physics Society and the NUS Statistics and Data Science Society. I think the biggest takeaway from being president was that I had the chance to go to the United Kingdom for a contest called the UK University Integration Bee. I already knew the organiser before this contest; his name is Vishal, and he's my friend. Apparently, he has been hosting this contest since 2022 or something like that. I can't remember the exact year, but it's somewhere in the 2020s.

Initially, it started as a competition among UK universities, like Oxford, Cambridge, Imperial and Durham — some of these, and maybe others. Then Vishal decided to expand it to Singapore, I think because he came to Singapore for a research internship or something like that. That was 2024. He reached out to NUS and NTU, and that's how NUS got involved in this competition. The first two rounds are held at NUS; in fact, the second round is when the NTU and NUS teams come together to compete. In the final round, the top-performing

students are invited to the UK to participate. I guess that's the nice thing about being president: you really get to see a lot of things, get exposed to a lot of things and have many, many opportunities.

KARTIK *Interesting. So when were you a project director? Do you remember the year?*

PANG ERN It was from 2024 until mid-2025.

KARTIK *2024, so two years ago. Was that during your first or second year?*

PANG ERN First year.

Burnout and Time Management

KARTIK *A project director in your first year — wow, that's pretty cool. As a first-year student, you were a project director, you were new to university, you had to focus on your academics, you were also a teaching assistant, and you had leadership responsibilities. Did you ever burn out, or how did you balance all of these things?*

PANG ERN Firstly, burnout is a concept I initially didn't believe was real. I think that in my whole life, I've only experienced burnout once. I guess some people experience it more than once, but my experience was pretty unexpected. First, the way I test for burnout is as follows. If I'm tired, I just find some place to sleep. Thankfully, I have my bed next to me, but if I'm in school, there are only one or two places where I can really sleep. One is the department lounge; that's where I usually sleep on the sofa. In the past, I went to a place called Pit Stop, which had massage chairs and things like that, so I would sleep for maybe one or two hours and relax there. But I really don't like sleeping with my head down on the table; it actually makes me uncomfortable. Sleeping helps, and sleeping is how I test whether I'm burnt out. What do I mean? Say I'm studying very hard for something. If I'm tired, I obviously can't look at the screen anymore, because that might make me feel worse, so I'll go for a nap. The moment I wake up, if I have the motivation to look at my work again — usually my mathematics stuff — then it's definitely not burnout. It just means you're really tired. In fact, this was quite common for me back in secondary school. Sometimes, when I went home after school, I would just sleep on the sofa, and when I woke up, I would do my work and maybe read Olympiad mathematics if I had time.

I don't think that was burnout, and even at university, I don't think burnout was that common. I think it really only happened once. It was during the Special Term after my first year — Special Term just refers to the summer break.

The summer break was from May to August 2025. I had an undergraduate research project as part of the Undergraduate Research Opportunities Programme in Science (UROPS) that we have at NUS. I did this research project with a professor at NUS, and over the span of those three months, I realised that,

firstly, the papers I had to analyse were really difficult. I relied on AI a lot for help, but back then it wasn't really that good at helping me understand research-level material; I think it was more suited to elementary university-level content. I had a lot of difficulty trying to get things done, and sometimes I asked my professor for advice. There were times when I was doing the report and I was okay.

But I remember one or two times when I was writing up the report and became tired, so I slept. When I woke up and saw it all again, I was like, 'Oh, I'm not going to look at this.' It made me want to avoid the issue. I guess that was the only situation in my life where I experienced burnout. If I just study mathematics in general — for example, I have my bookshelf right in front of me — I can pick up a random mathematics book and read it for a very long time, and I'll enjoy it. It's nice. But when I look back at what happened to me during that research project, that was burnout. Burnout meant that I didn't want to look at anything else.

I just wanted to get it done and over with and sleep forever, maybe. As for how I manage my time, I think you asked about that in relation to other areas. Firstly, a lot of people know this about me: I'm a person who values efficiency. If I have a task, I try to get everything done as soon as possible. For instance, at NUS, I'm part of — not exactly a community or committee or something like that, but I have to take photos for different events. It was for the open houses; we have two, one in March and one in May. After we took the photos, the person who assigned me this role would tell me that I had maybe about four to five days to edit and then submit the photos. But I would do things pretty quickly. The event ran from around 8 a.m. until five or six p.m., and I think I submitted everything to him that night. I don't want things to get done at the very last minute, because if something else needs to be done after I edit the pictures, at least he still has some time to tell me what to do. So submitting early is nice. I don't like to leave things until the last minute.

I don't like submitting something an hour before the deadline. Some people post on Instagram stories, saying that they submitted an assignment two minutes or even one minute before the platform closed. I don't think this is a nice thing to brag about anyway, because it just shows that your time-management skills are really bad. I guess I've had proper time-management skills since my primary school days. Even though I suffered from a gaming addiction in primary school, I could control it, and I still spent a lot of time working things out for my academic subjects. I think secondary school was the real test of doing a lot of things, because I had a leadership position, competitions and my academic studies. I went through a lot back then, but having good, proper time-management skills is really essential. The funny thing is that I didn't have a to-do list back then. I somehow knew what I needed to do in the back of my mind, because at some random point of the day, I would just think, 'Okay, I need to do this by this time,' and so on. But now at university, you don't go to a fixed classroom for classes every day, and you

don't have the same set of friends around, so what I have now is a calendar. I use Google Calendar and put a lot of my stuff in, and I think, 'Oh, okay, this event is coming up; have I done everything already?'

Even for my linear algebra tutorial in the previous semester, Semester 2, I taught every Monday from 10 a.m. to 12 p.m., or 11 a.m. to 1 p.m. — I can't remember, but it was two one-hour slots. Think about it: it was a Monday class, so you'd definitely need to make a lot of preparations beforehand, over the weekend, right? But generally, I wouldn't use the weekend for this kind of thing. I would finish a lot of things during the weekdays and get everything sorted really quickly. To a lot of people's surprise, I even had the time to vet my students' solutions before class, although it was only the same handful of students who came up to me and asked questions.

But I did have the time to reply to students' queries here and there. So I guess that when people claim they're busy, they're faking it most of the time. It's just a matter of how you manage your time.

Exchange at EPFL

KARTIK *I see. So, like you said, time-management discipline has been instilled in you since primary school. I think that's a really important trait. And as you said, you're going to EPFL in Switzerland, and you're bringing all these experiences and skills with you. What's the most exciting thing about studying in Switzerland, and studying maths, especially within Europe?*

PANG ERN The first thing is that I've heard Switzerland is very expensive. I don't think everything is that expensive, though; I have to see it for myself. I guess it will be a very interesting experience, because the first time I travelled outside Asia was when I went to the UK in March. In fact, I went to three different cities in the UK: London, Cambridge and Canterbury. I've always been interested in Europe since I was young — I knew about British monarchs and things like that, a completely random fact — and I'm still interested in it to this day. So it makes me more excited that I'm going to Europe for exchange; all the more reason to look forward to it. And I think EPFL has a really good mathematics faculty.

I was really impressed by the fact that it's the only university in the world with two Fields Medallists: Martin Hairer and Maryna Viazovska. I'm more familiar with Viazovska's work, because she's known for proving the sphere-packing problem in eight dimensions. I think they have some other influential mathematical figures over there too. I'm really looking forward to having a different life there and interacting with the mathematics community as well. I really want to see how Europeans treat mathematics. I've heard they have a faster-paced curriculum than Singapore's. Apparently, Europeans study a bit of calculus, linear algebra and discrete mathematics in high school — I think

this is the case in places like France and Germany — which is why, when they go to university, they generally start off with something like real analysis.

I heard this from one of my seniors at NUS who went to Heidelberg in Germany for exchange.

Careers Beyond Academia

KARTIK *Interesting. As you said, Europe's pretty famous for mathematics. Many mathematicians were European as well, especially in the olden days — Euclid and Archimedes, for example. But I'd say all of these people were more on the academic side, and a lot of the general public think that if you study Pure Mathematics, you have to go into research or teaching or something like that. Could you shed some light on the other career prospects for a Pure Mathematics student, if there are any?*

PANG ERN There's this misconception that if you do Pure Mathematics, chances are you end up as a research mathematician, or maybe a high school teacher or something like that. But that is not the case. Unfortunately, I don't have that much information to share, but I can share what I know from what I've heard. Firstly, if you're a Pure Mathematics person, whether you have a bachelor's degree or a PhD in Pure Mathematics, it's not like 20-ish years ago, when not many people went to university. In this modern day and age, it's harder to find a tenure position around the world. That's what I've heard from my professors: especially if you're working in some less classical areas of maths, it's really difficult to get a tenure position anywhere in the world.

There's also the situation where, if you did your bachelor's degree at NUS and want to be hired by NUS one day, you need to get your PhD somewhere outside Singapore, because they want some overseas experience. You can't just learn techniques from your professors; you need to learn other things from other influential mathematical figures around the world. So I think there's a valid reason for that. But as a pure mathematician, other than going into academia, there's this general saying that people go into quant. Other than that, you can go into finance, investments and risk-related work, though I'm not exactly familiar with those sorts of things. The thing is that industry is where the money is, and that's where they look for people with mathematics backgrounds.

To quote some people I know, many mathematics people have sold themselves to the industry. I think it's a good thing anyway, because they need people who are fast and who are critical thinkers, and learning mathematics really teaches you how to think critically. In quant, I think there are two main roles. One is the quantitative trader role, where you sit behind a desk and trade during market hours. The other is being a quantitative researcher, where you develop algorithms for — I don't know exactly what — but you develop algorithms for a company. In fact, I recently got accepted into Optiver's FutureFocus

programme in Singapore. It's a five-day programme, and I'm really excited to see what it has in store for me, because I've recently been involved in some other events. Previously, Optiver invited me to another event, but what was its actual name? Let me go find the document.

I can't find it. But it was something like a discovery day, where you spent the whole afternoon at the office and tried to understand what goes on, and it gave you a brief introduction to quantitative trading. I've heard this five-day programme is somewhat different. In fact, the recruiter told me in the interview that when you complete this programme, you learn way more than you expect. So I'm looking forward to that. As for job prospects for mathematics people: apparently, if you go to any university website — say, an NUS webpage — they'll tell you that there are a lot of opportunities out there other than being a teacher or a researcher. It's just that I've never gone to a career fair to look at what is out there for us, so unfortunately, my perspective on this matter is not very deep.

KARTIK *I see. Anyway, thank you for sharing what you know. I've heard quant is a pretty big up-and-coming field as well. I think it combines computer science too, since you said some algorithms are involved?*

PANG ERN I guess it requires some computer science knowledge, for sure, but I think it's primarily maths in that sense. The main mathematical emphasis is on elementary probability and statistics — based on what I heard from a quantitative researcher I met at Optiver. He said that you don't need high-level maths to understand all these things; it's really a lot of intuition, based on what I've heard.

KARTIK *Interesting, good to know. I also have a lot of friends — I have one senior who's actually coming to NUS to study quant finance.*

PANG ERN From the material I've seen in quantitative finance — how do I say it? If you want to become a trader, I might be wrong, but from some discussions I've had with friends, what you learn as a quantitative finance major is not that relevant to being a quantitative trader. Doing something like mathematics or computer science is more relevant. But different people have different opinions; this is just what I personally think, based on some of the discussions I've had with my friends.

An Alternate Universe

KARTIK *In an alternate universe, if you weren't pursuing Pure Mathematics, what else do you think would interest you, and what would you take up at university?*

PANG ERN That's a very nice question. I've thought about what I would do other than mathematics. It's a very strange thing to say, and not many people know this

about me. If we trace back to my junior college days, I took various subjects: instead of Chemistry, I did Further Mathematics, and instead of Economics, I did Geography. A fun fact: if you compare my interests, a lot of people might think I love physics. I actually do love physics, but I enjoy geography much more. Since I was young, I have always loved geography. I would look at maps, look at random countries around the world and say, 'If I have this country, what is the capital? If I have the capital, what is the country?' And I would memorise the simple things, like the list of continents and oceans of the world, and some landscapes and tourist destinations around the world. Say I gave you a picture: could you tell me where it is? Well, I'm not a GeoGuessr expert who can pinpoint the exact location from a picture; I'm not that kind of guy. Although I played GeoGuessr, which I'll tell you about in a moment, my interest in geography was kind of a random thing. When I was in primary school, my mother bought a random encyclopaedia, and in primary school, you had a silent-reading session where you were forced to bring a book.

So sometimes I would bring this encyclopaedia and read random sections of it. I got so interested because there were a lot of colours and random facts, and I'm the kind of guy who likes trivia. I realised that I'm really interested in a lot of these geographical concepts, especially things related to human geography, and especially tourism. Moving on to secondary school, I loved geography, and in junior college, I took Geography as a subject as well. I think junior college was the period when GeoGuessr was pretty hyped up.

I remember playing the Singapore map format and challenging myself to, say, 20 seconds per location. I always got really, really high scores: out of 25,000, I could generally score around 23,000 or 24,000, which is almost perfect. I liked doing these kinds of things back then. If I could turn back time, I would be a Geography major, but I'm not sure what prospects there would be for me as a Geography major — maybe something in the public sector. I'm not exactly sure, because I never researched what you can do with a Geography degree. But I'm really interested in landscapes, tourism and these sorts of things. That's why I became so interested in looking at landscapes. In fact, I'm a photographer, and I'm really, really interested in photographing landscapes.

KARTIK *Wow, that's pretty unexpected. Maths and geography are kind of at opposite ends of the spectrum, right?*

PANG ERN Right. Mathematics and geography are at different ends of the spectrum, but somehow I do have an interest in geography.

KARTIK *That's unexpected to a lot of people. Pretty cool. As you said before, some advice is to look at things in a different way — to look at maths as more than just academia. It's interesting that you also like geography. I feel that being exposed to different subjects in high school lets you discover many different interests, rather than picking one and sort of going with it for the rest of your life. It's good to have other interests as well.*

PANG ERN That's true. But I feel it's important to mention one thing I've realised in life:

you shouldn't follow everything your friends do. What I mean is that you shouldn't follow the general crowd unless it's a really good thing. Why do I say that? In junior college, the general subject combination would usually require people to do Chemistry and Economics, but I didn't do either of those. They say that Chemistry in junior college unlocks many doors at university, and that's true. However, it wasn't applicable to me, because I don't need Chemistry at university. For example, when I'm doing real analysis, I don't need to be doing titration at all. Unless you can find some correspondence between the two — then sure, you might get a Fields Medal, I don't know. You don't need to learn how to do titration if you're doing analysis.

So why bother doing Chemistry? That's why my knowledge of Chemistry stopped right there. As for Economics, for some reason I couldn't get used to all these diagrams, and I always loved Geography. So I thought, 'Hey, why not just pursue this in junior college?' So I didn't do two subjects that I think more than 90 per cent of junior college students do. If you think about it using the inclusion–exclusion principle, the probability of finding someone who does neither subject is very, very low. And if you add Further Mathematics and H3 Mathematics, the probability gets even lower. I think junior college was really a phase when you picked your interests. Luckily, I had things in mind that I really loved, and I pursued them further. I think my teachers could see that as well.

Advice for Students

KARTIK *Interesting — that's an interesting take on life as well, and I appreciate you giving this advice to those watching the interview. There are a few questions to end with. Considering what students are like in the modern era, what advice would you give high-school students to help them thrive in high school and choose the right university course?*

PANG ERN Wait, can I not answer this? I don't know what to say.

KARTIK *All good, it's okay.*

PANG ERN Maybe you can move on to another question.

KARTIK *If a 16-year-old high-school student — maybe in JC, Secondary 4 or Secondary 3 — told you that they dreamt of becoming a mathematician, what advice would you give them?*

PANG ERN I guess this is a far easier question to answer. I would say that it's good to have that kind of ambition when you're young, but you've got to realise what is out there for you. As an aspiring mathematician, 16 years old is very, very young. It's good that you have the ambition to become a mathematician, for sure — no doubt. But you've got to realise whether what you know as a 16-year-old is

sufficient to plunge into the deeper areas of maths. That's one thing you've got to ask yourself first, because, as a 22-year-old mathematician right now, I realise that there are so many things in mathematics out there. It's so broad. You have algebra, analysis, logic, graph theory, even part of theoretical computer science, I guess. There are so many branches of maths.

Even someone working in pure algebra might not understand what someone working in pure analysis does. I don't know what pure analysis even entails, but you get the point. It's all maths, but people in different branches may not understand each other. I've even come across people working in the same field of maths who might not understand each other either, maybe because they are working in specific areas. My point is this: if you really want to become a mathematician, plunge into mathematics and do good research at a very early stage, you have to realise that all these branches and sub-branches of maths are so broad. How do you figure out what you want at a young age?

You need some exposure to all this higher-level content, because mathematics professors and researchers are the ones who can really advise and guide you, but I still feel that, as a 16-year-old, it's quite difficult to say what you actually like. My interest in maths is in analytic number theory, modular forms, theta functions and that kind of thing, and I don't think I would go anywhere else. I can't see myself working in something like pure combinatorics. Maybe I could delve into a bit of representation theory in the future, but that still has some links to what I've been doing in the past, because partitions and representation theory have some connections. I'm saying that I would not go into something very far away, like combinatorics. So if you do have some interest, continue reading.

You can pick up undergraduate texts; there are many, many accessible undergraduate texts out there. And not just that — videos are a good way to learn things. Compare this with my time as a primary or secondary school student: we didn't have that many resources on YouTube. In fact, 3Blue1Brown only started around then, but now he has made so many nice videos. Numberphile has progressed as well. There are even videos with AI voiceovers, but I don't watch them anyway. There are many other good channels on YouTube you can learn a thing or two from, so that you can decide whether becoming a research mathematician is really the way to go. You might also bump into professors one day, or attend talks, public lectures and things like that, and you can really find out for yourself.

KARTIK *Interesting, thank you for the advice. I agree 100%, and with the advent of AI as well, you can learn anything from AI. I'll give you an example from my own experience. I'm studying the Cambridge A-Levels, and I've done Further Mathematics as well. There was one chapter on linear algebra, which was a really new topic to me; I hadn't learnt matrices before that. Eigenvalues, eigenvectors, characteristic equations — this sort of material was very new, and having AI available really helped me. So I think, as you said, students should make full use of all the resources they have right now, right?*

PANG ERN And it's not just about resources, but also about having a good mentor, because finding a mentor is really difficult. Finding someone who can listen to you and guide you through your mathematical journey is hard.

Go and See the World

KARTIK *100%. It helps if you have someone experienced who can guide you and fix your mistakes along the way. Perfect. Now, to finish off the interview, one last question. If you could leave every student watching this with one piece of advice about anything at all — your outlook on life, maths, balancing everything or all of your work — what would it be? What's the one piece of advice you would share with the world?*

PANG ERN I think I was influenced by the impact of COVID-19. What I'm going to tell you is, surprisingly, not about maths. It's about going out to experience and see the world. That is my advice. The reason I thought of this is that after COVID subsided — around early 2023 — I had my first solo trip, to China, in June 2023. I left Singapore on Thursday, 15 June 2023. My advice to students is to go and see the world. There are a lot of things out there to see. China is a very big country, with a lot to see: many nice landscapes, food and heritage. Go and see the world.

When I went to Europe recently, I thought, 'Wow' — seeing Big Ben in person, seeing Trinity College in Cambridge for the first time, and going punting, like in the movie *The Theory of Everything*, the one about Stephen Hawking, if you know it. There's also *The Man Who Knew Infinity*, the movie about Ramanujan. I went to Trinity College and all the different sites where the movie was filmed. If you see these things in person, it makes you feel different. Visiting China was one of the goals I had back then. I went to Korea as well, but it's mainly China that I've been travelling to, because I really love the landscapes and food over there. One particular city I love is Shenzhen in China. Another city around the world that I like is Dubai; I really love the city and its metropolitan vibe.

I know some people prefer something more rural. In due course, I do have some places I want to visit around the world. Speaking of exchange, when I go for my fall exchange, my girlfriend will visit me while I'm in Switzerland, and we're going to travel through some countries in Europe. We have some places in mind, such as Iceland, Sweden, the Netherlands and Italy. Another place we want to visit is Los Angeles in the United States. If you ask a guy why he wants to visit LA, chances are you might know why: it's because he grew up playing GTA 5. A lot of the scenes in GTA 5 are based on Los Angeles, so I've always wanted to visit it.

So really, go and see the world. Travel. There are a lot of things to see out there.

KARTIK *Excellent. Thank you so much, Pang Ern. I've been wanting to speak to you for a long time, especially since I've seen your work in maths, and I've heard about your work from other places. As I said, thank you so much for helping introduce me to the IYMC.*

It has been a big change, and it has been amazing learning about maths as well. I hope we can keep in touch. Thank you so much for your time today.

PANG ERN Sure. Actually, I took a screenshot of this screen so that I can post it somewhere, maybe Instagram. Once you're done with the transcript, please send it to me; I'm really interested to see how this went.

KARTIK *100%. I've got you.*

PANG ERN Maybe you can communicate with me via WhatsApp or Telegram or something like that.

KARTIK *Okay, sure.*

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