

Innovation and Creativity in Mathematics Teaching

One-day conference for Mathematics teachers

12th July 2019 - Cardiff Metropolitan University



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



09:15-09:45	Registration; Welcome; Housekeeping					
09:45-10:30	Keynote: Professor Adrian Oldknow: Inspiring Learners and Teachers through Technology-enhanced STEM Learning Activities (TeSLA)					
10:30-11:30	Session 1	Number and Proof – from concrete to abstract <i>Earles</i>	Developing Flipped Classroom Approaches <i>Weinhandl</i>	Ideas for using GeoGebra and Origami <i>Budinski</i>	Undoing the Made-Up Mind <i>Jones</i>	
11:30-11:40	Coffee					
11:40-12:40	Session 2	Experimental (and fun) ways to introduce AS Hypothesis Testing <i>Hendy, Mackie</i>	Differential Equations: First order to coupled systems. It could be "Rocket Science"! <i>Wells</i>	Silent video tasks – development and implementation in the mathematics classroom <i>Kristinsdottir</i>	Using Geogebra to illustrate and motivate FMU1 concepts <i>Sanders</i>	
12:40-13:30	Lunch					
13:30-14:30	Session 3	Integral Mathematics Resources <i>Phipps</i>	Implementing the Flipped Classroom at A-level – Research and Practice <i>Oakes, et al</i>	Modelling real-life situations with functions and GeoGebra <i>Budinski</i>	Developing digital resources for supporting learning (Welsh) <i>Evans</i>	
14:30-15:30	Session 4	Connections between Pure and Applied Mathematics <i>Fleming</i>	Visualising Statistics – Formalising processes from intuitions to calculations <i>Andre</i>	Mapping a 2D game to 3D, designing and printing it via GeoGebra <i>Kristinsdottir</i>	Creating and using GeoGebra Applets for the Classroom <i>Neil Dickson</i>	Studying FM through FMSP via a blended learning option: what makes a successful learner? <i>Lyakhova, Eakin</i>
15:30-15:40	Coffee					
15:40-16:40	Session 5	Review of WJEC A level papers 2019 <i>Wells</i>	Possible Uses of Gamification in Teaching Mathematics <i>Barbarics</i>	Flipped Videos from Powerpoints <i>Sanders</i>	Flipped Videos from Powerpoints (Welsh) <i>Thomas</i>	Tools for Connected Planning & Learning <i>Oakes</i>
16:40-17:00	Closing address					

Broadly: **A-level** **Geogebra** **STEAM/Tech** **FCA** **Resources**

Keynote

Inspiring Learners and Teachers through Technology-enhanced STEM Learning Activities (TeSLA)

Professor Andrew Oldknow (University of Chichester)

Read maths at Oxford 1964-67. 3 years secondary school maths teaching. 3 years FE computing & maths teaching. MTech in Computer Science at Brunel. 25 years HE teaching. Head of Department of Maths & Computing. Personal Chair. Retired 1997. 15 years as consultant to IT companies (HP, Intel, Smart, TI etc) on STEM education. Chair of PD and ICT committees of the Mathematical Association. Retired 2010 to establish Cambridge Centre for Innovation in Technological Education CCITE. Volunteer.

As well as learning mathematics, and related STEM subjects, we all want our students to develop curiosity, creativity and to appreciate the power and beauty of our subject, as well as learning more about the world around us and the opportunities it presents. Fortunately most learners now have access to the Internet at home and/or school. The session will explore some of the free software tools, such as GeoGebra, Tracker, Algodoo, Scratch 3, MakeCode and TinkerCAD, which teachers and learners can use to make maths come alive. It will demonstrate animation, use of still and video images, mechanics' microworlds, data-logging, graphing, analysis and modelling in activities designed to foster the Royal Academy of Engineering's 'Engineering Habits of Mind' EHoMs.

Key words: STEM, inspiration, curiosity, creativity, technology

Session 1

Number and Proof – from concrete to abstract

Stephen Earles (FMSP Wales)

Started teaching in FE in London then moved to West Wales. 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 3 years.

In this session, we will look at the link between numbers and how they can reinforce the concepts of proof. The session will look at deepening the understanding of Maths by using number together with the important concepts that need to be included in a solution to a proof problem. We will look at problems from both GCSE and A level.

Key words: Deduction, exhaustion, contradiction

Participants should bring: Paper and pens

Developing Flipped Classroom Approaches

Robert Weinhandl (Johannes Kepler Universität Linz, Akademisches Gymnasium Wien)

- *Secondary school teacher of mathematics as well as geography and economics*
- *Teacher trainer in professional teacher development and basic training of secondary school teachers*
- *PhD student with research interest in flipped approaches of mathematics education*
- *“e-Education Expert” – Master's Programme 2013-2015, Donau-Universität Krems*

Teaching and learning mathematics following a flipped classroom approach (FCA) has been gaining practical and scientific relevance and research suggests that FCA education can be more fruitful than traditional teaching. Although interest in FCA is growing, there is already a development of this approach – namely: flipped learning approaches (FLA).

In FC education the location (pre-class vs. in-class phase) is of relevance and teachers orchestrate educational processes. An FLA differentiates between individual and group learning environments. Teachers and students co-determine activities. The group learning environment is an interactive and dynamic space in which students apply mathematical concepts and creatively construct concrete learning artefacts. By contrast, it is characteristic of an individual learning environment that students acquire basic knowledge and competencies at their own pace and with self-chosen learning materials. In both the individual and group learning environments, the teacher acts as a guide, offering tailored assistance when students ask for it.

The session will consist of: (a) Information on FLA mathematics, (b) concrete examples and discussions, and (c) working on one's own FL education. According to the principles of FLA we will jump back and forth between the three parts according to participants' wishes.

Key words: Flipped education, technology-enhanced learning, student-led learning

Participants should bring: Laptop and/or smartphone would be good

Ideas for Using GeoGebra and Origami

Natalija Budinski (Petro Kuzmjak School Serbia)

Teacher of mathematics and PhD candidate at the University of East Sarajevo. One of the 300 the most innovative Microsoft teachers in the world, three times awarded by European schoolnet, Brussels for teaching projects based on real life and mathematics. Published several papers in educational journals.

This session presents opportunities using technology, such as educational software GeoGebra and origami in teaching mathematics to 12 to 18 years old students. Origami is a well-known ancient paper folding activity and it is also recognized as a beneficial tool for learning mathematics. Combining hands-on activities with technology contributes to learning mathematical concepts related to geometry and algebra. With this combination the two approaches supplement each other. Exploring different problem solving strategies in hands-on and digital environments develops reasoning skills and supports the deeper understanding of problems. Origami requires following a certain procedure, while GeoGebra allows crafting other procedures that leads to solutions.

In this session we will provide several examples from teaching practice that we developed during application of this method in teaching mathematics in classrooms over several years. Participants will have an opportunity to take part in activities that connect origami and GeoGebra and learn how to combine Origami and GeoGebra in teaching perpendicularity, Pythagoras Theorem, the doubling the cube problem, and polyhedrons.

Key words: GeoGebra, origami, creativity
Participants should bring: Laptop with Geogebra loaded, Internet access

Undoing the Made-Up Mind

Elizabeth Anne Jones (Elfin Bow Art and Music)

A former Head of Art in a secondary school, Elizabeth returned to freelance work in 2015 and currently works as a Creative Practitioner for Lead Creative Schools in Wales and as an artist, musician and educator.

The arts and maths have many parallels as separate curriculum subjects. Not least the fact that most children have made up their minds about whether they are subjects that they can 'do' or not, by the time they leave primary school. As educators, we have great influence over our students learning 'blueprint.' We can confirm their beliefs and expectations, or we can break them wide open.

In a multi-sensory space, we will take a practical and theoretical look at how we can remove barriers to learning through creative approaches to maths. Taking inspiration from a recent Lead Creative Schools project at Penyffordd School, we will ask how teaching maths through the arts can foster a deep appreciation of both subjects, demystifying them and facilitating an environment where quality, memorable, learning can take place.

Elizabeth will lead you through a series of discussions and 'hands-on' learning experiences, which will stimulate ideas for how to help your students 'find the maths' in a variety of creative contexts, leaving you with plenty of practical tips for you to take back to your own students.

Key words: Maths through art, removing barriers to learning
Participants should bring: Paper and pencils to make notes. Possibly a camera to document activities and ideas.

Session 2

Experimental (and fun) ways to introduce AS Hypothesis Testing

Philip Mackie and Theresa Hendy (Gower College Swansea)

Phil and Theresa have both been teaching A level mathematics for more than twenty years in Further Education. Phil previously worked in a marine laboratory doing mathematical modelling and statistical analysis of oceanic carbon fluxes and Theresa taught maths in a secondary school.

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)

Differential Equations: First order to coupled systems. It could be “Rocket Science”!

Adrian Wells (RhGMB Cymru/ FMSP Wales, Swansea University)

Joint Area Coordinator for Mid and West Wales, sometime Senior Assistant Headteacher; sometime Head of Mathematics with 40 years teaching experience, sometime Peer Inspector (ESTYN). Examiner/Team Leader for EDEXCEL in Further Pure Mathematics with 30+ years' experience.

A viewpoint on the teaching approaches to differential equations, from variable separable/ implicit integration to the use of auxiliary equations in solving first and second order DEs including the superposition of solutions.

Coupled DEs: substitution vs a matrix approach.

Key words: Teaching approaches; Second order DE (Pure)/context; coupled DE

Silent video tasks – development and implementation in the mathematics classroom

Bjarnheiður (Bea) Kristinsdóttir (University of Iceland)

Bea started her PhD studies in mathematics education at the University of Iceland in fall 2016. She holds a MSc degree in applied mathematics from the Technical University Bergakademie Freiberg in Germany and has seven years' experience of teaching mathematics on upper secondary school level.

Silent video tasks are innovative tasks currently being developed and used for formative assessment in mathematics classrooms. Silent videos are short animated films without text or sound that show mathematics dynamically. Students work in pairs to add their voice-over to the video. Teachers listen to their students' solutions and prepare a group discussion for the follow-up lesson.

In this workshop we will watch examples of silent videos, get to know what they are and what they are not, and work on preparing and recording our own voice-overs to silent videos.

Key words: silent video task; task design; formative assessment; lower and upper secondary school
Participants should bring: Laptop/tablet. Also, a phone with recording software/voice recorder might be helpful.

Using Geogebra to illustrate and motivate FMU1 concepts

Paul Sanders (FMSP (Wales) since 2013)

Head of Mathematics, Monmouth School for 28 years. For FMSP I have produced and delivered Professional Learning Courses for Further Maths units 1,3,4 and 6. Geogebra has featured heavily in these courses.

The complex number and matrix sections of the unit 1 Further Maths specification provide significant opportunities for Geogebra to illustrate and motivate some quite complicated abstract concepts.

The session will start with a brief demonstration of some of these applications and a discussion of how they might be used in the classroom.

The major part of the session will be dedicated to creating some of these Geogebra applications ourselves.

Participants will be provided with a copy of all the applications provided they bring a USB stick to the session.

The session will assume no more than a basic familiarity with Geogebra but it should also be of interest to more experienced users who are looking for ways to incorporate it into their Further Maths teaching.

Key words:

Geogebra; Complex Numbers; Matrices

Participants should bring:

A laptop with Geogebra downloaded and a USB stick.

If you haven't yet downloaded a version then I would recommend Geogebra Classic 5 which is the full package and apparently faster than Classic 6. It is also the version I use so I'll find it easier to offer advice or give assistance in the practical part of the session. Many people find a mouse much easier to use with Geogebra than a touchpad.

Session 3

Integral Mathematics Resources

Carl Phipps (FMSP/Swansea University)

Currently the FMSP Area Co-ordinator for CSC and ES regions. A former Head of Mathematics in two South Wales Comprehensive schools.

MEI's virtual learning environment, Integral, contains extensive resources to support the teaching and learning of many mathematics courses, including A level Mathematics and Further Mathematics. It is available bilingually.

This session will give participants an insight into the structure of Integral resources and website. Resources will be demonstrated and we will consider the range of available material.

Participants with an Integral account* will be able to explore resources in any particular areas of interest.

The session will also give an update on possible future developments.

Key words: Integral resources, A-level Mathematics, A-level Further Mathematics

Participants should bring: Would be useful for participants to have any device, phone, tablet or computer, but access is determined by users having available accounts.

* Registering with FMSPW offers (amongst other benefits) a free teacher account for these resource – it will be beneficial to do this well in advance of this session.

Implementing the Flipped Classroom at A-level – Research and Practice

Dominic Oakes (FMSPW, Swansea University); Marie Joubert (University of Nottingham); Andy Davies (Ysgol Eirias); Helen Hayes (Ysgol Bryn Elian)

Dominic Oakes: FMSPW - Scheme of Work Coordinator, PL & Research; Formerly Head of Mathematics, Music, ICT; Member of SLT.

Marie Joubert: Senior Research Fellow in Mathematics Education at the University of Nottingham, formerly national research coordinator for the National Network of Excellence in Mathematics (in Wales)

Andy Davies: Head of Mathematics Ysgol Eirias

Helen Hayes: Teacher of Mathematics

The Flipped Classroom Approach (FCA) can be defined as a technology-enhanced pedagogy that delivers parts of the course materials through video resources before class, followed by the integrated use of assessments, mini-lectures, individual problem solving, and small-group learning activities inside the classroom.

We have carried out research into the FCA in North Wales in response to identified pressures of time making it difficult to deliver the curriculum with a focus on understanding, depth and connection. The research has been encouraging in addressing the identified problems.

In this session we will summarise our research findings and offer practical advice on how to begin implementing an FCA. We will focus on A-level though the FCA is used with younger students too.

Participants will gain an understanding of the FCA and the knowledge to implement it.

Key words: Flipped Classroom Approach, technology-enhanced pedagogy

Modelling Real-Life Situation with Functions and GeoGebra

Natalija Budinski (Petro Kuzmjak School Serbia)

Teacher of mathematics and PhD candidate at the University of East Sarajevo. One of the 300 the most innovative Microsoft teachers in the world, three times awarded by European schoolnet, Brussels for teaching projects based on real life and mathematics. Published several papers in educational journals.

This session provides ideas of how to implement real contexts in teaching mathematics. It is often said that mathematics is all around us, but a traditional, theory-based way of teaching mathematics does not illustrate that fact to students. We will look at examples based on real-world contexts relevant to students and connected to mathematical functions such as logarithmic, exponential or trigonometric. The modelling process begins from the real-world situation and goes to the mathematical model and its solution. It is supported by educational software GeoGebra which provides excellent ground for developing students' mathematical knowledge.

Key words: GeoGebra, modelling, real-life problems
Participants should bring: Laptop with Geogebra loaded, Internet access

Developing digital resources for supporting learning (Welsh medium presentation)

Gareth Evans (Ysgol y Creuddyn)

Head of Mathematics at an 11-18 Welsh medium secondary school near Llandudno. Creator of www.mathemateg.com and curriculum pioneer for the new Mathematics and Numeracy AOLE.

This session will explore the creation, development and promotion of www.mathemateg.com, a website to host mathematical resources.

- How do you set up a website?
- How do you control which resources are publicly available and which are more restricted?
- How do you include games and other embedded materials on a website?
- How do you use social media to promote your website?
- How do you set up a YouTube channel and create content for it?

We will also take a look at some of the resources available on www.mathemateg.com, considering some novel tasks that could be used at classroom level. For example, Descartes' method for calculating the square root of a number using only a compass and ruler will be discussed.

Key words: Resources, website, YouTube, QR codes

Session 4

Connections between Pure and Applied Maths

Colin Fleming (FMSPW, Swansea University)

I am currently Coordinator for FMSPW in North Wales. Before joining FMSPW in 2013, I taught for 38 years in Northumberland and North Wales, 32 of them as Head of Department.

Good A level teaching helps students to make connections between topics in pure maths and mechanics and statistics.

In this session, we will look at some topics in mechanics and statistics that provide opportunities to apply pure mathematics, so encouraging students to make connections between different areas of maths.

Key words: Connections, A-level Mathematics, A-level Further Mathematics

Visualising Statistics – Formalising processes from intuitions to calculations

Mag. Martin Andre (Johannes Kepler University – JKU Linz, Austria & Pedagogical University Tyrol – PHT, Innsbruck, Austria)

Martin Andre is currently finishing his PhD in statistics education at the JKU. He is a researcher and lecturer in the Centre for Didactics at the PHT, where he educates mathematics teachers at primary and secondary school level. His research interests include statistics education and the use of technology in mathematics education.

When teaching statistics, we should use context-based data that are relevant to students. This gives students the possibility to attach meaning to the data and facilitates an intuitive access to statistical concepts. Working with visualizations also assists students to access their intuitive knowledge of statistics. As practicing statistics contains many processes from posing a question to interpreting visualisations or results of calculations on data, students should learn to conduct their own statistical investigations. Therefore, the analysis of context-based data should contain different entire cycles of visual analysis and statistical investigations, which build upon each other.

As a theoretical background, an overview of theories on processing data in school education will be presented in the first part of the workshop. In a second, practical part, we will apply these theories based on working materials for statistics education in higher secondary schools using Education for Sustainable Development as the context and the software Gapminder for visualisations. Based upon this, we will reflect on possibilities of doing statistical calculations with(out) technology, e.g., by GeoGebra or SPSS. In a third part we will analyse the addressed competencies regarding the A-levels.

Key words: Intuitive statistical knowledge, data visualisation, visual data analysis, Formalizing statistical knowledge

Participants should bring: Participants should bring laptops with access to the internet;
Laptops should have the following installed: GeoGebra (version 5 or 6), Excel

Mapping a 2D game to 3D, designing and printing it via GeoGebra

Bjarnheiður (Bea) Kristinsdóttir (University of Iceland)

In this workshop Bea presents work by Diego Lieban, a PhD student in mathematics education and a GeoGebra 3d-printing specialist at the Johannes Kepler University in Linz, Austria. Diego is also a mathematics professor and teacher educator at the Federal Institute of Education in Bento Gonçalves, Brazil.

In this workshop you will think collaboratively about ways that enable us to extend a 2D logic game into 3D and play with an example of how this can be done with a 3D printer. The presented activities were developed by Diego Lieban and his 10-15-year-old students.

Key words: game; logic; combinatorics; probability theory; geometry; digital model; physical model; 3D printing with GeoGebra; modelling in GeoGebra

Participants should bring: A laptop/tablet is not required but it can be beneficial.

Creating and using GeoGebra Applets for the Classroom

Neil Dickson (Ysgol Emrys Ap Iwan)

Started teaching in FE in London then moved to West Wales. 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 3 years.

Visualising new mathematical concepts is a key step in the learning process if learners are to obtain a deep and connected understanding. It is challenging to convey many mathematical concepts visually with traditional teaching methods restricted to drawing on the 2-dimensional surface of a whiteboard but GeoGebra applets allow mathematics to be visualised and explored by learners from a whole new perspective. Many educators will be familiar with using GeoGebra as a dynamic geometry tool to visualise algebraic functions, coordinate geometry and graph/shape transformations but may not be aware that GeoGebra provides a platform that can be used to allow learners to visualise almost all any mathematics concepts including statistics and mechanics.

This session will focus on exploring and sharing a wide range of GeoGebra applets that have been developed to introduce challenging mathematical concepts. Ideas will be presented for resources and activities that encourage learners to explore applets; opportunities will be provided for delegates to try out these applets during the session. The session will give an introduction to creating and sharing GeoGebra applets and finally close with discussing how we could move forward as a community in terms of ensuring GeoGebra or other forms of visualisation technology are fully embraced by educators and incorporated into mathematics lessons.

Key words: GeoGebra

Participants should bring: Laptop with Geogebra loaded (Version 5) Internet access

Studying Further Mathematics through FMSP via a blended learning option: what makes a successful learner?

Sofya Lyakhova, Bethan Eakins (Swansea University – The Further Maths Support Programme Wales)

Sofya Lyakhova is an Associate Professor of Mathematics and the Programme Leader for the Further Mathematics Support Programme Wales. Sofya's recent research includes students' experience of studying through a blended learning model.

Bethan Eakins supports state-funded schools and colleges in all counties/regions of Wales by providing tuition for students through a variety of learning methods.

The session will provide insight into the experience of students learning Further Mathematics through the FMSP. Using “real life” case studies and example of previous FMSP students we will showcase the benefits and challenges of the blended learning approach that the FMSP has adopted and provide practical information on what makes a successful learner. Participants should then be equipped to support their students studying Further Mathematics through the FMSP and/or borrow our tips to support their own students studying Further Mathematics “in house”.

Key words: Blended learning, practical approaches, student experiences, transition, learning

Participants should bring: Laptop

Session 5

Review of WJEC A level papers 2019

Adrian Wells (RhGMB Cymru/ FMSP Wales, Swansea University)

Joint Area Coordinator for Mid and West Wales, sometime Senior Assistant Headteacher; sometime Head of Mathematics with 40 years teaching experience, sometime Peer Inspector (ESTYN). Examiner/Team Leader for EDEXCEL in Further Pure Mathematics with 30+ years' experience.

A review of the first tranche of A level exam papers used by WJEC as compared to the specimen materials and where possible, to papers used by the English Exam Boards. With specific reference to the perceived removal of 'scaffolding' in the questions asked and how best to approach this in the classroom, teaching for understanding and exam success.

Are we in danger of significant divergence from the system in England and is that a good thing?

Key words: Problem solving; divergence; teaching for understanding

Possible Uses of Gamification in Teaching Mathematics

Marta Barbarics (Eötvös Loránd University, Budapest, Hungary, Petrik Lajos Bilingual Vocational School of Chemistry, Environmental Protection and Information Technology, Budapest Semesters in Mathematics Education) Marta Barbarics studies at the Doctoral School of Education of Eötvös Loránd University in Budapest, Hungary. She also teaches Mathematics, English as a foreign language, and Mathematics in English in both secondary and tertiary education. Her main interests are playful design and alternative assessment methods in connection with gamification.

In this session, we will look at the link between numbers and how they can reinforce the concepts of proof. The session will look at deepening the understanding of Maths by using number together with the important concepts that need to be included in a solution to a proof problem. We will look at problems from both GCSE and A level.

Key words: gamification, assessment, playfulness

Flipped Videos from Powerpoints (Welsh & English medium presentations)

Susan Thomas and Paul Sanders (FMSPW)

Paul: Head of Mathematics, Monmouth School for 28 years. FMSP Wales since 2013. For FMSP I have produced and delivered Professional Learning Courses and am currently producing video resources with Susan.

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

The session will start by considering the anticipated role of videos in the flipped classroom and by viewing short excerpts from videos developed by the FMSP team, prepared using the Screencast-o-matic software.

Our main aim is to suggest and demonstrate a reasonable method for teachers to prepare their own videos from either an existing (and developing) bank of Powerpoints or their own Powerpoints.

Our intention is that participants will be able to produce a short video thus leaving the session able to produce Flipped Videos for their classes.

Key words: Flipped Classroom Approach, Flipped Videos

Participants should bring: Laptop loaded with the free version of the Screencast-o-matic software

Tools for Connected Planning & Learning

Dominic Oakes (Swansea University, FMSPW)

FMSPW - Scheme of Work Coordinator, PL & Research; Formerly Head of Mathematics, Music, ICT; Member of SLT.

Programmes of Study often work through specifications topic by topic. Can we improve developing mathematical thinking by looking at the connections in the material and travelling through the mathematics in a different way? FMSPW has written Schemes of Work for the new Mathematics & Further Mathematics A-Levels. We have mapped prior & dependent topics for every topic in the syllabi. At present this is represented in a spreadsheet and a MindMap.

Our MindMap is complicated - it has to be printed on A0 paper to be at all legible! We are developing a 3-D version of the MindMap using the Unreal Game Engine to allow students and teachers to travel through the curriculum. In this session we will be showing progress so far.

Can we use these resources to grow our teachers' (& students') understanding of the patterns running through mathematics? Participants will design alternative plans for the start of Maths AS with these ideas in mind.

Key words: Connection, Mindmap, gaming engine