Inside the mind of teenage maths genius Alex Gunning

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ALEX Gunning is not very good at the trumpet.

He glances cheerfully at the offending instrument, propped in a sunlit corner of the room fronting this inner-Melbourne home, as his three younger sisters and step-mum Katherine, a music teacher, subject him to a good-natured ribbing. “It’s because he never practises,” says Katherine, quietly chiding three-year-old Genevieve for bouncing around on the piano stool and scattering biscuit crumbs all over a floral-patterned rug. “In our family it’s like, ‘Do music or else!’” chimes in violin-playing Cathy, 12, while 10-year-old Victoria (clarinet, cello and recorder) nods vigorously.

“A lot of studies show that studying music improves maths outcomes,” Katherine continues, leaning down to pat a superannuated ginger tabby weaving through her legs. “Even as a little kid, Alex understood key signatures and stuff because he could see the patterns.” Does that make him better at music? “No.” The undiluted answer makes everyone laugh. “Intellectually, he’s good at it,” she says, “but physically not as good. Alex has made it through on the bare minimum.”

In the corner, riding the edge of an overstuffed armchair, Alex grins, scratches at his chin. The 17-year-old couldn’t give two hoots about blowing his trumpet. Scales and arpeggios: boring. Part of, but apart from, this loving jumble of Saturday-morning home life, Alex Gunning –
recently ranked No. 1 maths brain for his age group in the world – is busy running numbers through his beautiful mind.

When Alex returned from Cape Town, South Africa, in July after winning a gold medal at the 55th International Mathematical Olympiad (IMO) with Australia’s first ever perfect score, there were no crowds at the airport clamouring for selfies with him; no TV cameras or ticker-tape parade. Intellectual problem-solving makes for an uninspiring spectator sport, a couple of rungs down the glamour ladder from chess. Still, victory was sweet for the teen dubbed the “rock star of maths” by the Australian Mathematics Trust. “It’s an absolutely extraordinary achievement,” says Angelo Di Pasquale, Australia’s team leader at the Olympiad. “The Chinese team almost always gets a clean sweep of gold medals and the Americans, Russians and Koreans gobble up all the rest. Australia doesn’t usually get a gold medal, so for Alex to get it with a perfect score is incredible.”

Di Pasquale has been training Australia’s mathletes since 2000. To put Alex’s win into perspective, he cited another IMO alumni, Australia’s most famous mathematician Terence Tao. Tao, winner of the prestigious Fields Medal – the equivalent of a Nobel Prize for maths – competed in the IMO three times. “His third time he got a gold medal, which is great, but he never got a perfect score,” says Di Pasquale. “I don’t think we’ll see the likes of Alex again for another generation.”

Only 500 of the world’s elite high-school maths brains made it to that hall at the University of Cape Town where, over two four-and-a-half-hour sessions, they sat in rows bent over sheets of paper silently unpicking six very knotty questions. The competitors attacked the questions with combinatorics and graph theory; they grappled with functional equations, polynomials and geometric inequalities. Alex was in his element. “You don’t know immediately what techniques will work with what question,” he says now. “The important thing to do in the beginning is just to get your mind around all the questions, because you can often work on them in the background.”

The handful of Australians at the competition had come through a challenging, year-long selection process. They began by beating thousands of other school students in qualifying exams before going on to attend summer schools and two rigorous 10-day training camps. When Alex sat down at his desk in Cape Town to begin his calculations he had hundreds of hours of practice under his belt and an arsenal of problem-solving techniques at his disposal. He also had a natural instinct, a genetic gift that allows him to recognise patterns in the number clusters, to sail coolly across different branches of mathematics, skimming a geometric angle here, scooping up a prime number there, to come up with a stunning solution. “He sees connections between things more readily than most,” says Di Pasquale.

To outsiders, maths at this level is abstract and impenetrable. The process of working out the question is part of the answer: it’s all about the proof. A proof is a series of steps based on axioms and deduction rules that reaches a desired conclusion. So far, so logical. But, as the great mathematician Vladimir Arnold said, “Proofs are to mathematics what spelling is to poetry.” There is more to it: an indefinable something at the nexus between science and art that makes an answer soar, with the power, on occasion, to upend our understanding of the cosmos. The very best proofs are simple and elegant, in the way that the most compelling arguments in rhetoric are often devastatingly succinct. To maths aficionados, a 12-line proof
can be as breathtaking to behold as a Van Gogh.

The questions at the IMO grew progressively harder over the two days. Some of Alex’s answers were similar to the official solutions; others were different but nonetheless correct. His solution to the formidable final question, which most contestants didn’t even attempt, was not only different and correct. It was, in the words of one Olympiad adjudicator, “beautiful”. While some competitors were pummelling and crunching the numbers into submission, filling page after page, Alex was applying the finishing touches to the maths equivalent of perfect little oil paintings. On both days, he finished a couple of hours early.

Alex carries the weight of genius lightly. He’s a happy soul, highly regarded by his IMO teammates and well-liked at his non-selective state school, Glen Waverley Secondary College, where he’s in Year 11. He plays chess (“but not especially well”), reads “reasonably decent” science fiction, and does well enough at the trumpet, despite his family’s teasing, to play in the school band. For fun, he reads Harold Davenport’s Multiplicative Number Theory, Michael Spivak’s notoriously tricky Calculus, and crunches maths problems that would make his classmates weep. “I’ll just look some problems up and say, ‘That looks interesting. OK, I’ll do that’,” he says. “That’s the good thing about having an interest in what you’re good at.”

The ginger cat, Walter, clambers up onto the boy’s lap and sniffs at a plate of biscuits. “Walter used to ignore him when he was younger and ran around a lot,” says Katherine, “but now Alex is his favourite because he sits still and reads.” Alex “eats books at a terrific rate”, his father James agrees.

James Gunning has a PhD in Applied Mathematics and is a geophysicist at the CSIRO. He takes no credit for his son’s abilities, beyond suggesting reading material and, through his work, exposing Alex to the range of applicability in mathematics, a field he refers to as “the lingua franca of the sciences”. Gunning wears his practicality like a comfy cardigan and, proud as he is, he’s cautious about having anybody get carried away by Alex’s achievements. Mathematics is a peer-driven pursuit and its practitioners tend to care little about accolades or prizes, he says, pointing to the celebrated Russian mathematician Grigori Perelman, who turned down the $1 million Clay Millennium Prize he won in 2010. “It’s not about awards; it’s more about challenging yourself,” he says, adding that for Alex to peg himself to his IMO No.1 ranking (he shared first place with two students from China and Taiwan) would be “a slightly strange response”.

“Alex has done exceedingly well but being a professional mathematician is a long road and you don’t want to get too beaten up about a high-water mark along the way,” he says. “Very likely Alex will wind up doing some form of pure or applied mathematics, or perhaps theoretical physics, and that’s seven years of university work. It’s a long apprenticeship and Alex is only right at the beginning.”

He acknowledges Alex is “gifted” but warns not to underestimate how hard he’s worked. “It’s probably very difficult to be as successful as he is without a genetic blessing, but on the other hand he’s also sweated quite a bit,” he says. “He hasn’t just cruised on natural ability.” Alex showed an interest in numbers from an early age. “I remember a colleague of mine asking Alex what his favourite computer game was and he said, ‘Excel’,” Gunning laughs. “He had discovered you could write the integers in column one and some formula in column two and
drag a certain button and the formula would be reproduced all the way down. He thought this was terribly exciting.” Alex was six years old.

As Alex talks to me in the mysterious language of maths, his father kindly draws analogies to bridge the yawning chasm of understanding. This thing is “like playing Bach with panache”; that one is “like the way a writer uses vocabulary”. Combinatorics, he explains, is “well, counting stuff, but not really that”. Figuring out the probability of winning TattsLotto division three could be considered a combinatorics problem. “A pretty simple one!” he adds, and he and Alex fall about laughing.

Gunning eventually takes pity on the maths dunce in the room and rewards me with a maths-geek joke. “An exceptionally sociable mathematician,” he says, grinning wryly, “is someone who looks at your shoes rather than his own shoes in conversation.” It’s funny because it’s true. Mathematicians are the first to admit it’s a field that cultivates eccentrics. Why is that? “It requires a devotion to abstraction and a capacity for periods of very, very long sustained concentration on one thing,” says Gunning. “It’s the kind of work environment where the modern obsession with multi-tasking is anathema. Probably because of the sheer amount of private time you need to cultivate your skills, you’re possibly a little less socially aware than others.”

Father and son delve into an animated discussion about the well-documented quirks of the Hungarian mathematician Paul Erdős. The most prolific mathematician of the 20th century, he was also the most sociable – but only with fellow alpha-brains. “He travelled around the world… just popping in to see different mathematicians and saying, ‘OK, do some maths with me’,” says Alex admiringly. Erdős co-authored so many papers that he became the maths world’s Kevin Bacon, with mathematicians ranking themselves by degrees of separation. (James Gunning’s former supervisor worked with someone who worked with Erdős, so he has an Erdős ranking of 3.)

Mathematicians use a vocabulary peculiar to their field and Gunning is amused to see the terminology drift into completely non-mathematical contexts in the family home. “Because [daughter] Cathy and Alex spend such a lot of time together, I’ve noticed Cathy has started to use expressions such as, ‘This is true even if that is the case’ and particular little linguistic tics like, ‘The set of sweet blue cheeses is at measure zero’ – bizarre things like that.”

Alex acknowledges the set of people at his school who share his boundless enthusiasm for maths is nudging zero. That’s why he flourished at the training camps and why he considered the IMO competition “fun”. “It was nice to meet so many people interested in the same thing,” he says.

“The great thing about these competitions is that these guys go to a place where being freakishly good at these things is not all that unusual,” says former ABC broadcaster Adam Spencer, the newly appointed Maths & Science Ambassador at the University of Sydney. Spencer, unofficially Australia’s coolest nerd, officiated at the IMO team announcement ceremony at Parliament House in June and took a shine to Alex. “A lot of these kids are at selective schools and even there they are outliers,” he says. “Now, when Alex gets to go and hang out with other people who enjoy nothing more than busting really hard algebra problems, he gets to realise what they’ve got is not weird; it’s nothing to feel ashamed of or
feel unusual about. It’s beautiful.”

The beauty of maths only reveals itself with patience, said Iranian mathematician Maryam Mirzakhani upon winning the Fields Medal in August – the first female to do so. “I can see that without being excited, mathematics can look pointless and cold,” she added.

Maths as it is taught in schools has an image problem, Gunning agrees. “It is portrayed as a necessary but painful rite of passage – a duty and a chore on the way to your chosen uni degree. It is possible to grow to love the field for its own sake, but to get to that frontier of mathematics, it’s about 10 years ahead of the syllabus and most high school teachers don’t have any idea that it’s a living, growing subject.”

Alex’s local public school recognised, appreciated and nurtured his talent early, creating a maths enhancement group and arranging a mentor from Monash University. Alex had the option to go to a selective school but, Gunning says, Glen Waverley Secondary College has “one of the most affirmative intellectual cultures in a government school I’ve ever seen. He’s quite privileged to be there – his teachers have been tremendous in creating opportunities and putting resources behind him.”

Alex is lucky (and self-motivated). But Spencer says the Australian education system can do better: by exposing primary school children to a better syllabus and installing more passionate, qualified maths teachers. His view chimes with that of Australia’s chief scientist, Professor Ian Chubb. As part of a national science strategy unveiled in September, Chubb recommended that every primary school have at least one specialist maths and science teacher – a policy already used in Victoria and South Australia. Director of the Australian Mathematical Sciences Institute, Professor Geoff Prince, went further, saying the failure to staff schools with inspiring maths teachers was at a “critical” level, with 40 per cent of classes in years 7 to 10 not being taught by qualified maths teachers.

“The Alex Gunnings will always rise through the processes we’ve got,” says Spencer. “But we can’t look at his individual result and go, ‘That reflects where Australia is at as a nation.’ We can do more for kids who have a bit of potential and a natural curiosity and get a buzz from maths. The way it’s taught now, it’s not until third-year university that you get to see some of the true beauty that’s inherent in mathematics.”

In any discipline, children are motivated by aesthetics, and Alex agrees it’s a shame students are only exposed to mathematical “grunt work”. “The thing they teach you at school is: repetition is good, repetition is good,” he says. “I would tell other kids before dismissing mathematics as boring to have a look at some of the other more interesting problems out there.”

Back into the swing of the school year at Glen Waverley, Alex is studying vectors and matrices and looking forward to next year’s International Mathematical Olympiad, where he hopes the questions are “a bit harder”. The gold medal doesn’t change his day-to-day school life much. “It just gives me an excuse to say to the teachers…” he pauses, glances at his father. “Well, it just gives me more of an excuse to stuff around in class, I guess.”

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