Innovation and Creativity in Mathematics Teaching IV

One-day conference for Mathematics teachers

12th July 2024 – Online: Teams & Gather

RhGMC
MSPW

Rheolir gan Brifysgol Abertawe, Sefydliad Gwyddorau Cyfrifiadurol a Mathemategol Cymru
Managed by Swansea University, Wales Institute of Mathematical and Computational Sciences

Ariennir gan Lywodraeth Cymru
Funded by Welsh Government

Subject to Revision

8:00	Doors Open			
08:30	Welcome			
08:35	*Lyakhova*: An introduction to MSPW *Hunt*: Geometry Has a Life!			
09:00	Encouraging more girls into studying Maths *Watson, Lyakhova* *primary, 11-16, post-16*	Mathematics as a Human endeavour: historical enrichment in mathematics classrooms *Ball* *11-16*	An Innovative Way of Teaching and Assessing Critical Thinking in Mathematics *Klymchuk* *11-16, post-16*	Hypothesis Testing *Earles* *post-16*
09:45	Dialogic Learning: Research & Practice *(Hendy, Oakes & research teachers)*			
10:20	BREAK			
10:30	Why Children Enjoy Maths *Hunt* *primary, 11-16, post-16*	A journey through mathematical thinking *Lewis-Coll* *primary, 11-16, post-16*	X (formerly known as Twitter) Geometry *Oakes* *11-16, post-16*	Geogebra: linking golden tori - a transformational experience! *Jones* *post-16*
11:15	Transition through Enrichment *(Hunt & involved teachers)*		What MSPW Do *(Oakes)*	
12:00	LUNCH			
13:00	Engaging Parents in helping children to become mathematicians *Hendy & Mountain* *primary, 11-16*		Discrete and Decision Maths for the new Additional Maths course *Earles* *11-16, post-16*	Filling Spaces *Thomas* *post-16*
13:45	Visionary schools: FMSPW case studies *(Lyakhova, Oakes and case studies teachers)*			
14:20	BREAK			
14:30	Primary CfW: learning through play and more *Andrews, Lyakhova, Townsend & Wallis* *primary, 11-16*		Programming Mathematical Illustrations *Rhind* *11-16, post-16*	Teaching Mechanics with the aid of Geogebra *Sanders* *post-16*
15:15	Closing Address			
15:30	Mingling in cafe			
16:30	Final Close			

For everyone	Presentation	Discussion Group	Maths Chat

Broadly:	Engagement	Enrichment	Pedagogy	A-level

Welcome & Housekeeping

Dominic Oakes

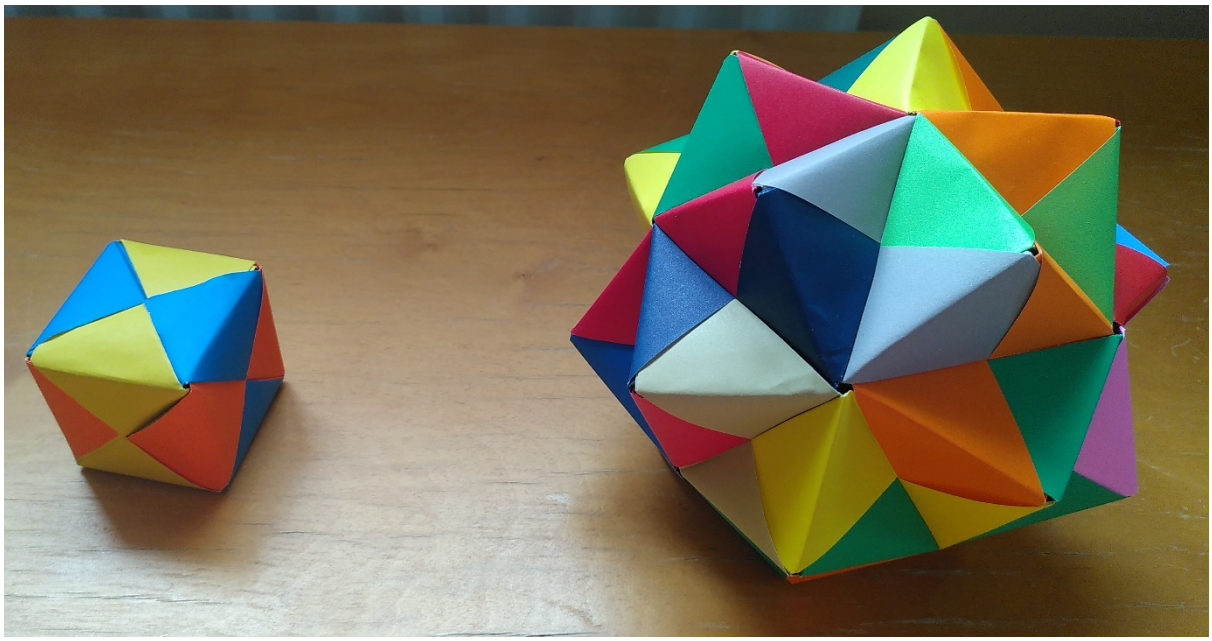
An Introduction to MSPW

Sofya Lyakhova

Geometry Has a Life!

Francis Hunt

Paper folding (origami) is a great way to make colourful, engaging, mathematically-stimulating objects for students to discuss. In this session we will make the cube shown above with 6 simple “modules”. But a class of thirty could make 30 such modules and assemble it into the spiky ball shape above. What’s its mathematical name? How many vertices, faces and edges has it got? All will be revealed in the session. If you can get hold of six colourful squares of origami paper, two each of your three favourite colours, before the session, your creation will be all the better for it.



Workshops

Dialogic Learning: Research & Practice *(Hendy, Oakes & research teachers)*

- How do you know if your students have understood the concept you have been teaching? How does the use of structured discussion in mathematics change the students' experience in the classroom?
- Theresa researched Dialogic Learning (DL) through the use of Magic Whiteboards with A-level students for her Master's Degree. Dominic and Theresa are researching it in three schools at present with students from Y9 to sixth form.
- The discussion will start with a brief outline of our recent research, followed by contributions from the teachers involved. It will be then opened up for input from the floor and general discussion around DL.

Transition through Enrichment *(Hunt & involved teachers)*

- This discussion group will give you the opportunity to explore the role of mathematical enrichment activities in supporting transition between primary school and secondary school.
- On the panel will be a number of teachers and former teachers who have been involved with the Royal Institution's Primary Maths Masterclasses series (a good way of strengthening links between primary and secondary schools).
- There will be MSPW staff who have used the FMSPW Primary Pilot materials (a resource for secondary teachers visiting primary schools). We will also have a number who have used the FMSPW's year 7 and year 8 Maths Club resources (a good way to create a wider view of maths and maintain children's enthusiasm as they move into secondary school maths).
- This will be an ideal session for you to explore ideas about maths enrichment to support children in their primary-secondary transition.

What MSPW Do - And Might Do *(Oakes)*

- MSPW have five main areas of work: Tuition, Resources, Enrichment, Professional Learning and Research. After a quick tour, we can look further/deeper at anything folk wish to.
- We are also very open to ideas – some of what we do has been inspired by the work or ideas of teachers around Wales. If you have an idea that we might be able to bring to fruition, come along and put it forward.

Visionary schools: FMSPW case studies *(Lyakhova, Oakes and case studies teachers)*

- MSPW have been working on Case Studies of some successful mathematics departments around Wales. These have begun to be published on Hwb and will soon be available on our website.
- Learn from schools which are making first steps towards their FM provision, already introduced small fully-timetabled FM classes or increased the number of FM students from just a few to healthy group.
- Includes inspirational, ready to borrow tips on managing transition from primary to secondary, inspiring all abilities in early secondary, strengthening GCSE results, building transition to A-level Maths and securing support from the school leadership teams for offering FM.

Speakers

Kate Andrews
Kate has worked in regional school improvement since 2017. In addition to her work as an advisor for Mathematics and Numeracy Kate represents the region on the Welsh Government group responsible for the online personal assessments. She began her career in education in 1992 and taught KS2 for 8 years in Swindon before moving to Cardiff where she was deputy headteacher of a large primary for 11 years. During this time, she gained her NPQH qualification. Kate was seconded to Welsh Government as a partner in the National Support Programme assisting the education profession with the implementation of the Literacy and Numeracy Framework. Kate was Pembrokeshire's primary mathematics and numeracy advisor for four years before she moved to regional working

Stuart Ball
Stuart's teaching career has spanned 17 years. After completing his teaching qualification in Aberdeen, he initially taught mathematics in a secondary school in Scotland during the transition to Curriculum for Excellence before relocation to Wales in 2009. He has held a number of roles including numeracy coordinator and then head of department at Caerleon Comprehensive as well as Lead Network School for mathematics within the regional consortium before his appointment to Assistant Headteacher at West Monmouth School. It was during his mathematics degree at the University of St Andrews that he developed an interest in the story of mathematical discovery having been fortunate to be taught by the founders of the MacTutor History of Mathematics Archive.

Stephen Earles
Started teaching in FE in London then moved to West Wales. I worked as a classroom teacher for 10 years and then became a Head of Department. Held the post for 19 years before taking early retirement. Have worked as an Area Coordinator for the FMSP Wales for almost 7 years and I am responsible for the tuition that is offered by MSPW.

Theresa Hendy
Theresa's teaching career has spanned more than 30 years. She initially taught mathematics in a secondary school and continued in Further Education including being a Head of Department and Curriculum Leader for maths and science as well as teaching basic skills and access to HE courses for adults. Theresa joined the FMSPW team in 2010 initially as a tutor and recently was appointed as an Area Coordinator for South & Mid-Wales and Professional Learning lead. Theresa holds an MA in Education. She is passionate about encouraging peer-to-peer dialogue in a traditional classroom and worked as a teacher-researcher for the National Network for Excellence in Mathematics in Wales in 2016. In November last year, Theresa assumed the role of Senior Adult Learning Numeracy Practitioner for the start of the Multiply project and in this capacity, she has been instrumental in conducting family learning sessions within primary and secondary schools across Swansea.

Francis Hunt
Francis studied maths at Cambridge University before working as a software engineer, and then teaching and researching at the University Engineering Department. He worked as a maths lecturer at the University of South Wales (USW) between 2006 and 2019, before joining the FMSPW in 2020. He has given Royal Institution Maths Masterclasses at KS3 and Primary level, has tutored A-level and GCSE mathematics, and mentored for the UKMT. He now coordinates the post-16 enrichment at the MSPW, and is area coordinator for Central South and South East Wales.

Ifor John Jones
B.Sc. (Jt. Hons) (Maths & Computer Science), M.Ed.(Computer Education & Curriculum Studies)
Retired Maths & IT teacher with experience of working in Wales (both Welsh & English medium), Zambia and Papua New Guinea – both teaching (Maths & IT) and school management.
Has worked for FMSPW since 2018 in various roles, particularly in dynamic software and enrichment.

Sergiy Klymchuk
Sergiy is an academic with a PhD in differential equations (1988) and with research interest in mathematics education. He is the author of more than 250 publications including the internationally acclaimed book on popular mathematics "Money Puzzles: On Critical Thinking and Financial Literacy" that has been published in 9 countries. Sergiy received numerous research and teaching grants and awards in mathematics education. He is a Fellow of the Institute of Mathematics and its Applications (UK), a member of the Royal Society of New Zealand and several international organisations on mathematics education. Since 2000 Sergiy has been teaching mathematics at Auckland University of Technology (AUT) in New Zealand.

James Lewis-Coll
Worked in the Scottish, English and now in the Welsh education system.

In a previous school I developed and ran PGCE courses for secondary mathematics and for primary students. Have worked for CSC as a mathematics specialist for about 9 years supporting schools with developments in mathematics. I enjoy attending mathematics conferences!

Speakers

Sofya Lyakhova
Sofya is an associate professor of mathematics at Swansea University and MSPW Programme Leader. She has worked on a range of research projects initially in pure mathematics, and later in mathematics education and technology-enhanced learning within the Wales context. Sofya holds a PhD in Pure Mathematics from Bristol University. Prior to joining FMSPW in 2010, she worked in medical technology companies. Sofya is a co-opted trustee of the Joint Mathematical Council of the UK and a member of the advisory board of the Academy for the Mathematical Sciences.

Emily Mountain
Emily is a dedicated and innovative educational practitioner with over 15 years' experience teaching across all age groups within the primary setting. She has an extensive knowledge of the primary school curriculum and a proven track record in delivering effective leadership and project management in numeracy. Throughout her career, she has worked as a class teacher, interventions teacher, and Mathematics Lead, enhancing the quality of numeracy teaching, and promoting best practice to pupils, parents, and practitioners from across the education sector. Joining the Multiply project in April, Emily assumed the role of Senior Adult Learning Numeracy Practitioner. In this capacity, she has been instrumental in conducting family learning sessions within primary schools across Swansea, furthering the project's objectives.

Dominic Oakes
MSPW Resources and Research Lead, North Wales Area Coordinator
Qualified as Mathematics teacher in 1992. Taught in a range of schools – inner city, suburban, rural. Head of Mathematics. SLT.
Consultancy: CfEM, Tribal, YDP Poland, TES, Primary MAT. Expert advisor to Mathematics and Numeracy AoLE.
Research interests: Connections in Mathematics curriculum design, Flipped Classroom Approach

Elian Rhind
Elian studied Mathematics as both an undergraduate and postgraduate student at Swansea University, completing a PhD in Mathematics in 2018. In the same year, was a fixed-term tutor for the Mathematics Department at Swansea University. Worked with MSPW as a student helper for many years but joined the programme working in a fuller capacity in 2018.

Paul Sanders
After 35 years teaching Maths in 11-18 schools in Lancashire and Monmouthshire, I am now in my eleventh year working with FMSPW/MSPW and have been actively involved with the development of the professional learning programme and many of the video resources for A level Maths and Further Maths courses.

Susan Thomas
Head of Maths at Llanhari (Jan 1992-Sept'96), at Ystalyfera (1996-2010). FMSP Wales since 2011. FMSPW SoW Team.

Viv Townshend
Vivien is an experienced primary school teacher and former LA adviser who has worked with a wide variety of teachers, TAs, subject leaders and whole-staff groups in England. Vivien has worked with NCETM since 2008 as an associate evaluator and project lead for research and innovation, and now works part-time as Assistant Director for Evaluation and Impact. She leads on the evaluation of new programmes including Targeted Support in Maths and Mastering Number at KS2. Vivien also runs an educational consultancy specialising in the teaching of (and researching of) primary mathematics, and currently leads an online maths programme for two cohorts of primary school Teaching Assistants. Vivien received a PhD in mathematics education from Manchester Metropolitan University and currently lives on the Gower.

Rachel Wallis (Open University in Wales)
Rachel Wallis is a Curriculum Tutor on the Primary PGCE Programme, an alternative route into teaching (via a part-time or salaried route), at the Open University in Wales. Rachel undertook a degree in Pure Mathematics before becoming a primary teacher. She was a primary teacher for 15 years and worked in Initial Teacher Education in Wales for 10 years before joining the Open University in September 2020. Between 2016 and 2020, Rachel worked alongside Mathematics and Numeracy pioneer teachers as part of the Camau project facilitating the development of research informed progression frameworks for Curriculum for Wales and has since worked to support the development of materials for understanding of the Proficiencies. Rachel has recently completed a PhD in design based research focusing on measures as a context for learning the multiplicative relationship. Her main research interests are mathematics learning and teaching, curriculum and pedagogy.

Christine Watson
Christine Watson has worked as a maths teacher in a number of schools and in school improvement. She has experience of teacher professional development, of examining across GCE, GCSE and Entry Level Mathematics and has written a broad range of mathematics resources. Christine currently works in the University of Worcester PGCE Secondary team, leads workgroups for local Maths Hubs and is Area Coordinator for Worcestershire and Herefordshire for AMSP (Advanced Mathematics Support Programme).

Session 1

Encouraging more girls into studying Maths

Christine Watson (AMSP(MEI), Sofya Lyakhova (MSPW)

Enhancing mathematical proficiency offers valuable advantages to all students. Nonetheless, there exists a noticeable gender disparity, with fewer girls opting for mathematics post-GCSE compared to boys. This session aims to discuss strategies for schools to positively impact girls' engagement and enthusiasm for mathematics beyond secondary education. We will learn from the work of the Advanced Maths Support Programme in England and share insights on promoting mathematics to girls from recent case studies conducted by FMSPW in 2023 across schools in Wales.

Key words: *Female participation, pre-16 and post-16, enrichment, transition from primary to secondary*

Mathematics as a Human endeavour: historical enrichment in mathematics classrooms

Stuart Ball (West Monmouth School)

All mathematics that students learn as part of their 11-16 education has once been solved by real people and therefore talking about it helps us to see mathematics as a human activity. In my talk I will showcase my favourite historical episodes relevant to mathematics taught in the 11-16 curriculum and give my tips as to why and how I incorporate these in my teaching to encourage students to love maths.

Key words: *11-16, enrichment, history of mathematics*

An Innovative Way of Teaching and Assessing Critical Thinking in Mathematics

Sergiy Klymchuk (Auckland University of Technology, New Zealand)

Fake news, conspiracy theories, information wars and deep fakes are getting more common in our society. Therefore, abilities to recognise mistakes and think critically are very important nowadays. Including so-called provocative or 'impossible' questions in teaching and assessment in mathematics can enhance students' critical thinking skills. Such questions look like typical routine questions but in fact that have a catch – they are deliberately designed to mislead the solver. The intention is to prepare students for real life better. Results of several studies on attitudes of school mathematics teachers' and university mathematics lecturers towards using provocative mathematics questions in teaching and assessment are presented in the talk. Practical recommendations for teaching practice with many examples are also discussed.

Key words: *Problem solving, fake news, provocative questions, assessment, 11-16, 16-18.*

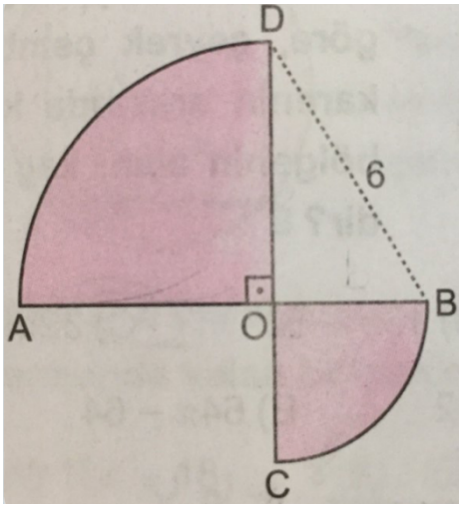
Hypothesis Testing

Stephen Earles (MSPW)

A practical, hands-on, data collecting session where we will look at introducing hypothesis testing with the Binomial Distribution using a variety of statistical experiments; all of which can easily be replicated in the classroom. We will also look at how GeoGebra can support the understanding of decision making when drawing conclusions.

Key words: *AS statistics, hypothesis testing, Binomial Distribution*

Participants should bring: *Classwiz calculator or similar (with probability distributions)*



Session 2

Why Children Enjoy Maths

Francis Hunt (MSPW)

In this talk I look at why, according to their feedback, children enjoy maths; demonstrate some activities that have been particularly popular with children, and argue for a much wider understanding of the "applications of maths". This talk is very much in line with the new WG Maths and Numeracy plan, "providing challenge in an enjoyable, fun and engaging way" and promoting "a positive change in mindset towards mathematics and numeracy to support learners' acquisition of the experiences, knowledge and skills that they need for active citizenship, lifelong learning and employment".

At the end of this talk you will have some new activities to try out with your classes, and some food for thought on what maths is and why we should teach it. This session will also provide a good lead-in to the discussion session on "Transition through Enrichment".

Key words: *enjoyment, popular activities, applications, mindset, active citizenship, lifelong learning*

A journey through mathematical thinking

James Lewis-Coll (Central South Consortium (CSC))

Having access to a wide range of curriculum tasks will support the development of using mathematics since "looking back may be the most important part of problem solving" (Wilson, Fernandez, Hadaway).

This session will consider a range of tasks that will challenge and support the development of students' mathematical skills via problem solving and contextual work. These tasks will be suitable for students across ks3, ks4 and ks5 linking to real-life contexts, practical applications and mathematical problems.

Key words: *Applying, modelling, contexts, mathematical thinking, mathematics, modelling, key stage 3, key stage 4, key stage 5, practical, applications, GCSE, A-level, cross-curricular, real-life, estimation.*

Participants should bring: *Paper and pens / pencils, calculator*

X (formerly known as Twitter) Geometry

Dominic Oakes (MSPW)

Twitter is distracting enough but my timeline has been increasingly hijacked by geometry problems. It is interesting firstly how many solutions some of these problems attract and secondly the range of approaches.

In this session we will look at a few problems gleaned from Twitter and discuss assumptions, solutions, tricks, developing geometrical intuition. We shall also look at the role of dynamic software in this area.

Participants will go away with a lovely set of problems and some Twitter Geometers to follow! Copies of the apps will be available after the conference.

Key words: *geometry, invariance, geogebra*

Geogebra: linking golden tori - a transformational experience!

Ifor John Jones (MSPW)

The session relates to my personal study of 3D virtual models using the Geogebra 'surface' command with rotations and translations – golden chains and the Olympic symbol with overlapping tori.

It goes on to consider Geogebra models of naturally occurring objects (shells and a pulsating heart), and man-made objects suitable for inspiring students - rugby ball and 3D pitch. Some of the models will include animation – the only way I could get a rugby ball between the posts!

The culmination of this year's study has been the production of a model of a Mobius band with an ant - moving along the centre line of the band. This proved to be an exciting application of 3D parametric equations, planes and vectors using a system of orthogonal vectors linked to points on the surface of the Mobius band, for which Geogebra helped my understanding significantly. I believe this is a fine example of how a problem-solving approach can lead to the development of understanding. Some of the mathematical content is an extension of advanced level maths but the use of Geogebra could enable some of these ideas to be introduced to inspire students at an earlier age.

Key words: *Geogebra, 3D virtual models, torus, rotation, translation, vectors, orthogonal vectors, surface command, mobius band, planes*

Session 3

Engaging Parents in helping children become mathematicians – suitable for all age children

Theresa Hendy (MSPW) and Emily Mountain (Multiply)

A new project Multiply Numeracy for Parents will share their findings on running sessions for parents (and grandparents) of secondary students.

We will look at issues such as:

How can we give parents confidence to support their children without necessarily knowledge of the mathematics curriculum.

Dealing with possible maths anxiety in parents and helping them create a positive environment at home around mathematics.

Concrete Pictorial Abstract – how can parents support this at home. Participants will be directed to open source resources for PBL and cross curricular activities across all age groups.

Key words: *Foundation, primary, secondary, manipulatives, parents, concrete, pictorial, abstract, confidence*

Discrete and Decision Maths for the new Additional Maths course

Stephen Earles (MSPW)

Having taught the Edexcel specification for many years, I always felt that decision mathematics has a lot to offer to students including those preparing to study social science and business as well as Mathematics. The session is to introduce decision mathematics as a concept and to bring some interesting questions from past specifications. Recommended to anyone preparing to teach WJEC Additional Mathematics new specification.

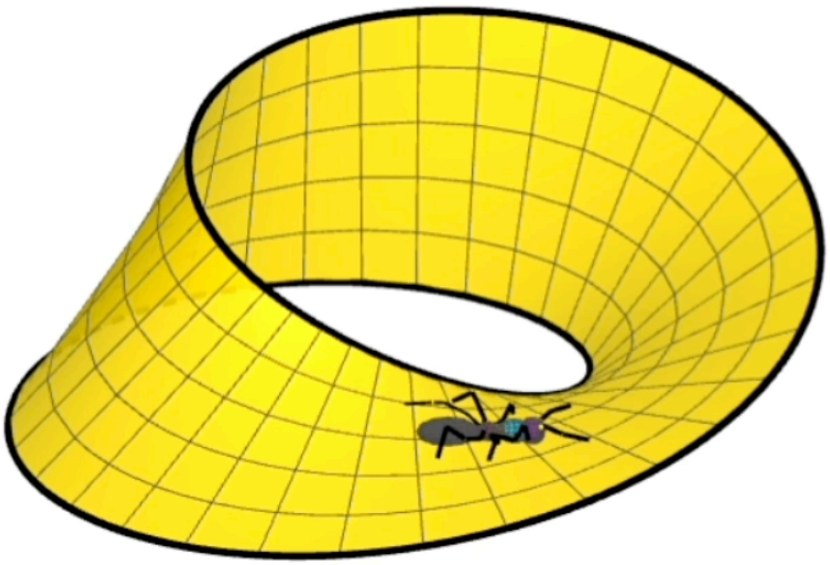
Key words: *Algorithm, Graph Theory, Networks, Linear Programming*

Filling Spaces

Susan Thomas (MSPW)

Head of Maths at Llanhari (Jan 1992-Sept'96), at Ystalyfera (1996-2010). FMSP Wales since 2011. FMSPW SoW Team.

This session will involve a bees' honeycomb, the structure of snow particles into ice, the trapezium rule, into Riemann Integral, finding areas of circle, triangle, half-circle, volumes of cone, hemisphere, etc by integration, ...



Session 4

Primary CfW: learning through play and more

Kate Andrews (Partneriaeth), Sofya Lyakhova (MSPW/Swansea University), Viv Townshend (educational consultant/NCETM) and Rachel Wallis (Open University in Wales)

This session is to update secondary teachers on new and exciting trends in primary research and practice relevant to the new curriculum for Wales followed by tips from FMSPW case studies on enhancing transition from primary to secondary education.

Key words: *Primary, Transition, Active, Authentic Contexts, Proficiencies, Reasoning, Mathematical relationships*

Programming Mathematical Illustrations

Elian Rhind (MSPW)

A versatile aspect of Mathematics is to visualise its beauty using contemporary tools. In this session we use the programming language Python to investigate examples with a focus on fractals. Methodologies and philosophies from Mathematics carry over well to programming and vice-versa, hence the two may prove to be complementary companions for the learning student.

The session is designed for everyone, regardless of programming experience. Having previous exposure may help but the focus of the workshop is on idea and discussion.

Key words: *Python, Fractals, Programming, Abstraction, Systematic*

Participants should bring: *Python installed (entirely optional, only if you want to join in and try some code for yourself).*

Teaching Mechanics with the aid of Geogebra

Paul Sanders (MSPW)

The session will introduce Geogebra apps that could be used in the classroom to aid the teaching of the Mechanics content of the M2 unit of WJEC AS Maths. The apps, which include both animations and solutions of different situations, will be viewed and time will be devoted to discussion of how they might be used in the classroom.

The session does not require previous use of Geogebra and will include suggestions of how these apps and similar ones can be used by teachers of different levels of experience with the software.

Copies of the apps and videos of the apps in action will be available after the conference.

Key words: *Geogebra, Mechanics, Kinematics of motion in a line, Newton's Laws, Animations of motion*