

The Mathematics Enrichment Programme

Report for 2018 – 2019

Dr Jenny Sharp

Working with over 2600 students and 230 teachers from over 200 different schools this academic year

The Mathematics Enrichment Programme started at Plymouth in 1996 with the first Mathematics Masterclasses for year 9 students and since then I have grown it into a complete programme for students aged 9 to 15 who are able and interested in mathematics. The aim of the programme is to provide academically rich activities for students (and schools) with the aim of keeping the students able and interested in mathematics so that they consider taking Mathematics at A level.

Events at the University of Plymouth

In 2018 – 19 there were workshops for students from year 5 (aged 9 and 10) right through to those in year 12 (aged 16 and 17). Schools attending came from across Devon, Cornwall and into Somerset with over 1135 students (250 primary, 906 secondary) and nearly 160 teachers (55 primary and 103 secondary) from over 100 different schools (37 primary, 67 secondary) attending high quality mathematics events at Plymouth University.

In addition, as an invited speaker at 26 other masterclass events, I worked with over 1250 primary and secondary students from around another 200 schools and about 50 teachers across the South of England.

Year 5 (aged 9 – 10 years)

The workshops for year 5's in April and May were a day long workshop organised and run by myself. There were 5 days, for a total of 80 pupils from 22 local primary schools. The pupils have to be accompanied by a member of staff from their school and the day provides a valuable training resource for them. The masterclass was entitled "Tactics and Strategies – Doing, Thinking and Talking Mathematics" and it was designed to get the pupils (and their teachers!) thinking. It emphasised the importance of being able to explain what you are doing both verbally and in writing so that someone else could follow the argument. The days always had a real buzz to them and many of the schools have reported back that they have used some of the material with the rest of the class back in school with the pupils who attended acting as teachers.

Year 6 (aged 10 – 11 years)

The year 6 masterclass days in June are a carousel of three activities during the day. There were 4 days with 170 pupils from 33 schools attending along with a teacher or teaching assistant from the school. Throughout each day, the pupils have three different sessions; this year I ran a session on coordinates using the graphic calculator and our Mathematics with Education students ran two sessions, one on the mathematics of magic squares and the other which was a carousel of puzzles. Since we were repeating the session three times a day over 4 days, we needed to make sure that we were just as enthusiastic the twelfth time as we were the first!

Year 7 (aged 11 – 12 years)

The workshops for year 7's ran in January and there were 4 days reaching a total of 96 pupils from 21 schools along with a mathematics teacher from each of the schools. The workshop was organised and run by myself. It was entitled "Polygons, Polyhedrons, Flexagons and Topology". The students and teachers explored the properties of 2D and 3D shapes, going on to Euler's Formula, Mobius Strips and the fascinating properties of flexagons and magic wallets. It was a very hands-on day and provided the teachers with a wealth of resources to take back to their classrooms.

Year 8 (aged 12 – 13 years)

71 students and again a maths teacher from each of 17 different schools attended one out of 4 whole day masterclasses organised and run by myself. The class was called "Patterns and Predictions" and the participants explored finding patterns, describing patterns mathematically, making predictions and testing them to see if the predictions were correct. It was designed for

students to find out that their predictions, while seeming valid at the time, were not always correct – this is something that does not usually happen with predictable school mathematics! Again, the teachers who attended saw the day as a valuable source of ideas and resources for teaching back in school.

Year 9 (aged 13 – 14 years)

The Year 9 Masterclasses are part of a nationwide programme of Masterclasses started by the Royal Institution in 1981; Plymouth is one of over 60 Masterclass groups now established throughout the UK. 2019 saw the 23rd annual series in the Plymouth Masterclass programme which I have organised and run since its beginning in 1996. The series consisted of 5 masterclasses on fortnightly Saturday mornings in the spring.

43 students from 9 different schools across Plymouth, SE Cornwall and Devon attended each Saturday morning and there were 5 teachers who also attended every week – a number of them graduates from the Mathematics with Education Degree here at Plymouth. Undergraduates from the Mathematics with Education Degree as well as some final year students taking the School Placement module came along and some ran the final session.

I ran the first session which was entitled “From Flowers to Fine Art - An investigation into a remarkable number” which explored the Fibonacci sequence and the Golden Ratio. Luke Cole, a teacher from Saltash School and a Mathematics with Education graduate ran the second masterclass. It was entitled “Biggest and Best” and introduced the students to Linear Programming – Luke developed the masterclass from the material covered in his final year module on this subject. Anton Ilderton ran the third session looking how dimensional analysis can help with understanding “Quantum Stuff”. Matthew Craven ran the fourth session on “Non Euclidean Geometry” which took the students beyond their usual view of geometry on flat surfaces into that on curved surfaces. The final session was a carousel of puzzles that was overseen by the Mathematics with Education students.

Year 9 South West Masterclass Day

This day, which this year was on 21st June, is a follow up day which I organise for students who attended the year 9 Saturday masterclasses in the Spring Term from the Ri series from Plymouth, Truro, Bideford and Exeter. This year there were 90 students from 33 schools from across the South West. While most students were unaccompanied by school staff, 6 teachers attended the day. They were able to experience 2 out of 5 different sessions during the day plus a plenary. Three undergraduate students ran a session on magic squares and visiting speakers were Suki Honey who ran a session on mathematical origami, Margaret Harding from The Advanced Mathematics Support Programme ran a session on properties of prime numbers and their use in cryptography, Luke Cole, a teacher from Saltash School and a Mathematics with Education graduate ran a session on fractals and Sam Durban from the Royal Institution looked at Game Theory. The plenary was given by Lee Fawcett, the Royal Statistical Society Guy Lecturer whose talk was entitled ‘The Storm of the Century! Using data to anticipate extreme climate events’ which proved informative and engaging for the students and the staff alike.

Year 10 Residential Masterclass Course (aged 14 – 15)

The year 10 residential course at Easter which I have organised and run since 2001 is one of the highlights of the year even though it is the most stressful – being responsible for a group of fifteen years olds for three days and two nights! This course is a follow-up course for students who attended the Saturday Year 9 classes the previous year. I open it up to the Truro Group, Bideford Group as well as the group from Plymouth. This year the course was again oversubscribed with 46 students applying for 24 places so, for a third year, the course ran twice as I can never say no to students who want to do maths during their Easter holidays!

I and three Plymouth University students (Jaide Duxbury and Paul Gerry who are Mathematics with Education undergraduates and Zack Courtenay who is a PGCE student) were residential with the students and other speakers visited us during the course of the three days. The course consisted of a number of workshop plus time for social activities.

The workshops were varied: We started with a session solving collaborative group problems so that the students could get to know each other, I led a session exploring Matrices with an

application to coding, Colin Christopher explored Number Theory with the students and Stuart Rowlands led a session on the topic of whether mathematics is invented or discovered which led to some good discussions. Luke Cole who was a regular helper on the residential course over the three 3 years came back again this year as a speaker and ran a session on Fractal Geometry. The team quiz which was run by Zack, Paul and Jaide proved to be highly competitive!

In between the sessions, there was time for the students to socialise; it was good to see some old fashioned board and card games being played rather than the students being on their phones - Uno, Rumikub and Labyrinth were popular.

Year 10 Work Experience

A Year 10 Work experience week in July has run for a number of years and this year there were 9 students from 6 schools. During the week, under the supervision of Paul Gerry, a Maths with Education student, they were busy creating resources for the above workshops; I now have many new puzzle sheets and campus maths trails and they analysed the feedback forms from this year's workshops.

Year 10 Mathematics Taster Day

Following on from a successful first attempt at a large scale year 10 taster day last year, it was decided that SOCEM would repeat it again this year in December 2018. I organised the event and two days ran, in total 470 students and 44 teachers from 26 different schools across Devon and Cornwall attended over the 2 days.

Each day there were 12 different workshops running with the students attending 3 of them. Engineering provided three of the workshops: Trevor Bevin and his team did Bridge Building, Jahir Rizvi and Raj Basu ran a boat building workshop and Dave Simmonds and his team ran some Surveying and Hydraulics activities. From Mathematics, workshops were run by Nathan Broomhead, Colin Christopher, Matthew Craven, Martin Lavelle, David McMullan, Craig McNeile and Gosia Wojtys. Staff from the Advanced Mathematics Support Programme provided 4 other workshops. The plenary session each day was given by Ben Sparks from the AMSP, it was entitled "The Creation of Number" and was a very entertaining journey through humanity's attempts to wrestle with the deepest questions behind our day-to-day use of numbers, and their consequences.

Year 12 Mathematics Taster Day

Following on from the successful large scale year 10 taster days, it was decided to try a Year 12 Taster Day entitled "What to do with an A level in Mathematics". Two days ran in July 2019 with a total of 81 students and 10 teachers from 8 different schools. The students experienced three different workshops designed to show them where the mathematics that they are meeting at A level can take them. The workshops were a mixture of 'pure' maths and applications. Workshop leaders were Colin Christopher, Matthew Craven, Vincent Drach, Craig McNeile and Julian Stander from Mathematics with Dave Simmonds, Pete Arber, Long-yan Li, Oscar de la Torre Rodriguez and Tom Tosdevin from Engineering.

Invited masterclasses:

In addition to these events, I also ran 2 sessions for the **Children's University** here at Plymouth, working with 246 students, the entire year 7 cohort from a Cornish secondary school and 96 year 3 and 4 students from a local primary schools and 30 from a secondary school.

As a result of the school attending the Science and Technology Showcase, I was invited by St Mewan's Primary School to take part in their STEM day. Myself and 5 undergraduate mathematics students spent the whole day working with all 400 students and the teachers exploring flexagons, soma cubes, platonic solids and tessellations.

As part of the nationwide Royal Institution (Ri) Masterclass programme I was invited by the Ri to give 17 Saturday masterclasses at a number of series across the country, working with about 700 students from over 150 different schools. For the Secondary Programme I presented masterclasses at Imperial College, Kingston University, Swansea University, Brighton University, Kings College London Maths School, Ada College in Tottenham, Kingsley School in Bideford, Ipswich High School, Brighton and Hove Prep School, Ceders School in Croydon, Axminster Primary School as well as 4 masterclasses at the Royal Institution in London.

In August, I ran 7 sessions at the Royal Institution in London for their summer schools programme. These were for students aged 7 – 9, 10 – 12 and 13 – 15. My session on Codes and Ciphers is always popular and so it was repeated four times for two different age groups. I ran a session on Pascal's triangle, one on topology and the Patterns and Predictions session for the 13 – 15 year olds. There were nearly 175 students over the week who came from across London.

At the end of the summer, I was invited to run a workshop as part of Tavistock Library's Science festival and once again the Topology workshop came into action. 15 children with 9 parents/carers attended and the workshop attracted the attention of some of the regular users of the library who came over to see what we were doing!

Plans to continue this well established, and obviously needed, programme of events for 2019 – 20 are in place.

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