

# Dyson - draft #6

## Main Personal Statement

I am particularly interested in abstract topics that aren't covered in the A Level curriculum. Things like group theory, Galois theory, category theory, topology, linear algebra, etc. I especially love visualizing these abstract concepts.

For example, my Computer Science coursework is focused on visualising 2D linear transformations. When I was first learning them in school, I struggled to visualise them, as did many of my peers, so I wanted a tool that would show a given transformation and allow you to interact with it. An interactive version of the 3blue1brown linear algebra series would be perfect, but I couldn't find anything suitable. I mainly wanted to see matrix multiplication represented as transformation composition. Since I couldn't find a suitable app, I made one myself. During development, I faced many mathematical challenges around converting between coordinate systems and drawing lines on the canvas. It has involved solving many interesting geometric problems, and researching computational methods. The project has proved useful for explaining matrices to my peers, and teachers have said they will use it to teach the topic.

Certain questions in textbooks have prompted me to write my own LaTeX papers to explore the ideas they present. For example, a question which asked for polynomials which give pure powers of  $n$  when summed from 1 to  $n$ . While exploring

the generalisation, I found an interesting pattern in the coefficients that looked like those of binomial expansions. Exploring this pattern, I found a formula. My proof was originally several pages long but then I asked a forum about my discovery and learned that it was a finite telescoping series. This made my proof far shorter, and I learned a valuable lesson about stepping back to see simpler solutions, and collaborating with other people. I also researched solutions to similar problems, stumbled upon the Bernoulli numbers, and ended up with several citations.

When I listened to A Brief History of Mathematics on BBC Sounds, my favourite episode was about Galois. It detailed his life and inspired me to look further into Galois theory, and I found two YouTube videos on the topic. It's incredibly interesting and I definitely want to learn more about it. Abstract algebras like Galois theory, group theory, and the dual numbers are the topics that interest me most.

Early in Year 12, I joined an MIT MOOC about using matrices to solve linear differential equations. I didn't know what differential equations were, and I barely understood matrices, but I wanted to extend my knowledge. It started with linear transformations and matrices, and then introduced eigenvectors and eigenvalues. My main takeaways were row echelon form and Gauss-Jordan elimination, which allowed me to easily solve linear simultaneous equations by hand. I supplemented it with the 3blue1brown linear algebra series, but when the course started to use these techniques to solve differential equations, I had to stop because I knew nothing about the subject. I tried to learn about differential equations with another MIT course, but it wasn't very helpful for me, so I had to step away and come back later, although it did teach me valuable lessons about mathematical modelling. I

also learned that having a good foundation is vitally important when learning new topics.

I completed the UKMT Senior Challenge and got Gold and Best in School. I will be taking TMUA, MAT, and STEP this year. I also attended the Imperial College London Further maths Year 12 programme, which gave me a better understanding of many topics and stoked my passion for higher level maths. I'm also on the Problem Solving Matters course, provided by the AMSP.

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## **SAQ Personal Statement**

I watched Welch Labs' series on complex numbers, which has a great visualisation of multifunctions and 4D Riemann Surfaces. I first watched this series before I'd learned about complex numbers in school and only understood the first half of it. I have since rewatched the series and I now understand most of it, but not quite all of it, and the more advanced parts are very interesting to me. The series is fantastic at communicating complex ideas in a visual way, and has greatly increased my understanding of them, supplemented with other online learning resources.

Episode 2 of The Numberphile Podcast is an interview with Ken Ribet about Fermat's Last Theorem. This episode is very interesting and gives a good overview of the story and touches on Wiles' proof. However, I wanted to investigate further.

I watched some YouTube videos about elliptic curves and modular forms and got a very surface-level overview of the topic. Upon further research, I continued to learn more about it. I still don't understand it in much detail, but I think I get the gist and I love the connections between number theory and complex analysis. Connecting seemingly disconnected areas of mathematics like this is something I love, just like how I connected polynomials that sum to pure powers with coefficients of binomial expansions.

I want to be at Cambridge because I know that I would benefit significantly from the environment and teaching style. Being surrounded by other nerds who love maths just as much as I do will fuel my passion for the subject and keep me working hard. I also know that I learn better in small groups when I can chat comfortably with someone who knows what they're talking about. The supervisions at Cambridge will provide that environment where I feel comfortable asking questions to an academic, and I can better expand my knowledge and learning.

314 words, 1866 characters