10th International Conference on Technology in Mathematics Teaching

Enhancing Mathematics Education Through Technology

University of Portsmouth, UK
Tuesday 5 – Friday 8 July 2011
Hosted by the University of Portsmouth and University of Chichester

Contents

Welcome to ICTMT10 2
Essential information 4
Maps 7
Conference timetable 12
Academic programme 14

Tuesday 11.30 – 12.30  Plenary 1 – Keynote 14
Tuesday 13.30 – 15.00  Parallel session 1 – Papers 14
Tuesday 15.30 – 17.00  Parallel session 2 – Papers/workshops 16
Wednesday 09.00 – 10.00  Plenary 2 – Keynote 18
Wednesday 10.00 – 11.30  Parallel session 3 – Papers/workshops 20
Wednesday 12.00 – 13.30  Parallel session 4 – Papers/workshops 22
Wednesday 14.30 – 16.00  Parallel session 5 – Papers/workshops 24
Wednesday 16.30 – 17.30  Meetings and discussions 26
Wednesday 18.00 – 19.00  Invited lecture 25
Thursday 09.00 – 10.30  Parallel session 6 – Papers/workshops 26
Thursday 11.00 – 12.00  Plenary 3 – Keynote 27
Friday 08.30 – 10.00  Parallel session 7 – Papers/workshops 28
Friday 10.30 – 12.00  Parallel session 8 – Papers/workshops 30
Friday 12.00 – 13.00  Plenary 4 – Keynote 31
Invited lecture – Abstract and biography 32
Keynotes – Abstracts and biographies 34
Papers – Abstracts 38
Workshops – Abstracts 95
Special ICTMT themed edition of journal 106
About our sponsors 107
Social programme 110
General information 113
About the City of Portsmouth 115
ICTMT10 history and background 115
International scientific committee 116
Local organising committee 116
Acknowledgements 117
Notes 118
Personal conference timetable 120
Welcome to ICTMT10

Welcome to Portsmouth for the 10th International Conference on Technology in Mathematics Teaching. We are delighted to have you with us for this well-established, biennial event, whether you have attended past ICTMT conferences or are joining for the first time.

We look forward to sharing an exciting programme of events with contributions from lecturers, teachers, educators, curriculum designers, mathematicians, mathematics education researchers, learning technologists, educational software designers, a ballistics expert ... and even a world land speed record holder. All of us share a common interest in improving the quality of teaching and learning in mathematics through the effective use of technology. Whether you are a researcher or practitioner, this conference is a great opportunity to discuss better practices, theoretical know-how, innovative ideas, different perspectives on educational technologies and their impact on the teaching and learning of mathematics. We very much hope that you will be able to make the most of your time here in Portsmouth on the south coast of England.

It is appropriate that ICTMT10 is in England, where the first ICTMT conference took place almost 20 years ago. Our goal is to maintain the high standard of the past conferences held in Birmingham, England (1993); Edinburgh, Scotland (1995); Koblenz, Germany (1997); Plymouth, England (1999); Klagenfurt, Austria (2001); Volos, Greece (2003); Bristol, England (2005); Hradec Králové, Czech Republic (2007); and Metz, France (2009).

Professor Richard Noss will be opening the first day of the conference by asking the important question: “What mathematics does technology make learnable?” The second day of the conference focuses exclusively on the theme of professional teacher development with an opening keynote by Professor Paul Drijvers on tools, teachers and teaching technologies followed by a programme of hands-on workshops providing experience of the technology.

Since the 2012 Olympics will be held in London next year, a special theme of sports and leisure has been included in the programme for ICTMT10. The Olympic motto of “citius, altius, fortius” (faster, higher, stronger) could equally well be applied to this conference as we strive to improve mathematics education. It also seems appropriate to have the “fastest man on Earth” Andy Green speaking at the conference in a special invited lecture about how the Bloodhound Supersonic Car and the world land speed record can make a further contribution to student engagement, one of the major conference themes. In the keynote on the third day of the conference, ballistics expert Colin White will present sports projectiles of all kinds as further tools to stimulate student engagement and motivation.

On the final day of the conference Professor Colette Laborde will be analysing the nature of interactive feedback in dynamical mathematics technology. The other themes of curriculum, applications, student support, assessment and innovation are all represented throughout a full academic programme.

The social programme opens with a drinks reception attended by the Mayor of Portsmouth followed by an evening up the Spinnaker Tower down by the harbour at Gunwharf Quays. You will have exclusive use of this famous landmark and viewpoint throughout the evening and can get your bearings for the week ahead. On the second day the Bloodhound Supersonic Car talk is followed by another drinks reception, so the afternoon of day three provides opportunities for getting out and about in Hampshire on a choice of interesting excursions. No one will want to return late, because the conference banquet will be held on board the 150-year old ironclad battleship HMS Warrior in Portsmouth Harbour. The singing of sea shanties will add to the atmosphere of your dinner at this memorable location towards the end of what we hope will be a memorable conference for you.

Thanks to everyone who has contributed to the planning and preparation for the conference through papers or workshops and practical help. We also thank the sponsors who have generously supported our conference. We wish you all an extremely interesting, useful and enjoyable ICTMT10 conference here in Portsmouth!

Michael McCabe and Alison Clark-Wilson
(on behalf of the ICTMT10 Local Organising Committee)
Essential information

Registration

Delegates can register early at the ground floor reception of Rees Hall between 17.00 and 20.00 on Monday 4th July. The main registration will be from 09.30 – 11.00 in the atrium of Portland Building on Tuesday 5th July. Final booking and cash payment for the excursions on Thursday 7th July can be made at this time. The registration desk will be open in the atrium of Portland Building, each subsequent morning of the conference, from 09.00 to 11.00.

Look out for the conference ambassadors in their purple University of Portsmouth T-shirts! They will be around to give you help and advice throughout the conference.

Accommodation

Accommodation is at Rees Hall, Southsea. Check-in is from 14.00 on Monday 4th July and check-out is by 10.00 on the day of departure. All rooms in Rees Hall are en-suite and many have sea views.

Facilities in Rees Hall include:

- Reception open until 23.00 each evening
- Tea and coffee making facilities in each room
- Direct dial telephones in each room
- Licensed bar
- Two guest lounges
- Courtyard garden
- Lift to all floors

Transport

- Car parks – the nearest car park to Rees Hall is Clarence Pier. However there is plenty of metered on-street parking. Use the Portsmouth City Council website for further information on where to park in the city and the charges: www.portsmouth.gov.uk/living/parking.html
- Buses – details of the First Bus Network can be found on their website: www.firstgroup.com/ukbus/southwest/hampshire/map/index.php
- Trains – Portsmouth has two main stations, ‘Portsmouth & Southsea’ and ‘Portsmouth Harbour’. For details of train services, visit: www.nationalrail.co.uk
- Ferries – Wightlink operates a regular catamaran service to the Isle of Wight. All conference delegates and their guests are entitled to a 50% reduction on day trips. The presentation of your conference badge is required to qualify for this special deal. For details, visit: www.wightlink.co.uk
- Coaches – Portsmouth Hard is the main interchange for coach travel to other parts of the country. For details, visit: www.nationalexpress.com
- Taxis
  - Aqua Cars: Tel. 023 9281 8123
  - Citywide: Tel. 023 9283 3333
  - Streamline: Tel. 023 9281 1111

Conference rooms

The conference rooms are split between Portland, Richmond and Lion Gate buildings.

Portland Building is the main centre for registration, plenary and some general sessions, exhibition space, refreshments and meals. Richmond Building has three lecture theatres for general sessions and the Bloodhound talk by Andy Green. The computer labs in Lion Gate Building will be used for most workshop sessions.

Conference ambassadors

Conference ambassadors (in their purple University of Portsmouth T-shirts) will be around the conference venues. Most of the conference ambassadors are undergraduate students from the Department of Mathematics at the University, so they will be able to solve your mathematics problems as well as giving you local advice! They also speak a wide variety of languages if needed. Some are planning teaching careers and will be attending conferences sessions, so do feel free to discuss your own academic interests with them!

Catering

Breakfast will be served in Rees Hall from 07.30 – 09.00 each day.

Lunch will be served in the Portland Atrium / Café areas. There will be a hot lunch provided on Tuesday and Wednesday and a packed lunch to take on your excursion on Thursday. After the close of conference on Friday there will be a cold buffet lunch.

The evening meal on Thursday is the conference dinner on board the HMS Warrior. On Tuesday evening there are plenty of places to eat in Gunwharf Quays during your visit to Spinnaker Tower. After the invited talk on Wednesday there will be drinks and nibbles in the Portland Atrium, after which you are free to revisit Gunwharf Quays for dinner or explore numerous other restaurants in the city.

All morning and afternoon refreshments throughout the conference will be served in the Portland Building Atrium / Café areas.

Further help and advice

The main source of information throughout the conference is the registration desk in Portland Building atrium. The conference ambassadors in their purple University of Portsmouth T-shirts can also provide you with personal help and will be available around the conference venues.

If you need further conference help, please call:
Mobile: 07791 076240
Office: 023 9284 6277

Other useful numbers are:
Rees Hall reception: 023 9284 3869
Emergency assistance: 023 9284 3333
Walking route – Rees Hall to Portland Building

Note that the map on page 9 of this booklet may also be helpful in planning your route.

From Rees Hall (the lower of the two stars marked on the map below) turn right out of the front door, then right again at the junction with the main road (A288 on map) running alongside Rees Hall (Bellevue Terrace / Kings Terrace).

Continue to the roundabout. Go straight over the roundabout into Landport Terrace.

Cross the road at the zebra crossing and go into Ravelin Park through the ornate green gates. Walk straight across the park to the road on the other side (keeping the University Library on your right-hand side).

Outside the main entrance to the University Library cross the road and continue down Burnaby Road. At the traffic lights by the railway bridge go straight over into Burnaby Terrace and go under the railway bridge.

At the bend in the road you will see a number of buildings in front of you – on the right is Dennis Sciama and The Hub, on the left is the brightly coloured Richmond Building (Portsmouth Business School). Looking at Richmond Building, the white building to the right is Portland Building.

Go through the wooden gates into the courtyard and follow the signs for the registration venue in Portland Building Atrium.
Maps

The University in Portsmouth

Portsmouth in Southern England

BY ROAD
Portsmouth to London 75 miles

BY TRAIN
Portsmouth & Southsea to London, Waterloo
1 hour 30 mins

BY ROAD
Portsmouth to Birmingham 145 miles

BY FERRY
Portsmouth & Southsea to Le Havre
1 hour 20 mins

© University of Portsmouth. All rights reserved
Designed and produced by增值服务

Cartography - Open Learning Centre 2001
### Conference timetable

**PO** = Portland Building  
**PA** = Portland Atrium  
**RB** = Richmond Building  
**LG** = Lion Gate Building  
**RH** = Rees Hall  
**ST** = Spinnaker Tower  
**WA** = HMS Warrior

#### Monday 4th July

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.00 – 20.00</td>
<td>Registration</td>
<td>RH</td>
</tr>
</tbody>
</table>

#### Tuesday 5th July

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>09.00 – 11.00</td>
<td>Registration</td>
<td>PA</td>
</tr>
<tr>
<td>11.00 – 11.30</td>
<td>Welcome</td>
<td>PO 1.53</td>
</tr>
<tr>
<td></td>
<td>Professor John Craven</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Vice-Chancellor, University of Portsmouth</strong></td>
<td></td>
</tr>
<tr>
<td>11.30 – 12.30</td>
<td>Introductions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marie Joubert</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>International Scientific Committee</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Michael McCabe and Alison Clark-Wilson</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Local Organising Committee</strong></td>
<td></td>
</tr>
<tr>
<td>12.30 – 13.30</td>
<td>Lunch (hot)</td>
<td>PA</td>
</tr>
<tr>
<td>13.30 – 15.00</td>
<td>Parallel Session 1</td>
<td>PO / RB</td>
</tr>
<tr>
<td>15.00 – 15.30</td>
<td>Tea</td>
<td>PA</td>
</tr>
<tr>
<td>15.30 – 17.00</td>
<td>Parallel Session 2</td>
<td>PO / RB</td>
</tr>
<tr>
<td>18.30 – 19.30</td>
<td>Welcome Reception</td>
<td>PA</td>
</tr>
<tr>
<td></td>
<td>Professor Clive Behagg</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Vice-Chancellor, University of Chichester</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cllr Cheryl Buggy</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lord Mayor of Portsmouth</strong></td>
<td></td>
</tr>
<tr>
<td>19.30 – 23.00</td>
<td>Spinnaker Tower</td>
<td>ST</td>
</tr>
</tbody>
</table>

#### Wednesday 6th July

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>09.00 – 10.00</td>
<td>Plenary</td>
<td>PO 1.53</td>
</tr>
<tr>
<td></td>
<td>Keynote 2 – Professor Paul Drijvers</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Utrecht University</strong></td>
<td></td>
</tr>
<tr>
<td>10.00 – 11.30</td>
<td>Parallel Session 3</td>
<td>PO / RB / LG</td>
</tr>
<tr>
<td>11.30 – 12.00</td>
<td>Coffee</td>
<td>PA</td>
</tr>
<tr>
<td>12.00 – 13.30</td>
<td>Parallel Session 4</td>
<td>PO / RB / LG</td>
</tr>
</tbody>
</table>

#### Thursday 7th July

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>09.00 – 10.30</td>
<td>Parallel Session 6</td>
<td>PO / LG</td>
</tr>
<tr>
<td>10.30 – 11.00</td>
<td>Coffee</td>
<td>PA</td>
</tr>
<tr>
<td>11.00 – 12.00</td>
<td>Plenary</td>
<td>PO 1.53</td>
</tr>
<tr>
<td></td>
<td>Keynote 3 – Colin White</td>
<td></td>
</tr>
<tr>
<td>12.00</td>
<td>Lunch (packed)</td>
<td>PA</td>
</tr>
<tr>
<td>12.40</td>
<td>Excursions depart Portland</td>
<td>PO</td>
</tr>
<tr>
<td>12.45</td>
<td>Excursions depart Rees Hall</td>
<td>RH</td>
</tr>
<tr>
<td>19.00</td>
<td>Pre-dinner drinks on HMS Warrior (plus singing of sea shanties)</td>
<td>WA</td>
</tr>
<tr>
<td>19.45</td>
<td>Conference dinner on HMS Warrior</td>
<td>WA</td>
</tr>
</tbody>
</table>

#### Friday 8th July

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.30 – 10.00</td>
<td>Parallel Session 7</td>
<td>PO / RB / LG</td>
</tr>
<tr>
<td>10.00 – 10.30</td>
<td>Coffee</td>
<td>PA</td>
</tr>
<tr>
<td>10.30 – 12.00</td>
<td>Parallel Session 8</td>
<td>PO / RB / LG</td>
</tr>
<tr>
<td>12.00 – 13.00</td>
<td>Plenary</td>
<td>PO 1.53</td>
</tr>
<tr>
<td></td>
<td>Keynote 4 – Professor Colette Laborde</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>University of Grenoble</strong></td>
<td></td>
</tr>
<tr>
<td>13.00 – 13.15</td>
<td>Closing ceremony and ICTMT11 announcement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alison Clark-Wilson and Michael McCabe</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Local Organising Committee</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marie Joubert</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>International Scientific Committee</strong></td>
<td></td>
</tr>
<tr>
<td>13.15</td>
<td>Lunch and departure</td>
<td>PA</td>
</tr>
</tbody>
</table>
The academic programme of the conference comprises:

- Four plenary keynote talks, one on each day of the conference
- One invited lecture about the world land speed record
- Eight parallel sessions covering the eight conference themes

The eight conference themes are:

AP = Applications
AS = Assessment
CU = Curriculum
IN = Innovation
SE = Student Engagement
SL = Sports and Leisure
SS = Student Support
TD = Teacher Development

Each paper (P) or workshop (W) is identified by a code as follows: Session + Theme + Order + Paper/Workshop. For example:

5CU2P = Session 5 + Theme: CUrriculum + 2nd Paper

All papers are of 20 minutes’ duration plus five minutes of questions. Session chairs will be maintaining strict control over time-keeping to allow time for changeovers!

All workshops are of 1½ hours’ duration. The plenary keynotes and invited lecture are for 1 hour.

### Academic programme

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Tuesday 11.30 – 12.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum</td>
<td>5PL1 (Professor Richard Noss)</td>
</tr>
<tr>
<td>Room: PO 1.53</td>
<td>What mathematics does technology make learnable?</td>
</tr>
</tbody>
</table>

### Tuesday 11.30 – 12.30

#### Plenary 1 – Keynote

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Tuesday 13.30 – 15.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP = Applications</td>
<td>1AP1P (Gregory D. Foley)</td>
</tr>
<tr>
<td>Assessment</td>
<td>Modeling and spatial reasoning</td>
</tr>
<tr>
<td>Room: PO 0.27</td>
<td>1AP2P (Thomas Borys)</td>
</tr>
<tr>
<td>Applications</td>
<td>Using cryptology to teach fundamental ideas of mathematics</td>
</tr>
<tr>
<td>Assessment</td>
<td>1AP3P (Nikolay M. Salnikov)</td>
</tr>
<tr>
<td>Assessment</td>
<td>Some approaches to advanced mathematical education in a multiprofile lyceum</td>
</tr>
</tbody>
</table>

### Tuesday 13.30 – 15.00

#### Parallel Session 1 – Papers

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Tuesday 13.30 – 15.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>1CU1P (L. Aszalos, M. Bako and T. Mihalydeak)</td>
</tr>
<tr>
<td>Curriculum</td>
<td>Wiki as a textbook?</td>
</tr>
<tr>
<td>Room: PO 1.21</td>
<td>1CU2P (Alexandre Borovik)</td>
</tr>
<tr>
<td>Curriculum</td>
<td>The strange fate of abstract thinking</td>
</tr>
<tr>
<td>Room: PO 1.21</td>
<td>1CU3P (Oliver Bowles)</td>
</tr>
<tr>
<td>Curriculum</td>
<td>A “future” curriculum in a “3rd Industrial Revolution”?</td>
</tr>
</tbody>
</table>

### Innovation

<table>
<thead>
<tr>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1SE1P (Nicole Scherger)</td>
</tr>
<tr>
<td>The redesign of a quantitative literacy class: student responses to a lab-based format</td>
</tr>
<tr>
<td>1SE2P (Tyger Yegamaram)</td>
</tr>
<tr>
<td>Using technology to improve the conceptual understanding of three-dimensional geometry in primary school learners</td>
</tr>
<tr>
<td>1SE3P (Aija Cunska)</td>
</tr>
<tr>
<td>Attractive mathematical induction</td>
</tr>
</tbody>
</table>

### Sports and Leisure

<table>
<thead>
<tr>
<th>Sports and Leisure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1SL1P (Ian Galloway)</td>
</tr>
<tr>
<td>Exploring impulse and momentum using handheld technology</td>
</tr>
<tr>
<td>1SL2P (Michael McCabe, Ian Galloway and Chris Blow)</td>
</tr>
<tr>
<td>Extreme CAS, the Bloodhound SuperSonic Car and the world land speed record – taking computer algebra to the limit</td>
</tr>
<tr>
<td>1SL3P (Michael McCabe, Graham Bryant, David Harris, Dave Briggs, Steve Knight, Carol Bryan and Robin Gorman)</td>
</tr>
<tr>
<td>Research informed teaching projects in pro-am astronomy with Maple, MATLAB and GeoGebra</td>
</tr>
</tbody>
</table>

### Student Support

<table>
<thead>
<tr>
<th>Student Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1SS1P (David Driver)</td>
</tr>
<tr>
<td>Student problem solving achievement in a CAS environment</td>
</tr>
<tr>
<td>1SS2P (Tom Button and Richard Lissaman)</td>
</tr>
<tr>
<td>Using live online tutoring to provide access to higher level mathematics for pre-university students</td>
</tr>
</tbody>
</table>

### Teacher Development

<table>
<thead>
<tr>
<th>Teacher Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1TD1P (Elissavet Kalogeria, Chronis Kynigos and Giorgos Psycharis)</td>
</tr>
<tr>
<td>Teachers’ scenarios with the use of digital tools in mathematics as a means of redefining the teacher-curriculum relationship</td>
</tr>
<tr>
<td>1TD2P (Sirje Pihlap)</td>
</tr>
<tr>
<td>Teachers’ attitudes and beliefs about using ICT in teaching mathematics</td>
</tr>
<tr>
<td>1TD3P (Sue de Pomerai and Sharon Tripconey)</td>
</tr>
<tr>
<td>Using live online technology to engage mathematics teachers in professional development</td>
</tr>
</tbody>
</table>
### Applications

**Room: PO 0.27**

- **2AP1P (Hasan Akyuzlu)**
  - Risk-based decision-making by 15-year-old students
- **2AP2P (Ali Jafarabadi)**
  - The indirect impact of using modern technology, especially the calculator and the Internet, in reducing mathematics anxiety

### Assessment

**Room: RB LT2**

- **WORKSHOP (1½ hours)**
  - **2AS1W (Sue Milne and Leslie Fletcher)**
    - Seizing the opportunity of using online learning for UK mathematics support

### Curriculum

**Room: PO 1.21**

- **2CU1P (Christian Bokhove and Paul Drijvers)**
  - Design principles for an online algebra course
- **2CU2P (Lianghuo Fan)**
  - Reviewing the impact of technology on the development of a mathematics curriculum from two cases in China and Singapore
- **2CU3P (Dragana Martinovic and Zekeriya Karadag)**
  - Dynamic and interactive mathematics learning environments

### Innovation

**Room: PO 1.20**

- **2IN1P (Antonín Janěšák and Jarmila Novotná)**
  - Theatrical or efficient use of ICT in mathematics teaching?
- **2IN2P (Marie Joubert)**
  - Using Grand Challenges within technology enhanced learning (TEL) to frame research and practice in mathematics teaching with technology
- **2IN3P (Hans-Georg Weigand)**
  - New technologies in the next decade

### Student Engagement

**Room: RB LT3**

- **2SE1P (Barbara Schmidt-Thieme, Hans-Georg Weigand and Andreas Bauer)**
  - Change of and transfer between representations – especially between digital and paper-and-pencil representations
- **2SE2P (Alasdair McAndrew)**
  - Using open-source software to teach tertiary mathematics
- **2SE3P (Rita Desfitri)**
  - Children’s activities regarding mental mathematics at lower middle school

### Sports and Leisure

**Room: RB LT3**

- **2IN1W (Cindy Hunt)**
  - Wirelessly connecting TI-Nspire CX handhelds in the classroom to share mathematical ideas

### Student Support

**Room: PO 0.36**

- **2SS1P (Rein Prank)**
  - Analysing T-algebra solution files to improve student support
- **2SS2P (Ornella Robutti, Ferdinando Arzarello and Francesca Ferrara)**
  - Mathematical modelling with technology: the dynamic role of representations
- **2SS3P (Gabriel Katz and Vladimir Nodelman)**
  - The visualisation of multivalued functions

### Teacher Development

**Room: PO 1.53**

- **2TD1P (Rosalyn Hyde and Julie-Ann Edwards)**
  - Pre-service teachers’ understandings of learning to use information technologies in secondary mathematics teaching
- **2TD2P (Reda Abu-Elwari)**
  - How prospective teachers’ use of the Cabri II environment can have an effect on the posing of fractal problems
- **2TD3P (Jon D. Davis)**
  - Prospective teachers’ curricular interactions and beliefs with regard to computer algebra systems
### Theme/room

**Wednesday 09.00 – 10.00**  
Plenary 2 – Keynote

**Teacher Development**
PL2 (Professor Paul Drijvers)  
Tools and teachers

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Wednesday 10.00 – 11.30</th>
<th>Parallel Session 3 – Papers / workshops</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications</strong></td>
<td></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td>Room: LG 0.14a</td>
<td></td>
<td>3AP1W (Sarah Chapman)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On your bike: practical application of mathematics</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td></td>
<td>3AS1P (Mako E. Haruta)</td>
</tr>
<tr>
<td>Room: RB LT2</td>
<td></td>
<td>Good calculus problems for the TI-89 calculator and an online homework system: a decade of use in a university mathematics department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3AS2P (Giles Tewkesbury, Simon Chester and David Sanders)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An overview of approaches for producing mathematics question banks and the automatic creation of numerical calculation questions in Questionmark Perception using macros in Excel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3AS3P (Moshe Leiba and Rafi Nachmias)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessing mathematical problem solving behavior in web-based environments using log file analysis</td>
</tr>
<tr>
<td><strong>Curriculum</strong></td>
<td></td>
<td>3IN1P (Douglas Butler)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Online resources for the busy teacher</td>
</tr>
<tr>
<td><strong>Innovation</strong></td>
<td></td>
<td>3IN2P (Timothy Collinson)</td>
</tr>
<tr>
<td>Room: PO 1.20</td>
<td></td>
<td>Mobile apps in mathematics education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3IN3P (Duncan Samson, Helmut Linneweber-Lammerskitten and Marc Schäfer)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VITALmaths – a bank of video clips for autonomous learning of mathematics</td>
</tr>
</tbody>
</table>

---

### Student Engagement

**Wednesday 10.00 – 11.30**  
Parallel Session 3 – Papers / workshops

**Student Engagement**

| Room: RB LT3 |  |
|  | 3SE1P (Ilona Kletskin) |
|  | Teaching mathematics online: creating a rich learning environment |
|  | 3SE2P (Jean McGivney-Burelle) |
|  | Contemporary mathematics: It's starting to click |

### Sports and Leisure

**Wednesday 10.00 – 11.30**  
Parallel Session 3 – Papers / workshops

**Sports and Leisure**

| Room: PO 0.36 |  |
|  | 3SS1P (Susana Carreira and Nélia Amado) |
|  | Home technologies: how do they shape beyond-school mathematical problem solving activity? |
|  | 3SS2P (Nicole Panorkou and Dave Pratt) |
|  | Designing windows for researching students’ experiences of dimension |
|  | 3SS3P (Tadeusz Ratusiński) |
|  | Didactic computer games as a tool for discovering reductive reasoning |

### Teacher Development

**Wednesday 10.00 – 11.30**  
Parallel Session 3 – Papers / workshops

**Teacher Development**

<p>| Room: LG 0.07 |  |
|  | WORKSHOP (1½ hours) |
|  | 3TD1W (Helen Humble and Dave Eacott) |
|  | Around the world in 60 minutes using Google Earth: helping secondary school mathematics learners to develop their understanding of bearings |
| Room: LG 0.14b |  |
|  | WORKSHOP (1½ hours) |
|  | 3TD2W (Greg Wilson and Randall Jull) |
|  | Mathematics in the palm of their hands: developing the use of iPods and other mobile technology to support secondary school mathematics learners |</p>
<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Academic programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wednesday 12.00 – 13.30 Parallel Session 4 – Papers / workshops</td>
<td></td>
</tr>
<tr>
<td>Applications</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4AP1W (Pip Huyton)</td>
</tr>
<tr>
<td></td>
<td><em>A classroom activity – just how fast does ‘Bloodhound’ go?</em></td>
</tr>
<tr>
<td>Assessment</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td>Curriculum</td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4IN1W (Marie Joubert)</td>
</tr>
<tr>
<td></td>
<td><em>Technology for mathematics teaching: taking the concerns and interests of practitioners to inform a research agenda for technology enhanced learning</em></td>
</tr>
<tr>
<td>Student Engagement</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4SL1W (Angela Jones and Val Brooks)</td>
</tr>
<tr>
<td></td>
<td><em>Cars – Maths in Motion</em></td>
</tr>
<tr>
<td>Sports and Leisure</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4SS1P (Eleonora Faggiano and Rosa Laura Ancona)</td>
</tr>
<tr>
<td></td>
<td><em>Interactive white boards (IWBs) to support mathematical learning: current practices and open problems</em></td>
</tr>
<tr>
<td>Student Support</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4SS2P (Samer Habre)</td>
</tr>
<tr>
<td></td>
<td><em>Improving understanding in ordinary differential equations through writing in a dynamic environment</em></td>
</tr>
<tr>
<td></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4SS3P (Roy Williams)</td>
</tr>
<tr>
<td></td>
<td><em>Benchmarking and mastery: integrating teaching, learning and assessment</em></td>
</tr>
<tr>
<td>Teacher Development</td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4TD1P (Ahmad Fadzillah Hanafiah)</td>
</tr>
<tr>
<td></td>
<td><em>Teachers’ beliefs in the use of the calculator in Brunei primary schools mathematics</em></td>
</tr>
<tr>
<td></td>
<td>4TD2P (Zafer F. Alshehri)</td>
</tr>
<tr>
<td></td>
<td><em>Technology-integrated mathematics education in the Saudi context</em></td>
</tr>
<tr>
<td></td>
<td>4TD3P (Matija Lokar)</td>
</tr>
<tr>
<td></td>
<td><em>Video tutorials in teaching mathematics</em></td>
</tr>
<tr>
<td></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td></td>
<td>4TD1W (Randall Jull and Chris Martin)</td>
</tr>
<tr>
<td></td>
<td><em>Three-dimensional geometry in a virtual 3D world: using Google SketchUp to support secondary school mathematics learners to appreciate three-dimensional shapes, plans and elevations</em></td>
</tr>
<tr>
<td></td>
<td>4TD2W (Dave Eacott and Lucia Threadgill)</td>
</tr>
<tr>
<td></td>
<td><em>Lights, camera, mathematics: how the use of digital cameras can support secondary school mathematics learners</em></td>
</tr>
<tr>
<td></td>
<td>4TD3W (Jane Woods)</td>
</tr>
<tr>
<td></td>
<td><em>Bring interaction and flexibility to your classroom!</em></td>
</tr>
</tbody>
</table>
### Academic programme

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Wednesday 14.30 – 16.00</th>
<th>Parallel Session 5 – Papers / workshops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>WORKSHOP (1½ hours)</td>
<td></td>
</tr>
<tr>
<td>Room: PO 1.33</td>
<td>5AP1W (Peter Ransom)</td>
<td>Bruneil's bridges, boats, books and box</td>
</tr>
<tr>
<td>Assessment</td>
<td>5CU1P (Dirk Brockmann-Behnsen)</td>
<td>A long-term educational treatment using dynamic geometry software</td>
</tr>
<tr>
<td>Curriculum</td>
<td>5CU2P (Margarida Oliveira and Suzana Nápoles)</td>
<td>Old proofs, new technologies</td>
</tr>
<tr>
<td>Room: PO 1.21</td>
<td>5CU3P (Othman Ali Alghtani and Nasser Elsayed Abdelhamid)</td>
<td>Using technological approaches in teaching mathematics: the perspectives of mathematics teachers</td>
</tr>
<tr>
<td>Innovation</td>
<td>5IN1P (Jana Vavøinová)</td>
<td>Mobile computer laboratory for teaching mathematics</td>
</tr>
<tr>
<td>Room: PO 1.20</td>
<td>5IN2P (Vaclav Nadvornik)</td>
<td>Video tutorials for supporting mathematics home studying</td>
</tr>
<tr>
<td>Student Engagement</td>
<td>5IN3P (Ana Isabel Sacristan, Sandra Evely Parada and Lourdes Miranda)</td>
<td>The problem of the digital divide for mathematics teachers in developing countries</td>
</tr>
<tr>
<td>Room: LG 0.07</td>
<td>WORKSHOP (1½ hours)</td>
<td>How can ICT motivate pupils to want to learn a difficult subject?</td>
</tr>
<tr>
<td>Sports and Leisure</td>
<td>5SL1P (André Heck, Daan Knobbe, Nic Nijdam, Onne Slooten and Peter Uylings)</td>
<td>Exploring swinging and aerial movements</td>
</tr>
<tr>
<td>Room: PO 1.26</td>
<td>5SL2P (Dot French)</td>
<td>Learning the ropes: how the technology of sailing and seamanship can enhance the teaching and learning of mathematics</td>
</tr>
<tr>
<td>Student Support</td>
<td>5SL3P (Ya Huang, Jos Darling and Richard Joiner)</td>
<td>Adapting the game-based learning software Racing Academy for use in engineering education</td>
</tr>
<tr>
<td>Teacher Development</td>
<td>5TD1P (Gilles Aldon)</td>
<td>Dynamic representation of mathematics: the case of statistics</td>
</tr>
<tr>
<td>Room: PO 1.53</td>
<td>5TD2P (Andreas Bauer, Hans-Georg Weigand, Caroline Bardini, Jacques Salles and Marie-Claire Combes)</td>
<td>Using multiple representations in the classroom – the EdUmatics project</td>
</tr>
<tr>
<td>Room: LG 0.14</td>
<td>WORKSHOP (1½ hours)</td>
<td>Matching, speed dating, human sculptures and curve stitching: developing secondary school learners’ understanding of line graphs using graphical calculators and digital cameras</td>
</tr>
<tr>
<td>Room: LG 0.14</td>
<td>5TD3P (Bärbel Barzel and Ralf Erens)</td>
<td>Starting to work with ICT</td>
</tr>
<tr>
<td>Room: PO 1.37</td>
<td>WORKSHOP (1½ hours)</td>
<td>A geometry tool for everyone: using GeoGebra software to support secondary school learners with understanding geometry and algebra</td>
</tr>
<tr>
<td>Room: PO 1.37</td>
<td>5TD3W (Ghada Nakhla)</td>
<td>The impact of technology on the way mathematics and statistics have been taught in the last decade</td>
</tr>
<tr>
<td>Theme/room</td>
<td>Wednesday 16.30 – 17.30</td>
<td>Meetings and discussions</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Assessment</td>
<td>M1 (Michael McCabe – convener) University of Portsmouth, UK</td>
<td>e-Assessment on trial: defence and prosecution</td>
</tr>
<tr>
<td>Room: LG 0.07</td>
<td></td>
<td>There are a wide range of tools and resources available for the e-assessment of mathematics, including QuestionMark Perception, MapleTA, i-assess, WileyPlus, MyMathLab, DEWIS, STACK and FETLAR. Some are commercial products; others are open source. Some have a wide selection of question banks available; others do not. Some cope well with mathematical questions and answers; others do not. Some are simple to use; others require significant programming. Defendants of e-assessment will have five minutes each to present their preferred solution, which will be available for trial. Come along as a witness, prosecutor, judge or member of the jury and join the discussion!</td>
</tr>
<tr>
<td></td>
<td>Defendants on trial will include:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colin Steele / Chris Sangwin STACK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alan Irving MyMathLab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sam Crowe WileyPlus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Michael McCabe MapleTA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Giles Tewkesbury / Roy Williams Questionmark Perception</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Martin Greenhow Maths e.g.</td>
<td></td>
</tr>
<tr>
<td>Teacher Development</td>
<td>M2 (Alison Clark-Wilson et al) University of Chichester, UK</td>
<td>EdUmatics project meeting</td>
</tr>
<tr>
<td>Room: PO 1.20</td>
<td></td>
<td>A meeting for the partners involved in the EU Comenius funded project ‘EdUmatics’.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open meeting</td>
<td>M3 (Duncan Lawson)</td>
<td>Meet the Editors of <em>Teaching Mathematics and its Applications</em>.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In this open meeting, conference delegates are welcome to meet the Journal’s Editors, Professor Duncan Lawson and Dr Chris Sangwin, to gain an insight into the Journal’s scope and what the Editorial Board looks for within its successful submissions. Please see page 106 for details of the paper submission process.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Wednesday 18.00 – 19.00</th>
<th>Invited lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Wing Commander Andy Green D.Sc. (Portsmouth) RAF Fighter Pilot</td>
<td></td>
</tr>
<tr>
<td>Room: RB LT1</td>
<td></td>
<td>The Bloodhound supersonic car and the world land speed record: an adventure in mathematics and technology</td>
</tr>
</tbody>
</table>
## Academic programme

### Thursday 09.00 – 10.30

**Parallel Session 6 – Papers / workshops**

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: PO 1.21</strong></td>
<td>6AP1W (Adrian Oldknow and Linda Tetlow) Integrating STEM and inspiring STEM activities with TI-Inspire technology</td>
</tr>
<tr>
<td></td>
<td>6AP2W (Adrian Oldknow and Linda Tetlow) Integrating STEM and inspiring STEM activities with TI-Inspire technology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: RB LT2</strong></td>
<td>6AS1P (Chris Sangwin) An assessment package for Maxima</td>
</tr>
<tr>
<td></td>
<td>6AS2P (Leslie Fletcher and Sue Milne) FETLAR and beyond: the MSOR's OER project and what happened afterwards (so far)</td>
</tr>
<tr>
<td></td>
<td>6AS3P (Martin Greenhow) Computer-aided assessment of mathematics and statistics for first year economics students</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Curriculum</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: PO 1.21</strong></td>
<td>6CU1P (Fernando Luis Santos and António Domingos) A technologically enhanced mathematics curriculum for teacher education: an exploratory study</td>
</tr>
<tr>
<td></td>
<td>6CU2P (Zhonghong Jiang) Implementing a dynamic geometry approach in classrooms</td>
</tr>
<tr>
<td></td>
<td>6CU3P (Daniela Velichová) Interactive cognitive tools in mathematics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovation</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: PO 1.21</strong></td>
<td>6SL1P (André Heck and Peter Uylings) A jump forwards with mathematics and physics</td>
</tr>
<tr>
<td></td>
<td>6SL2P (Carol L. Robinson) Using sport to engage and motivate students to learn mathematics</td>
</tr>
<tr>
<td></td>
<td>6SL3P (Chris Mills) Introducing basic mathematical modelling concepts using sporting applications in MATLAB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Student Support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Support</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: PO 0.36</strong></td>
<td>6SS1P (Víctor Larios-Osorio) The influence of DGS on the production of geometrical justifications</td>
</tr>
<tr>
<td></td>
<td>6SS2P (Marzena Plachciok) Using interactive GeoGebra-based educational assistance for introducing concepts connected with averages – preliminary research results</td>
</tr>
<tr>
<td></td>
<td>6SS3P (Alla Stolyarevska) Some aspects of using the GeoGebra software package in mathematics teaching</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Teacher Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teacher Development</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: PO 1.53</strong></td>
<td>6TD1P (Muharrem Aktümen, Zekeriya Karadag and Tolga Kabaca) Cognitive development of pre-service teachers: misconception, cognitive conflict and conceptual understanding</td>
</tr>
<tr>
<td></td>
<td>6TD2P (Ana Isabel Sacristan, Ivonne Sandoval and Nadia Gil) Teachers engage in peer tutoring and course design inspired by a professional training model for incorporating technologies for mathematics teaching in Mexican schools</td>
</tr>
<tr>
<td></td>
<td>6TD3P (Alison Clark-Wilson) Researching teachers’ experiences of introducing multi-representational handheld technology – what and how do they learn?</td>
</tr>
</tbody>
</table>

### Thursday 11.00 – 12.00

**Plenary 3 – Keynote**

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Sports and Leisure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sports and Leisure</strong></td>
<td>WORKSHOP (1½ hours)</td>
</tr>
<tr>
<td><strong>Room: PO 1.53</strong></td>
<td>PL3 (Colin White) The mathematics of sports projectiles: a tool to stimulate student engagement and motivation</td>
</tr>
</tbody>
</table>

---

26 University of Portsmouth

10th International Conference on Technology in Mathematics Teaching
### Academic programme

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Friday 08.30 – 10.00</th>
<th>Parallel session 7 – Papers / workshops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>7AS1P (Alan Irving and Adam Crawford)</td>
<td>Automated assessment and feedback on MATLAB assignments in computational mathematics</td>
</tr>
<tr>
<td>Assessment</td>
<td>7AS2P (Jeremy Levesley, Sally Barton, Chris Sangwin and Bill Foster)</td>
<td>E-assessment in mathematics and statistics</td>
</tr>
<tr>
<td>Room: RB LT2</td>
<td>7AS3P (Colin Steele)</td>
<td>Computerised assessment and student attitudes</td>
</tr>
<tr>
<td>Curriculum</td>
<td>WORKSHOP (1½ hours)</td>
<td>7CU1W (Jim Noble)</td>
</tr>
<tr>
<td>Room: LG 0.07</td>
<td>Animated questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7IN1P (Allan Duncan)</td>
<td>Inspired connections in mathematics lessons – new pedagogy for new technology</td>
</tr>
<tr>
<td>Innovation</td>
<td>7IN2P (Pao-Chen Shih, Ju-Ling Chen, Kuo-En Chang and Yao-Ting Sung)</td>
<td>The effect of using Google SketchUp when teaching fifth graders about the surface area of composite solids</td>
</tr>
<tr>
<td>Room: PO 1.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Academic programme

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Student Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7SE1P (Tran Kien Minh)</td>
</tr>
<tr>
<td></td>
<td>Learning about functions within a geometrical and symbolic software environment: a two-year study</td>
</tr>
<tr>
<td></td>
<td>7SE2P (Alasdair McAndrew)</td>
</tr>
<tr>
<td></td>
<td>Investigating numerical quadrature rules with a computer algebra system</td>
</tr>
<tr>
<td></td>
<td>7SE3P (Tran Kiem Minh)</td>
</tr>
<tr>
<td></td>
<td>Learning about functions within a geometrical and symbolic software environment: a two-year study</td>
</tr>
</tbody>
</table>

### Sports and Leisure

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Student Support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7SS1P (Mikio Miyazaki, Taro Fujita, Youichi Murakami, Naoki Baba and Keith Jones)</td>
</tr>
<tr>
<td></td>
<td>Secondary school mathematics learners constructing geometric flow-chart proofs with a web-based learning support system</td>
</tr>
<tr>
<td></td>
<td>7SS2P (Magdalena Kucio)</td>
</tr>
<tr>
<td></td>
<td>The role of interactive assistance in discovering geometrical theorems at secondary school</td>
</tr>
<tr>
<td></td>
<td>7SS3P (Petra Suryinkova)</td>
</tr>
<tr>
<td></td>
<td>3D modelling in teaching and learning geometry</td>
</tr>
</tbody>
</table>

### Teacher Development

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Teacher Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7TD1P (Sue Brown)</td>
</tr>
<tr>
<td></td>
<td>Improving middle school teachers’ questioning strategies using video</td>
</tr>
<tr>
<td></td>
<td>7TD2P (Maha Abboud-Blanchard)</td>
</tr>
<tr>
<td></td>
<td>Mathematics and technology: exploring teacher educators’ professional development</td>
</tr>
<tr>
<td></td>
<td>7TD3P (Angela Jones)</td>
</tr>
<tr>
<td></td>
<td>Working in the 21st century – moving teacher professional development online</td>
</tr>
</tbody>
</table>
### Parallel session 8 – Papers / workshops

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Friday 10.30 – 12.00</th>
</tr>
</thead>
</table>
| Applications | 8AP1P (Maria Joana Torres and Ricardo Severino)  
Order and chaos: interactive computational activities for the classroom |
| Applications | 8AP2P (Yakov Zinder and Tim Langtry)  
Interactive self-paced learning using Mathematica |
| Assessment | 8AS1P (Peter Rowlett)  
Mathematics lecturers' views of the advantages and disadvantages of electronic and traditional assessment |
| Assessment | 8AS2P (Tim Lowe)  
Online support for a distance-learning mathematics course |
| Assessment | 8AS3P (Khoon Yoong Wong, Kwang-Shin Oh, Qiu Ting Yvonne Ng, Beng Chong Teo and Kalimuthu Kanchiyappan)  
Linking IT-based semi-automatic marking of student mathematics responses to pedagogical objectives |

<table>
<thead>
<tr>
<th>Curriculum</th>
<th>Room: PO 1.21</th>
</tr>
</thead>
</table>
| 8CU1P (Jean-Baptiste Lagrange and Giorgos Psycharis)  
Combining theoretical frameworks to investigate the potential of computer environments offering integrated geometrical and algebraic representations |
| 8CU2P (Sandra Nobre, Nélia Amado, Susana Carreira, João Pedro da Ponte)  
Solving contextual problems with the spreadsheet as an environment for the development of algebraic thinking |
| 8CU3P (Duduzile Sibaya, David Clarke and Patrick Sibaya)  
The use of technology in teaching secondary school mathematics |

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Room: LG 0.07</th>
</tr>
</thead>
</table>
| WORKSHOP (1½ hours)  
8IN1W (Nicola Bilsby)  
Developing mathematical understanding with ICT in the classroom |

| Student Engagement | |
| Sports and Leisure | |
| Student Support | |
| Teacher Development | |

<table>
<thead>
<tr>
<th>Theme/room</th>
<th>Friday 12.00 – 13.00</th>
</tr>
</thead>
</table>
| Student Support | PL4 (Professor Colette Laborde)  
The nature and role of feedback in ICT-based tasks for learning mathematics |

<table>
<thead>
<tr>
<th>Room: PO 1.53</th>
</tr>
</thead>
</table>
| PL4 (Professor Colette Laborde)  
The nature and role of feedback in ICT-based tasks for learning mathematics |
Invited lecture – Abstract and biography

The Bloodhound supersonic car and the world land speed record: an adventure in mathematics and technology

Wing Commander Andy Green D.Sc. (Portsmouth)
RAF Fighter Pilot

18.00 – 19.00, Wednesday 6th July, Richmond Building RB LT1

Abstract

Andy Green D.Sc. (Portsmouth) will be talking about the Bloodhound supersonic car (www.bloodhoundssc.com) in which he will be attempting to raise his own world land speed record to over 1000 mph. The primary objective of the project is to create a national surge in the popularity of Science, Technology, Engineering and Mathematics (STEM) subjects through the creation of an iconic project requiring extreme research and technology whilst simultaneously providing the means to enable the student population to join in the adventure. Andy Green is still the only person ever to break the sound barrier on land and has for 14 years held the title of the World’s Fastest Mathematician.

Andy Green will explain how mathematics and technology have enabled Bloodhound to be developed. The key objectives of the Bloodhound project are to:

- create a national surge in the popularity of Science, Technology, Engineering and Mathematics (STEM) subjects;
- create an iconic project requiring extreme research and technology whilst simultaneously providing the means to enable the student population to join in the adventure;
- achieve the first 1000 mph record on land; and
- generate very substantial and enduring media exposure for sponsors.

Biography

Andy Green gained a first class mathematics degree from the University of Oxford and is currently a full-time RAF fighter pilot and Wing Commander. In October 1997 he drove Thrust SSC at a speed of 763 mph in the Black Rock Desert in Nevada, making it the first car to officially break the sound barrier. He was awarded the Order of the British Empire (OBE) in the 1997 Queen’s New Year Honours and the Segrave Trophy that same year. In 1998 the University of Portsmouth awarded him an honorary degree in recognition of his achievements with the Thrust SSC team.

Biography of Richard Noble

As an RAF fighter pilot Andy Green may be called up for active service at very short notice. In this event Richard Noble, the overall director and driving force behind the Bloodhound project, has kindly agreed to present the invited lecture. Richard Noble himself was the holder of the land speed record from 1983 to 1997 and was project director for ThrustSSC the supersonic car, which Andy Green drove to the world land speed record in 1997. Richard Noble is the holder of numerous awards including the Order of the British Empire (OBE) in 1983 and an honorary doctorate from the University of Portsmouth in 1998. He is a visiting professor at the University of West England in Bristol, as well as being a “challenger, entrepreneur, record breaker and motivational speaker”.

Invited lecture – Abstract and biography
**KEYNOTE 1**

**What mathematics does technology make learnable?**

Professor Richard Noss  
London Knowledge Lab, Institute of Education, University of London, UK

11.30 – 12.30, Tuesday 5th July, Portland Building, Lecture Theatre 1.53

**Abstract**

Much of our time as mathematics educationalists is spent in considering how to enhance the teaching and learning of knowledge that has been subject only to small perturbations over the last century. The development of these curricula was formed by the needs of a pre-computational era, with inert technologies and forms of representation that are now largely anachronistic; representations that are finely tuned for doing mathematics in a pre-computational age, but not generally well adapted for learning it. Drawing on research I have undertaken over the last decade, I will consider how the ubiquity of digital representations affords the opportunity to re-evaluate what becomes possible to express and to design, and how we might rethink our notions of complexity, hierarchy and learnability.

**Biography**

Richard Noss is co-director of the London Knowledge Lab, an interdisciplinary collaboration between learning scientists at the Institute of Education (IOE) and computing scientists at Birkbeck, two colleges of the University of London. He is Professor of Mathematics Education at the IOE, and holds a Masters degree in pure mathematics and a PhD in mathematical education. He was co-founder and deputy scientific manager of Kaleidoscope, the European network of excellence for technology enhanced learning, and is currently the director of the Technology Enhanced Learning Research Programme, funded jointly by the Economic and Social Research Council and the Engineering and Physical Sciences Research Council.

Richard has directed or co-directed some 20 research projects, all of which have focused on some mix of technology enhanced learning, mathematics, and – for the last ten years or so – workplace learning. He currently directs the MiGen project, which seeks to design and implement an intelligent learning environment for improving 11–14 year-old students’ learning of mathematical generalisation. Richard has edited and authored some 120 scholarly articles and six books, including *Windows on Mathematical Meanings: Learning Cultures and Computers* (co-authored with Celia Hoyles) in 1996. His most recent book (co-authored with Hoyles, Kent and Bakker), *Improving Mathematics at Work*, questions the mathematical knowledge and skills that matter in the 21st century world of work, and studies how the use of mathematics in the workplace is evolving in the rapidly-changing context of new technologies and globalisation.


---

**KEYNOTE 2**

**Tools and teachers**

Professor Paul Drijvers  
Freudenthal Institute for Science and Mathematics Education, Utrecht University, Netherlands

09.00 – 10.00, Wednesday 6th July, Portland Building, Lecture Theatre 1.53

**Abstract**

Nowadays, mathematics teachers are confronted with a myriad of technological tools and resources that are available through technological means and through the Internet in particular. However, teachers may perceive difficulties in making use of these new opportunities. A new repertoire of teaching techniques, exploiting the available tools, is to be developed. In order to help teachers to benefit from technology in everyday mathematics teaching, therefore, it is important to have more knowledge about the technological tools with their strengths, weaknesses and didactical functions, as well as about new teaching techniques that may emerge in the technology-rich classroom.

In this presentation, we will first reflect on the nature of tools and on the didactical functions of technological tools for mathematics education in particular. Next we will discuss different means of exploiting such tools, potential. With the notion of instrumental orchestration as a theoretical lens, this includes the identification of different types of teaching techniques, and the recognition of the links between teachers’ preferences for these orchestrations and their views on mathematics, mathematics education and the role of technology therein.

**Biography**

Paul Drijvers is a researcher at the Freudenthal Institute for Science and Mathematics Education, Faculty of Science, Utrecht University, the Netherlands. His fields of research interest and expertise include technology in mathematics education, upper secondary mathematics curricula, pre-service and in-service teacher training, and algebra education. Recent work has focused on the design of interactive online resources for mathematics teaching and learning, and on the ways in which teachers exploit these resources. Other foci include Dutch national assessment, the editing of a handbook on mathematics education for teacher education, and a book on algebra education.
KEYNOTE 3

The mathematics of sports projectiles: a tool to stimulate student engagement and motivation

Colin White
Author and Presenter, formerly of the University of Portsmouth, UK

11.00 – 12.00, Thursday 7th July, Portland Building, Lecture Theatre 1.53

Abstract

In this keynote presentation Colin demonstrates how students readily engage in mathematical activities when the simple expedient of a familiar everyday artefact is employed.

The humble ball can be used to demonstrate and support many mathematical and mechanical dynamic theories: from the simple application of Newton's Laws to predict the flight of the ball through the air, to the more advanced concepts of gyroscopy, Magnus and Coriolis forces, and even the second-order linked differential equations that more accurately describe real-world projectile motion.

Many students have an innate interest in sport and the associated equipment, and are fascinated to see their intuitive game experiences reinforced by mathematical modelling equivalences. Even those students of a more sedentary inclination appreciate the potential of the ball as an adaptable and versatile piece of scientific apparatus.

In this presentation Colin will demonstrate, using a variety of sports equipment, a wide range of sports dynamic models. He will highlight such crucial issues as:

- Optimum rugby conversion and soccer penalty kicking strategies.
- How to play tennis safely in the nude (often the range will actually increase).
- How shot put range is affected by the sports stadium location and direction of throw.
- The best throwing technique to be used in a competitive iPod throwing contest.
- The chances of survival if your parachute fails while in freefall (even more essential).
- How to play tennis safely in the nude (essential for the enthusiastic sports naturist).
- How shot put range is affected by the sports stadium location and direction of throw.
- The best throwing technique to be used in a competitive iPod throwing contest.

Sports players are often highly charged emotive beings and, as such, they seem particularly susceptible to a range of myths and legends surrounding their sport. A key aspect of this presentation will be to mathematically debunk several of these ‘perceived wisdoms’. Examples include:

- The ‘late swing’ of a cricket ball (no such thing).
- The reduction in range when shooting a ball into a headwind (often the range will actually increase).
- Balls can never bounce higher than they are dropped (yes they sometimes can).
- The optimum impact point by a snooker cue onto the cue ball (seldom the centre).

Those who have seen Colin perform know that they are in for a presentation that is lively, informative, entertaining and studded with humorous anecdotes.

Biography

Colin White is one of the UK’s foremost authorities on sports projectile motion and modelling. Following a career in military ballistic modelling he worked for ten years as a Senior, then Principal, Lecturer in the Department of Sport and Exercise Science at the University of Portsmouth where he taught all aspects of sports equipment design, modelling and manufacture.

In August 2010 his book, Projectile Dynamics in Sport – Principles and Applications was published by Routledge and is now considered the definitive authoritative text on all things that are kicked, hit or thrown into motion, in the name of sport. Colin has lectured, presented and otherwise performed to audiences of all ages, abilities and interests and at a wide range of venues including presentations for radio and television. You can follow his ideas (occasionally relating to projectiles and sport) on twitter.com/whitec and he would love you to read and respond on his BallsBlog at: http://userweb.port.ac.uk/~whitec/Sports_Projectiles/Home.html.

KEYNOTE 4

The nature and role of feedback in ICT-based tasks for learning mathematics

Professor Colette Laborde
Emeritus Professor, Université Joseph Fourier, Grenoble, France

12.00 – 13.00, Friday 8th July, Portland Building, Lecture Theatre 1.53

Abstract

It is commonly accepted that an important feature of technology-based tasks lies in their possibility of providing feedback to students’ actions. The presentation of e-resources very often mentions their highly interactive character. The words “feedback” and “interactive” cover a huge range of meanings from immediate feedback in terms of True/False to situated feedback requiring an interpretation process from the students. The talk will analyse the variety of types and roles of feedback in the solving process of tasks based on dynamic mathematics technologies. It will also give evidence of the importance of the teachers’ role in the management of the classroom around the provided feedback. Finally, it will discuss the future of feedback types in resources supposed to be used independently from teacher that become more and more popular.

Biography

Colette Laborde graduated from the École Normale Supérieure (France) in Mathematics. She defended a Thèse d’Etat in Mathematics Education in 1982 about the language problems faced by students when learning mathematics. She was a full Professor at the Teacher Education Institute in Grenoble until 2006. She is currently Professor Emeritus at the Université Joseph Fourier, Grenoble. Her research work deals with the integration of the computer in the teaching and learning of mathematics and she is involved in the Cabri project, dynamic mathematics software programs distributed across the world. She currently works on the design of e-resources in mathematics for primary and middle school students making use of results of research in didactics of mathematics.

From 1985 to 2003, she was head of the doctoral program in Mathematics and Science Education at the Université Joseph Fourier, Grenoble. She supervised 29 PhD dissertations in the field of mathematics education.

She was a member of the executive committee of the International Commission for Mathematics Instruction (ICMI) from 1994 to 1998. She was the co-chair of the Topic Study Group on “New technologies in the Learning and Teaching of Mathematics” at the 11th International Congress in Mathematics Education (ICME11) in July 2008. She is a co-chair of the Topic Study Group “Teaching and Learning Geometry” at the 12th International Congress in Mathematics Education (ICME12) due to be held in July 2012.

She is a member of several Editorial Boards and scientific committees of international journals in mathematics education.
Mathematics and technology: exploring teacher educators' professional development

Maha Abboud-Blanchard
Université de Cergy-Pontoise, France

Session TTD2P

This paper reports on research which tackles the issue of how designing resources with digital technologies shapes the professional development of secondary mathematics teachers when preparing to become teacher educators. Drawing on previous research works that acknowledge the role of selecting and managing available resources for facilitating the use of technologies in mathematics teaching, I intend to go further in this direction and explore the role of designing such resources in teacher education. I therefore developed an educators' training course taking into account, on the one hand, their own experiences/habits as secondary teachers in the use of digital technologies, and on the other, the potential difficulties in the integration of technological tools into mathematics learning and teaching identified by the research in this domain. A principal task within this course was first to choose a technological tool, to use it with students and to observe and analyse this technology-based lesson. Secondly, the student educator had to design a resource based on this experience and reflect on its eventual use in teacher education. This paper also discusses how this task was accomplished and proposes an analysis of the resources designed. It also considers the impact of this work on the development of teachers' representations and alternative teaching strategies and on their understanding of what could be taught in teacher education programmes, and how teachers can be supported in implementing technology resources into their teaching practices.

How prospective teachers' use of the Cabri II environment can have an effect on the posing of fractal problems

Reda Abu-Elwan
Sultan Qaboos University, Oman

Session 2TD2P

The use of Cabri II in mathematics education has spread considerably in the last few years. Nevertheless, many teachers have not yet completely overcome their fears and suspicions about using it in geometry teaching. Furthermore, there is a generational gap that raises further difficulties: while most of the in-service teachers in Oman have little confidence in the new technologies nor with their application in educational activities, the younger teachers are more acquainted with these tools and appreciate their potential in geometry teaching. Fractal images are very beautiful and stunning. Fractal geometry presents a different form of geometry to that featured in classical geometry. However, it has failed to model and formalise many of the ordinary events and shapes surrounding us.

This study investigates how Cabri II might be effective in developing prospective teachers’ skills in developing new fractal problems for school-level geometry. The research was designed to introduce prospective mathematics teachers into a learning experience with a dynamic geometry environment (Cabri II), making them work in small groups (four students in each group) on developing fractal problems based on ‘Cabri II’ dynamic geometry.

Twenty-five prospective mathematics teachers participated in six activity sessions in topics including circle, triangle, fractal and other problem posing. The experience showed that the participants, after getting used to Cabri II, were able to apply their competence in the construction of interactive educational materials for a classroom situation. Moreover, they could focus on their (technical, mathematical and educational) difficulties to Cabri II, were able to apply their competence in the construction of interactive educational materials for a geometry.

Cognitive development of pre-service teachers: misconception, cognitive conflict and conceptual understanding

Muharrem Aktümen
Ahi Evran University, Kirsehir, Turkey

Zekeriya Karadag
Tufts University, MA, USA

Tolga Kabaca
Pamukkale University, Denizli, Turkey

Session 6TD1P

This paper reports on research investigating a group of pre-service teachers’ misconception of the regular versus equilateral hexagon. Seven pre-service teachers were recruited for the study and asked to construct an equilateral hexagon whose sides are 5 units in length. Although they were explicitly asked to create equilateral hexagons, our assumption was that they, or at least some of them, would create regular hexagons instead. In this qualitative research, participants were asked to construct their artefacts in the GeoGebra environment, which is a dynamic and interactive mathematics learning environment (DIMLE) and to screencast their work by using a software package. They all submitted their work at a public wiki space because the communications between researchers were performed online. The seven pre-service teachers created and submitted 15 constructs in total.

Their work was analysed by using frame analysis method (FAM) (Karadag, 2009; Cengel & Karadag, 2010). Selected students were interviewed to validate our interpretation of the results and to elaborate on the results of the analyses. During the interviews, students were presented with their own construction(s) as well as the constructs of equilateral, but not regular hexagons, developed by researchers.

The preliminary analysis results demonstrate not only the participants’ misconception and the reasons leading them to this misconception but how effectively they use a DIMLE (GeoGebra in this research) while working on a mathematics problem. Moreover, the results also demonstrate how their cognitive conflict emerged, how they re-assessed the situation to solve it, and how they improved their conceptual understanding through this resolution.

Risk-based decision-making by 15-year-old students

Hasan Akyuzlu
Institute of Education, University of London, UK

Session 2AP1P

The judgement of risk is a key factor in our decision-making. Yet, the complex nature of risk means that people find challenging the trade-offs involved in co-ordinating impact, likelihood and the many ethical and value-based judgements entailed (Brandstätter et al., 2006), in order to observe and trace two pairs of 15-year-old students’ thinking about risk during clinical interviews. This paper supports the prior work with teachers that students also drew on personal experiences and values but often did not easily trade-off impact and likelihood; in other words, co-ordination was far from trivial. They proposed a new mapping tool to support co-ordination between impact and likelihood. This tool allowed teachers to express views about impact, likelihood and other aspects of the perceived hazards in the decision-making process but required them to locate the relative risk of these hazards.

The mapping tool was designed at the end of their study and so to date has not been systematically tested. In the study reported here, I test the conjecture that the use of this mapping tool might facilitate students’ (as opposed to teachers’) risk-based decision-making. Therefore, I used the final previously tested version of the computer-based Deborah’s Dilemma (DD) (Pratt et al., 2010), in order to observe and trace two pairs of 15-year-old students’ thinking about risk during clinical interviews. This paper supports the prior work with teachers that students also drew on personal experiences and values and that, prior to use of the mapping tool,
Dynamic representation of mathematics: the case of statistics

Gilles Aldon
Ecole Normale Supérieure de Lyon, France

Session 5TD1P

The topic of module 2 of the EdUmatics project concerns the implementation within suitable software of dynamic representations in mathematics and the didactic engineering necessary to improve them in the classroom. The main aim of this module is to better understand the role of multi-representation for the learning of mathematics and the possibilities given by ICT to represent mathematical objects in a dynamic way. In this module teachers in training will have to explore dynamic representations of mathematics in different ways – cognitive, pedagogical and technological. Although not often taken into account, the case of statistics is very interesting to study because the description of data often requires different kinds of representation, each of them showing and hiding properties; a good understanding of data involves exploring different representations. Furthermore, it involves knowing how to translate one representation into another. Starting from this hypothesis, we elaborate on a class situation in which students were invited to measure their reaction time to a visual stimulus. After a certain number of trials, the first question might be: “What is your reaction time?” In order to answer this question, students have to do a statistical treatment of their data. The questions of the description, comparison and communication of data lead them to define the main characteristics of a statistic, but also to explore inferential statistics. This class activity is one of the three class activities which constitute the basis of the EdUmatics module 2. Starting from the mathematical problem, teachers will have to successively analyse a class situation, understand the role of representations, understand the possibilities ICT offers, build a new scenario taking into account their own teaching conditions, and test it. In this presentation, through the work of students, we will explore the potential of this situation being used in a teacher training course.

Using technological approaches in teaching mathematics: the perspectives of mathematics teachers

Othman Ali Ali Aghtani and Nasser Elsayed Abdelhamied
Tabuk University, Saudi Arabia

Session 5CU3P

The main aim of this paper is to investigate how mathematical teachers use a technological approach in teaching mathematics. To achieve this a questionnaire was prepared and sent to a sample of 120 mathematics teachers. We asked them to describe how they used technological approaches in teaching mathematics. The main results were that (i) most did not have a clear perspective of teaching related to how they use technology in the mathematics classroom and (ii) most did not consider the use of technology when they prepared their action plan.

Technology-integrated mathematics education in the Saudi context

Zafer F. Alshehri
College of Education, King Khalid University, Saudi Arabia

Session 4TD2P

Technology has had a long history of being integrated into the curricula of study. Its progress has also inevitably made a variety of new demands in the teaching and learning of all school disciplines such as mathematics. Consequently, the content of mathematics curricula and the methods by which mathematics is taught and learning assessed are changing.

This paper investigates the integration of technology and mathematics education in the Saudi context. However, an extensive review of the related literature has revealed that the integration of technology into the teaching and learning of Saudi school mathematics remains one of the current issues of under-investigation; and the term ‘integration’ remains ambiguous for a great number of mathematics teachers. In addition, recent studies have shown the need to better align mathematics teachers’ preparation in the integration of technology in classroom practices.

The paper concludes with implications and recommendations for further research and practice.

Wiki as a textbook?

L. Aszalos, M. Bako and T. Mihalydeak
University of Debrecen, Hungary

Session 1CU1P

If you would like to write a textbook that is useful and popular among students, you cannot rely on the fact that students use the index to find the right information (definitions, theorems and solutions). In the case of e-books, we have the opportunity to get the desired information with one click. With HTML or PDF formats the technical conditions are given, The TiddlyWiki is a favorite tool of many of us, and we can use it not only for note taking. The TiddlyWiki itself is an HTML file with JavaScript plugins and behaves like a big wiki system. Similarly to the well-known Wikipedia, we can insert mathematical formulas, pictures, diagrams and we can format the text by using simple rules. With links we can refer to the other parts of the textbook (previous definition, theorem, solution of an exercise) and to additional content on the Internet. With these links a structured conceptual network will be generated automatically, and this network enables students to choose a personal path when learning the content. The textbook for the introductory logic course for IT students at the University of Debrecen is made in TiddlyWiki format; this file includes the exercise book and the presentations, and forms an organic whole. In this article we would like to show the possibilities and benefits for students learning the material or preparing for exams. Moreover the students have the opportunity to add their comments to the curriculum, which helps the individual learning process. Using import and export tools students can share their notes between each other. We are planning to complement the exercise book with student’s solutions.
Starting to work with ICT

Bärbel Barzel and Ralf Enzensberger
University of Education, Freiburg, Germany
Session STD3P

With the increasing complexity of ICT it is becoming more challenging for teachers and students to use it. The first steps for colleagues using ICT are getting more difficult, especially if there is more than one programme or one tool that might be considered for use. Thus it is very important when working with ICT to create material in a transparent and clear way, which can be adapted by teachers for their everyday teaching. The material must allow different learning paths so that every individual can find his or her own way of putting it into practice.

The concept of a professional development course as an introduction for ICT use can be split up in two aspects:

a) Getting to know about the technical possibilities and features of the artefact.
b) Getting an idea of how the artefact can be included in some way, which benefits the teaching and the learning of mathematics. This idea does not focus purely on single tasks or a short-term environment but also for a longer period of teaching.

The examples, which have been developed and compiled within the framework of the Comenius project EdUmatics, show on a simple mathematical level that different representations of the tool are interrelated with different approaches to solving mathematical problems (e.g. in a symbolic, graphical and numerical way). As long as different types of learner use different ways for the same task, it is important that the different parts of the tool with different representations must be introduced in a parallel way without any “pre-dominated” hierarchy or preference given by the teacher.

Reference


Using multiple representations in the classroom – the EdUmatics project

Andreas Bauer and Hans-Georg Weigand
University of Würzburg, Germany

Caroline Bardini, Jacques Salles and Marie-Claire Combes
University of Montpellier, France

Session STD2P

The European Development for the Use of Mathematics Technology in Classrooms (EdUmatics) project aims to increase thoughtful integration of ICT in European mathematics classrooms by building and disseminating an online training course for in-service and pre-service secondary teachers, in particular by providing high quality teaching material based on research and experience from the 20 partners involved, who are leading experts in using ICT in the classroom from ten universities and research institutes together with ten secondary level schools across six European countries. The project consists of five different “chapters” (called modules):

1. Starting to work with ICT.
2. From static to dynamic representations.
3. Constructing functions and models.
5. Multiple representations.

The Würzburg Group developed module 5 together with the Institute for Research on the Educating of Mathematics (IREM) at the University of Montpellier. This module deals with the use of multiple external representations (MER) in the classroom, the interrelationships between employed software and how to use them wisely in class. The module includes didactic considerations about the use of MER, methodological reflections on how to make thoughtful use of ICT, discussions concerning the theoretical background of MER in the learning of mathematics and ready-to-use classroom activities. Advantages and disadvantages, goals and difficulties of the use of multiple representations are also discussed. In this paper we will give a short overview of the aims and methods of this project and we will present two classroom activities. The first one explores, using appropriate technological environments, the limits of methods used to determine the position of a curve with regard to its tangents. The other compares exponential and linear growth processes using interactive GeoGebra applets or handheld devices. Results of empirical investigations carried out by French and German teachers about these two classroom activities will also be examined.

Design principles for an online algebra course

Christian Bokhove and Paul Drijvers
Freudenthal Institute for Science and Mathematics Education, Utrecht University, Netherlands
Session 2CU1P

Procedural skills and conceptual understanding have been widely debated, especially with regard to algebra education (Schoenfeld, 2004). Meanwhile, the use of ICT in education has increased. In this article we report on a design research study that set out to investigate in what way ICT can be used to acquire, practise and assess algebraic expertise. The general framework of the study combines three elements: algebraic expertise (basic skills and symbol sense), theories on tool use (instrumental genesis) and assessment (formative assessment and feedback). In the first cycle of the study criteria for algebra tools were formulated (Bokhove & Drijvers, 2010a), and a first prototypical version of the intervention was designed (Bokhove & Drijvers, 2010b). Next, the results were used to identify design principles for a digital intervention in the Digital Mathematical Environment called 'Algebra met Inzicht' ["Algebra with Insight"], including concepts of crises, formative scenarios and feedback. In the second research cycle, the online intervention was field tested in a pilot lesson series for grade 12 mathematics students at one secondary school (N = 31), and a third cycle involving 9 schools (N = 334). Data includes results from a pre- and post-test, the scores and log files of the digital activities, and results from a student and teacher surveys. Results show that design principles regarding ‘crises’ and ‘formative scenarios’ seem to add to an improvement in algebraic expertise. The use of these design principles facilitates transfer of algebraic expertise.

References


Schoenfeld, A. H. (2004). The math wars. Educational Policy, 18(1), 253–286. For associated documentation email: c.bokhove@uu.nl
The strange fate of abstract thinking

Alexandre Borovik
School of Mathematics, University of Manchester, UK
Session 1CU2P

I will discuss the place and role of abstract mathematical thinking in the technology-based mathematics learning environment. I will argue that most accepted uses of ICT in mathematics teaching exploit the possibility of easy generation of concrete examples and encourage in students a bottom-up, inductive style of thinking. This increases the gap between mathematics as it is taught at universities and the modern research level mathematics where hierarchically structured top-down abstract thinking is quite prominent. Interactive representation of mathematical objects and processes via user-friendly interfaces is made possible by advances in computer science. Paradoxically, computer science itself requires a level of abstract thinking that far exceeds the one normally acquired by mathematics graduates. University mathematics has surrendered without fight the title of the “Queen of Abstract Thought”.

In my talk I will analyse a possible remedy as it tentatively emerges in computer science: the use of high level functional programming languages such as Haskell as a tool for handling abstract mathematical structures. In a very crude description, Haskell allows you, for example, to define natural numbers as successors of zero (thus implementing the Peano arithmetic) and then develop elementary number theory step-by-step, its theorems turning out to be algorithms and proofs – their formal verifications. This new approach, despite a number of teaching experiments around the world, is still mostly hypothetical. However, it raises a number of important methodological questions. For example, working in Haskell requires de-facto category-theoretic thinking (common in “research level” mathematics), not just the use of a language of naïve set theory. Meanwhile, there are claims that “without a cadre of people able and willing to engage in abstract thinking our technology-based assessment practices...”

The state of Victoria, Australia, as have certain European states at certain times, currently uses CAS (common in “research level” mathematics), not just the use of a language of naïve set theory. Meanwhile, there are claims that “without a cadre of people able and willing to engage in abstract thinking our technology-based assessment practices...”

A “future” curriculum in a “3rd Industrial Revolution”? 

Oliver Bowles
International School of Toulouse, France
Session 1CU3P

In the current mathematics curriculums the memorisation of “rules”, without understanding, can result in exceptional performance. This session proposes concrete lesson materials, in both computer assisted and non-computer assisted instruction environments, to develop and then assess student’s conceptual understandings and their approach to problems. It is hoped that these may provide concrete examples from which participants can brainstorm other useful activities considered “essential” in addressing the practical challenges of a “future” curriculum.

I was teaching the binomial theorem recently. Often students can lose from two to four marks out of six, due to “calculation” errors: e.g. \((2x-\frac{3}{2})^3\), forgetting to include the negative for: \((-\frac{3}{2})\), forgetting to raise the \(x\) coefficient to the power: \((2x)^3 = 2x^3\), etc. Conceptually they have understood that this expansion is a “choosing” problem that Pascal’s Triangle gives us the number of different ways \(x\) objects can be selected from \(n\) etc. Attention to detail (and the grave consequences a lack of rigour/detail can cause) is an “essential” lesson, but are there not more up-to-date activities e.g. the manufacture of precision engineered products and how to estimate such calculations (or a return to proof?) that can be used to instigate such learning (and that do not fall into the domain of CAS or other calculation software)?

The theory of computation (Turing, Von Neumann, Chomsky et al.), the study of what can and can’t be computed, stimulates thought as to which task humans can accomplish more effectively than can a “computing machine”. For educators, this is likely to have a profound impact on what should and should not be taught, particularly in the fields of science and mathematics.

The state of Victoria, Australia, as have certain European states at certain times, currently uses CAS – is this the direction of future curricula? What are the counter arguments?

1 It is not the author’s view that the efficient application of a rule is, therefore, evidence of poor “understanding”, only an observation that “rules” can be “memorized” without understanding and that some exercises given in mathematics are less effective than others at, for example, “testing” the proportional understanding, in the case of fractions arithmetic, that underly the rule.
3 www.ted.com/index.php/talks/conrad.wolfram_teaching_kids_real_math_with_computers.html
5 www.mei.org.uk/files/pdf/MEA_CAS_Report_v1a.pdf (p.15) (Half of the 100 universities and colleges contacted by the IB “reacted negatively” to the introduction of CAS in schools/colleges.)
A long-term educational treatment using dynamic geometry software

Dirk Brockmann-Behnsen
Institute for the Didactics of Mathematics and Physics (IDMP), Leibniz University, Hanover, Germany
Session 5CU1P

We accompany two classes over a period of two years with an optional extension of another year beginning in year 7. One of the classes undergoes a treatment, the other one serves as a control group. The focus of the treatment is being set on the geometry units within the subsequent forms. The treatment class is repeatedly acquainted with various kinds of heuristic aids and principles of operation and has permanent access to dynamic geometry software, as this software can be a “producer of new powerful heuristics” [Höll, 1998]. We encourage the students to argue in a deductive way about suitable mathematical problems. Our research is trying to establish whether the intensive and appropriate use of the software along with the instructions in heuristics will lead to significant improvement in the students’ performances, and, especially whatever upgrades in the geometric thinking of the students regarding the van Hiele levels can be registered (see Gawlick, 2004).

Improving middle school teachers’ questioning strategies using video

Sue Brown
University of Houston-Clear Lake, US
Session 7TD1P

This paper reports the results of a study focused on improving teachers’ questioning strategies. Seventeen middle school teachers enrolled in a graduate mathematics education course were asked to create a teaching portfolio. They videotaped themselves teaching a mathematics lesson to their middle school students, and then chose a 5–10 minute clip from the lesson where they focused on questioning their students. The teachers reviewed the clip, listed each question they asked, and categorised each question according to one of the three Costa’s categories. During class, each teacher presented the clip and the list of questions they asked to their small community of practice (three to four teachers). The community categorised the questions according to Costa’s levels of questioning and brainstormed ways the teacher might ask “better” questions. This process was repeated for a total of three videos. The components of the portfolio are an initial reflection paper on the teachers’ current questioning practices; three of the following: the video clip, a list of the questions with Costa’s categories identified for each question, and a paper summarising the brainstorming session and based on comments from the community as to what the teacher would do differently in terms of questioning when they teach this lesson next year; and a summary reflection paper on what the teacher learned from the project and any changes that might have occurred in their questioning practices. The portfolio was electronic and in creating it the teachers used Movie Maker, Teacher Tube, and Google Sites.

Online resources for the busy teacher

Douglas Butler
ICT Training Centre, Oundle, UK
Session 3IN1P

Busy teachers generally do not have the time to research and catalogue the fantastic resources that are now just a click away on the web. Online resources can now so easily add variety to a lesson, and Douglas is always on the lookout for material that is pedagogically sound and deserves a place in his “TSM Resources” website: www.tsm-resources.com.

Using live online tutoring to provide access to higher level mathematics for pre-university students

Tom Button and Richard Lissaman
The Further Mathematics Support Programme, UK
Session 1S52P

In England, the main pre-university qualifications are General Certificate of Education Advanced Levels (GCE A levels). An A level in Mathematics is taken by approximately 70,000 students each year. Around 15% of these students take an additional qualification in Advanced Level Further Mathematics. The Further Mathematics Support Programme (FMSP), previously the Further Mathematics Network, has been working with schools, colleges and universities across England to ensure universal access for students to this additional A level qualification since 2005. In particular, the FMSP has been providing tuition for students who are currently unable to access the qualification at their chosen school or college. A substantial proportion of this tuition is provided online using a shared whiteboard technology (Elluminate).

Online tuition usually takes the form of weekly, early-evening sessions in which a small group of students meet online with an experienced tutor to learn new mathematics and solve mathematical problems. In addition, students have access to extensive online resources to support their learning. The students are geographically located across England and many of them would not be able to study an additional mathematics qualification without the live online tuition provided by the FMSP. There are over 300 students receiving regular online tuition during this academic year with many more using the technology to access online revision classes. The FMSP has been providing live online tuition in mathematics for over four years. During this period, through a process of review and reflection, the FMSP has continued to improve and develop approaches to online learning and the provision has been extended. The aim of the session is to share our experiences of teaching mathematics online and consider the potential for further development.
Home technologies: how do they shape beyond-school mathematical problem-solving activity?

Susana Carreira and Nélia Amado
University of Algarve and UIDF, University of Lisbon, Portugal

Session SS31P

In this paper we analyse and discuss the mathematical activity of a 12-year-old participant in a web-based problem-solving competition – Sub14 – promoted by the University of Algarve, Portugal. Ultimately, our purpose is to contribute to the knowledge on the learning processes that occur outside the classroom, constantly and necessarily entangling technologically rich environments.

The theoretical framework supporting our analysis draws on the concept of humans-with-media (Borba & Villareal, 2005) and the notion of mediational artefact (Wertsch, 1991), which are vital for understanding the unbreakable entity resulting from the interactions between subject, object and action.

The preliminary results are the outcome of an exploratory study, integrated in a broader ongoing investigation. Although the results report to the exploratory study, they are expected to assist in decision making regarding the implementation of the research project.

Hence, we will focus on the work of one participant, Leonor, who has been attending the competition for the past three years. We describe and analyse two problems solved by Leonor in the competition, and try to understand (i) her mathematical problem-solving activity and (ii) how digital tools mediate such activity, particularly regarding the effective expression of her reasoning through the use of iconic signs.

The results show that Leonor uses ‘home technologies’ and, particularly, their graphical flexibility to ‘engineer’ her reasoning and develop her very own strategy in the problems given by Sub14. The computer is not only a means to present a neat solution to the problems. Instead, the tool becomes part of the solution’s creation process and it is being used as a ‘native language’ to think with, act with and communicate with. We suggest, therefore, that Leonor is a person-acting-with-mediational-artefacts (Wertsch, 1991), and argue that the computer is a significant mediational artefact in her problem-solving activity, which indicates that Leonor’s problem solution might be considered a ‘computer-mediated-solution’.

Researching teachers’ experiences of introducing multi-representational handheld technology – what and how do they learn?

Alison Clark-Wilson
University of Chichester, UK

Session 6TD3P

This research presentation presents selected outcomes from a longitudinal doctoral study that sought to gain a deep insight into how a group of English secondary school mathematics teachers learnt to integrate a complex multi-representational technological tool, the Texas Instruments TI-Nspire handheld device, into their classroom practice. Using Verillon and Rabardel’s (1996) theory of instrumented activity as the theoretical base the teachers’ instrument utilisation schemes are described, which suggest a clear trajectory for their evolving use of the tool. The presentation will describe a number of classroom tasks devised by the teachers to illustrate how both the range and integration of the technological applications (dynamic geometry, dynamic graphing, spreadsheets etc.) expanded over the timescale of the project. The content of this session will be of interest to teachers, researchers and developers who have an interest in the teacher development implications for new technologies and the design of related teacher development courses and materials.

Attractive mathematical induction

Aija Cunska
University of Latvia

Session 1SE3P

The method of mathematical induction can be compared with progress. We start with the lower degree and as a result of logical judgments we come to the general conclusion (result). As man always tries to advance, tries to develop his ideas in a logical way, consequently, nature itself makes man think in an inductive way.

The inductive method plays a significant role in understanding the principles of mathematics. Although the range of the problems concerning the usage of the mathematical induction method has grown, in school syllabi very little attention is paid to the issue.

The majority of students are visual learners. Therefore, if mathematical induction teaching methods are improved, more and more students would become interested in it. This is a powerful and sophisticated enough method to be acceptable for the majority.

This ‘century of information’ offers our society completely new opportunities in nearly all fields. However, the field of education is the one where the new technologies provide the greatest advantages.

Multimedia provides the opportunity to create teaching aids that combine text, pictures, sound and video, as well as quickly helping one to find necessary information. Professional usage of multimedia appliances turns the learning process into an exciting process of cognition.

For students the learning process sometimes may seem boring, but we can attract their attention with the help of information technologies. This can be done by creating multimedia learning objects. The multimedia learning objects can make the learning process more exciting, visually more perceptible and more specific. In that way teachers can work easier and faster, paying more attention to practical assignments. The created multimedia learning object “Mathematical induction” serves as successful evidence of that statement.

Mobile apps in mathematics education

Timothy Collinson
University of Portsmouth, UK

Session 3IN2P

The iPad (and more recently the iPad 2) has often been accused of being for the consumption of information only. Great for reading, web browsing, movies and the like, it in fact also enables creativity in a multitude of ways as many are finding out. In addition, schools, colleges and universities are discovering educational uses, or developing their own apps to support such usage. Some are trialling free devices for every student in a class or year, some are simply preparing for increasing numbers of students to be carrying and expecting to use their own devices.

This session will look at some of the apps that are available for mathematicians and those learning mathematics. We explore using apps ranging from free calculators to deluxe digital texts that exploit the potential of the device to its full. We will also consider more widely mobile apps and learning and whether this is a future that will grow or just a passing fad whipped up by Apple’s clever marketing. Has the ‘slate’ returned to the classroom? Or is this just a disruptive technology?

University of Portsmouth
Prospective teachers' curricular interactions and beliefs with regard to computer algebra systems

Jon D. Davis
Western Michigan University, US

Session 2TD3P

It is widely recognised that teachers' beliefs shape their use of technology in the classroom (Kendal & Stacey, 2002; Noss & Hoyles, 1996; Philipp, 2007; Schmidt, 1999; Walen, Williams, & Garner, 2003). This study reports on the beliefs (Richardson, 1998) and curricular interactions of six prospective secondary mathematics teachers (PSTs) with regard to computer algebra systems (CAS) as evidenced by intended curricula (Stein, Remillard, & Smith, 2007). They developed from three different US written reform-oriented mathematics textbook lessons. Four categories were used to describe PSTs' interactions with written lesson elements (keep, adapt, supplement, and omit). The PSTs showed remarkable variability in their intended curricula despite working from the same written curriculum. For instance, the percentage of the written curriculum lesson elements that the PSTs retained within their intended curricula from one textbook lesson varied from 19% to 95%. A Friedman rank test (Corder & Foreman, 2009) showed that PSTs' intended curricula were statistically different from one another within each of the three curriculum lessons. The PSTs possessed a variety of beliefs concerning CAS that emerged from their intended curricula. For instance, one PST viewed the CAS through a symbolic manipulation lens. That is, she did not believe that technology could be used to assist students in learning other goals such as identifying patterns. Consequently, she routinely adapted textbook activities so that students executed procedures by-hand first and then used the CAS to check their work. Another PST, however, believed that the CAS could fulfill a variety of different roles that depended on textbook lesson goals. At times, he delayed students' CAS use so that he could focus on students' symbolic manipulation skills, while at other times the technology provided students with opportunities to learn about mathematical concepts.

References


Using live online technology to engage mathematics teachers in professional development

Sue de Pomerai and Sharon Tripconey
The Further Mathematics Support Programme, UK

Session 1TD3P

The Further Mathematics Support Programme, previously the Further Mathematics Network, has been working with schools, colleges and universities across England to ensure universal access for students to Further Mathematics A level since 2005. The FMSP has provided tuition for students in schools and colleges that cannot offer this additional A level themselves. However, as student numbers taking Further Mathematics grow and universities increase the demand for potential STEM students to study Further Mathematics, schools and colleges have been encouraged to offer and teach it themselves. Until now, a shortage of experienced teachers in this area has been a significant barrier to this and the FMSP has recognised that it is crucial that mathematics teachers have the opportunity to develop their mathematical knowledge and teaching skills to meet the growing demand for teaching Further Mathematics.

Since 2007 our range of online courses for teachers have increased opportunities to access professional development (PD). Using an online shared interactive whiteboard which enables communication through audio, instant messaging and via handwritten mathematics, small groups of teachers meet online weekly with a tutor for five to ten weeks, allowing time for reflection and consolidation. The online sessions cover mathematical content, pedagogy and facilitate the exchange of ideas between the teachers, creating a supportive and collaborative working environment. In addition, delegates are given access to extensive online resources for teaching and learning and have extended access to tutor support and peer support through email and online forums.

By gathering feedback from teachers and through review and reflection, the FMSP has continued to improve and develop approaches to online PD, including a current trial using the technology to facilitate discussion sessions for teachers undertaking study at masters level.

The aim of the presentation is to share our experiences of online PD and consider the potential for further development.

Children's activities regarding mental mathematics at lower middle school

Rita Desfitri
University of Bung Hatta, Indonesia

Session 2SE3P

Almost all of mathematics can be described as mental in the sense that engaging in a mathematical task involves thinking. For this reason, every mathematical problem a child has to handle must involve several stages of mental mathematics. Activities relating to mental mathematics might see children engaging in any combination of explaining, visualising, interpreting, analysing, justifying, judging, or decision-making. At the same time, elementary algebra, as the primary focus in middle- and high-school levels, is sometimes defined as generalised arithmetic or as a language for generating mathematics. Since algebra is a language, it is also about interpreting, reasoning, and representing. This paper will discuss activities in teaching and learning mental mathematics using elementary algebra, for students at lower middle-school level.

Session 1T2D3P

Using live online technology to engage mathematics teachers in professional development

Sue de Pomerai and Sharon Tripconey
The Further Mathematics Support Programme, UK

Session 1TD3P

The Further Mathematics Support Programme, previously the Further Mathematics Network, has been working with schools, colleges and universities across England to ensure universal access for students to Further Mathematics A level since 2005. The FMSP has provided tuition for students in schools and colleges that cannot offer this additional A level themselves. However, as student numbers taking Further Mathematics grow and universities increase the demand for potential STEM students to study Further Mathematics, schools and colleges have been encouraged to offer and teach it themselves. Until now, a shortage of experienced teachers in this area has been a significant barrier to this and the FMSP has recognised that it is crucial that mathematics teachers have the opportunity to develop their mathematical knowledge and teaching skills to meet the growing demand for teaching Further Mathematics.

Since 2007 our range of online courses for teachers have increased opportunities to access professional development (PD). Using an online shared interactive whiteboard which enables communication through audio, instant messaging and via handwritten mathematics, small groups of teachers meet online weekly with a tutor for five to ten weeks, allowing time for reflection and consolidation. The online sessions cover mathematical content, pedagogy and facilitate the exchange of ideas between the teachers, creating a supportive and collaborative working environment. In addition, delegates are given access to extensive online resources for teaching and learning and have extended access to tutor support and peer support through email and online forums.

By gathering feedback from teachers and through review and reflection, the FMSP has continued to improve and develop approaches to online PD, including a current trial using the technology to facilitate discussion sessions for teachers undertaking study at masters level.

The aim of the presentation is to share our experiences of online PD and consider the potential for further development.

Children's activities regarding mental mathematics at lower middle school

Rita Desfitri
University of Bung Hatta, Indonesia

Session 2SE3P

Almost all of mathematics can be described as mental in the sense that engaging in a mathematical task involves thinking. For this reason, every mathematical problem a child has to handle must involve several stages of mental mathematics. Activities relating to mental mathematics might see children engaging in any combination of explaining, visualising, interpreting, analysing, justifying, judging, or decision-making. At the same time, elementary algebra, as the primary focus in middle- and high-school levels, is sometimes defined as generalised arithmetic or as a language for generating mathematics. Since algebra is a language, it is also about interpreting, reasoning, and representing. This paper will discuss activities in teaching and learning mental mathematics using elementary algebra, for students at lower middle-school level.
Student problem solving achievement in a CAS environment

David Driver
Brisbane State High School, Australia

Session 1SS1P

A calculator with Computer Algebra System (CAS) capability can be used as a teaching and learning tool and/or as an assessment instrument. In the classroom, it can be used by both the teacher and the student as a functional tool and/or as a pedagogical tool. In the examination room, it can be used by the student as a functional tool.

When it is used as a pedagogical tool in the classroom to aid student learning and understanding of the mathematics involved and as a functional tool to undertake repetitive tasks, it can subsequently be used in the exam room as a functional tool to aid in the manipulation involved in problem-solving tasks. When the CAS is used in all of these ways, the effect on student achievement (as measured by the exam) can be quite profound. When the student is first introduced to the CAS this also has an impact on the future gains in student achievement.

In this action research project, the CAS calculator was introduced to students and used to varying degrees in years 10, 11 and 12. The effects of the timing of this introduction and the level of use of the CAS by students in the classroom on their final year results were examined and reported here.

There is some evidence of an increase in the benefit to students (as measured by achievement in both mathematical procedures and problem solving) by introducing the calculator in Year 10 rather than Year 11. This gain is evident across the range of student ability.

Although a Casio ClassPad was used in this study, it is anticipated that similar effects would be observed with alternative technologies.

Guided interaction in mathematics lessons: A new pedagogy for new technology

Allan Duncan
University of Aberdeen, UK

Session 7IN1P

Does the use of handheld technology that allows dynamically linked multiple representations of mathematics concepts impact upon the dynamics of classrooms? Do teachers change the way they teach particular lessons? Do they alter the way they teach in general? What is the impact of changes in pedagogy or didactics on students' motivation, interest and ways of working? This presentation will report briefly on the findings of research, published in 2010, which asked teachers to report on lessons in which they used new technology. It will then focus on particular successful lessons that clearly demonstrate the benefits to be gained by using both new technology and new teaching approaches. Links between different representations of mathematics concepts are highlighted. Connections between different areas of mathematics are emphasised. The teachers described how the use of the technology, together with a more investigative teaching approach, with more opportunities of questioning and discussion, both between teacher and students and among students themselves, led to a deepening in understanding, an increased pace of learning and a surprising increase in motivation and engagement across all ability levels.

Interactive whiteboards (IWBs) to support mathematical learning: current practices and open problems

Eleonora Faggiano and Rosa Laura Ancona
Department of Mathematics, University of Bari, Italy

Session 4SS1P

With this work we intend to focus on the use of IWBs as methodological resources to support mathematics teaching and learning activities.

As research has already shown – see for instance Mousley et al. (2003) and Moss et al. (2007) – in spite of perceptions, it cannot be taken for granted that technological advances, alone, change essential aspects of teaching and learning, simply because they can bring about opportunities for change in pedagogical practice. We contend that an IWB could be used as a ‘semiotic mediator’ of the process of mathematical knowledge construction. Our hypothesis, in particular, is that this can be done if the teacher, starting from adequate learning experiences, creates suitable ‘a-didactic situations’ aiming to gradually promote the construction of meanings of mathematical objects.

The basic assumption is that the main aim of the educational design in mathematics is to foster the progressive construction of a personal heritage of mathematical knowledge, skills and attitudes which have to be meaningful, stable and fitted for the use in problematic situations both internal or external to the mathematics. As a theoretical framework we refer to: the theory of didactic situations (Brousseau, 1997); the notion of ‘mathematics laboratory’ as a Renaissance workshop (UMI-CIIM MIUR, 2004); the concept of ‘semiotic mediation’ (Bartolini, Bussi, & Mariotti, 2008); and the ‘instrumental approach’ – starting from Vérillon and Rabardel (1995) – and in particular, within it, the concept of ‘instrumental orchestration’ proposed by Trouche (2003). Some case studies (in Italian schools) will be analysed, according to the theoretical framework and the research hypothesis, focusing on the teacher and his/her needs in using the IWB in classroom activities.

Reviewing the impact of technology on the development of a mathematics curriculum from two cases in China and Singapore

Lianghuo Fan
School of Education, University of Southampton, UK

Session 2CU2P

The last two decades or so have witnessed the increasing impact of technology on mathematics teaching, learning and assessment. The rapid increase of this impact is particularly evident in the development of mathematics curricula. In this article, the author will draw on his recent experience as chief editor of two series of secondary mathematics textbooks developed and published in China and Singapore respectively, examine the impact of technology on the development of a mathematics curriculum, and discuss the future direction of using technology in curriculum development. Based on the two cases of curriculum development in China and Singapore, this article argues that modern information and communication technology has not only impacted what to teach and how to teach, but also why to teach. In relation to this, technology must be reflected and, more importantly, embedded into the development of mathematics curricula including textbooks, which is a most important pedagogical resource for teaching and learning. How this can be achieved is also discussed in the paper, mainly with the examples from the two cases in China and Singapore.
FETLAR and beyond: the MSOR's OER project and what happened afterwards (so far)

Leslie Fletcher
Liverpool John Moores University, UK
Sue Milne
ElAndWeb Ltd, UK
Session 6AS2P

FETLAR was the Maths, Stats & OR Network’s (MSOR) project in the first round of open educational resources (OER) funding from JISC and HEA. It involved an impressive list of contributors and resulted in the collection of a wide range of resources in a variety of formats from entire learning systems to individual articles and questions on topics ranging from place value to differential equations. These are now available in the FETLAR repository at http://fetlar.bham.ac.uk/repository

It also made the delivery and authoring tools for e-assessment in mathematics developed under the MathAssess project available in formats convenient for colleagues to download and use. These tools conform to the Question and Test Interoperability specification Version 2.1 (QTIv2.1), thus ensuring that the resources produced by them are sustainable and can be used with similarly conformant tools from other sources. The resources and tools are currently in use at partner institutions, where internal dissemination is resulting in collections of questions in Basic Maths, Maths for Biologists, Maths for Engineers and Maths for Teachers! Many of these questions are themselves OERs. There is also evidence of uptake by colleagues elsewhere in the UK and abroad. We shall also report on some interesting developments with which we expect to be involved around the time of this conference.

Modeling and spatial reasoning

Gregory D. Foley
Ohio University, USA
Session 1AP1P

Modeling and Spatial Reasoning (Modspar) is a year-long professional development (PD) course that addresses technological pedagogical content knowledge (TPACK) in discrete, continuous, and geometric modeling and in spatial reasoning – areas of current weakness in the U.S. teaching workforce. The course balances tasks, tools, and talk. Using instructional and assessment tasks with a high level of cognitive engagement is the pedagogical aim. The tools for Modspar are computer algebra, graphing, and geometry applications, including spherical and three-dimensional interactive geometry software. The Modspar course balances these tools and tasks with talk, that is, with mathematics language development through high-level classroom discourse. Modspar is part of a two-year PD program called Advanced Teacher Capacity (ATC), a research and development project that investigates the question: “How can teacher professional development improve instruction in innovative post-Algebra II courses for high school seniors and juniors?” Using Boston and Smith’s (2009) instructional quality assessment, the research during the 2010–2011 school year has focused on the instructional tasks and classroom discourse of Modspar participants as a function of whether they have access to classroom sets of TI-nspire CAS handheld computers. The session will provide course details and preliminary research results.

Learning the ropes: how the technology of sailing and seamanship can enhance the teaching and learning of mathematics

Dot French
Community College of Philadelphia, USA
Session SSL2P

In the sport of sailing, traditional practices of navigation and seamanship have been greatly impacted by the introduction of new electronic technologies that are radically altering the seascape. For example, GPS and digital chart-plotters are being widely adopted, although dead reckoning and celestial navigation are still essential skills for mariners embarking on serious coastal or trans-ocean voyages. Correspondingly, in mathematics education, electronic learning resources are creating new ways of teaching and learning mathematics. How does the inclusion of nautical content and technology, along with hands-on, activity-based methods, affect the ways in which students, especially those in pre-calculus and geometry courses, learn mathematics? Can activities that refer to navigation and sailing help create productive environments for studying mathematics in context? This paper discusses outcomes and attitudes of community college students who study mathematics using nautical references and technology, as well as hands-on activities, model-making and traditional methods. Students’ opinions on the use of technology for learning mathematics are explored, as are their opinions on how mathematics relates to the world outside the classroom.

Exploring impulse and momentum using handheld technology

Ian Galloway
Science Learning Centre South East, University of Southampton, UK
Session 1SL1P

Students at secondary school rarely encounter motion graphs beyond displacement or velocity against time. Yet in order to understand Newton’s third law it is useful to be able to graph force against time. This is relatively straightforward using any datalogging system. Most students, and teachers, have a limited understanding of the third law which, if not rectified, causes problems for the further study of dynamics.

In this presentation, using TI-Nspire, Vernier force plates and force probes we will explore the concepts of impulse and momentum. Previous work has shown that presenting ordinary events such as jumping up and down on the spot as a force time graph is met initially with misunderstanding. Cognitive conflict results in students reappraising the situation and reaching a much greater understanding of what is taking place. Force, and consequently impulse, is an abstract quantity which deserves more attention within the curriculum. As J.W. Warren writes, “It [force] has long been regarded as a simple concept…and insufficient consideration has been given to ensuring that it is taught correctly”. Using modern digital technologies it is now possible to address the problem in a new way.
Computer-aided assessment of mathematics and statistics for first year economics students

Martin Greenhow
Department of Mathematical Sciences, Brunel University, UK
Session 6AS3P

This paper will focus on exploiting computer-aided assessment (CAA) developed under the Metal project in a formative/summative mode within a first-year Mathematics for Economics module at Brunel University comprising over 300 students. Three year’s worth of results will be presented to demonstrate the positive impact on students’ perception of their learning and on the actuality of their learning as measured (in various methodologies) by their examination scripts. Such positive effects are underpinned by attributing marks for the CAA, thereby rewarding student engagement, coupled with the need to pass the exam component as well as the whole module, which forces the students to focus on their learning rather than simply on marks accrual. Indeed, the students (correctly) view the CAA as a learning resource in its own right and spend most of their time studying the very complete feedback screens. Repeating tests and group work is allowed, even encouraged, since each question realisation uses random parameters that are carried through to all aspects of the question (stem, key, mal-rule based distracters, MathML equations and SVG diagrams). This technology is exportable to other subject disciplines, as are most of the decontextualised questions that are mainly of A level standard.

The general nature of the approach will be demonstrated by presenting a new project, DeStress, a statistics equivalent of Metal, but with a wider intended target of statistics within social sciences. Here the focus will be less on manipulative skills (data is loaded into Excel) but more about the meaning of statistics. One challenging area is interpretation of charts and graphs where data still needs to exhibit certain characteristics after randomization has taken place. Again, most of the underlying statistics will be of A-level standard but dressed up in contexts that will be meaningful to students of Politics, Economics, Sociology and Geography.

Improving understanding in ordinary differential equations through writing in a dynamic environment

Samer Habre
Lebanese American University, Beirut, Lebanon
Session 4SS2P

Research on writing in mathematics has shown that students learn more effectively in an environment that promotes this skill and that writing is most beneficial when it is directed at the learning aspect. Writing however necessitates proficiency on the part of the students that may not have been developed at earlier learning stages. Research has indicated though that the burden placed on teachers and learners to master this skill is compensated by the mathematical learning in such an environment. Techniques to successfully integrate writing in the mathematics classroom can be varied. This presentation is on a study conducted at the Lebanese American University on students in an introductory differential equations class in which a reformatted approach is adopted, be it in the topics discussed, the textbook used, the technology employed, or the assignments/exams given. More precisely, the presentation explores the effect of writing on improving student understanding of particular topics in differential equations and investigates the development of the students’ writing skills.

Teachers’ beliefs in the use of the calculator in Brunei primary school mathematics

Ahmad Fadzillah Hanafiah
Ministry of Education, Brunei, Darussalam
Session 4TD1P

The ministry of education of Negara Brunei Darussalam is introducing calculators for teaching and learning purposes at primary level. Elsewhere, this has been the subject of heavy debate for many years, if not decades – from arguing whether the calculators should be permitted in the classroom to how calculators can be used effectively in the classroom (Hembree & Dessart, 1986). This paper explores the beliefs, perceived knowledge and practices of primary teachers concerning the use of calculators in the teaching and learning of mathematics, which were identified by means of a questionnaire consisting of 20 items. The items were derived from the survey instrument used by Brown et al. (2007), and divided into four categories namely catalyst beliefs, teachers’ knowledge, crutch beliefs and teacher practices.

Good calculus problems for the TI-89 calculator and an online homework system: a decade of use in a university mathematics department

Mako E. Haruta
University of Hartford, USA
Session 3AS1P

Ten years ago, the University of Hartford Mathematics Department introduced the Texas Instruments TI-89 graphing calculator into the calculus sequence, prompting a rethink of the mathematics curriculum in light of the CAS feature, and discussions on how to best integrate the technology without sacrificing student conceptual learning. The CAS feature of the TI-89 calculator can turn many traditional calculus problems into button pushing exercises that require little mathematical understanding. In response, department faculty members have continued to modify existing problems and develop new and challenging problems that creatively assess student understanding of concepts while allowing full use of the technology during testing, on homework and in the classroom. In tandem, the Mathematics Department also piloted and eventually adopted the free, interactive, online homework system WeBWorK. Results have showed a dramatic increase in the quantity of homework assignments completed as well as a rise in faculty-student interactions via email and in office hours. Student response to the online system has been positive. Administrative features such as the ability to “rebuild” an individual set allow for creative pedagogical enhancements to student learning. Both technologies are required in all calculus courses and have successfully expanded into higher courses such as Differential Equations, Linear Algebra, and Advanced Engineering Mathematics.
work and as a context for applied mathematics and physics at secondary and undergraduate level. Modelling activities give a good impression of the potential of the subject of human gait for practical student use. We present the results of their research work, which resembled the practice of sport scientists. Video analysis of the rotation during the backward somersault shows the increased speed when the body is tucked. Video measurement offers the opportunity to investigate the angle changes of hip and shoulder joints during a backward giant circle on the high bar. A gymnast flexes after reaching the lowest point and extends before the highest point. A mathematical model of the gymnast and the high bar can be used to explore the gymnast’s body motion to understand the timing of flexion and extension.

Mathematics and physics come together in the presented research project at a rather high, but manageable, level provided that the students have adequate tools. The work is a nice illustration of authentic experiences of secondary school students in doing sports science that they will never forget.

A jump forwards with mathematics and physics

André Heck and Peter Uylings
Universiteit van Amsterdam, Netherlands

Session 5SL1P

In this presentation we focus on human body motions such as bouncing on a jumping stick, rope skipping, hopping and making kangaroo jumps, skipping, and running. Students can record the movements on video and use their video clips to investigate the motions with suitable video analysis and modelling software. We discuss some mathematical models of these motions using basic physics and we compare modelling results with experimental data obtained from video measurements. The highlight is the application of the model of an inverted, planar spring-mass system: this rather simple model works well qualitatively and quantitatively for the complex motions of hopping, skipping and running at moderate speeds. The examples of video analysis and modelling activities give a good impression of the potential of the subject of human gait for practical student work and as a context for applied mathematics and physics at secondary and undergraduate level.

Adapting the game-based learning software Racing Academy for use in engineering education

Ya Huang
Department of Mechanical and Design Engineering, University of Portsmouth, UK

Jos Darling
Department of Mechanical Engineering, University of Bath, UK

Richard Joiner
Department of Psychology, University of Bath, UK

Session 5SL3P

Following the development and implementation of the game-based learning software Racing Academy in Mechanical Engineering courses at the University of Bath since 2008, the software was adapted for 160 Year 1 Mechanical Engineering students at the University of Portsmouth in 2010. Racing Academy employs principles of engineering dynamics to simulate and display on a PC, in real time, a car drag race in which students modify their car by selecting components, including choosing an engine, tyre and gearbox from a set menu. A work sheet was designed based on configuration provided by the software to try and lead students through the process of playing Racing Academy. The aim was to complete a drag race in the minimum time and display the time histories of velocity and acceleration. A lab report on how they had improved their lap times was assessed.

The display and ensuing analysis of velocity and acceleration in real time is expected to make more intuitive connections between physical observations of a race and the mathematical operation of integration and differentiation. These operations are fundamental ingredients in engineering dynamics education.

The students and staff at the University of Portsmouth involved in this project provided feedback based on questionnaires collected before and after the task. The questionnaires were designed in the same protocol as those used at Bath. Feedback at both institutions found improvement in students’ engineering understanding, but there was no increase in students’ motivation towards engineering after playing Racing Academy. This paper compares the results collected at the two institutions.

Pre-service teachers’ understandings of learning to use information technologies in secondary mathematics teaching

Rosalyn Hyde and Julie-Ann Edwards
University of Southampton, UK

Session 2TD1P

One of the biggest challenges facing pre-service teachers is that of learning how to make effective use of digital technologies in the classroom to enhance the learning of their students. For initial teacher educators, the challenge is to enable the development of teachers who have the capability to respond flexibly to new technologies and who are able to evaluate and reflect on the impact of such technologies on learning. This paper reports on the first part of an on-going research project examining ways in which pre-service mathematics teachers can more effectively develop skills in using digital technologies in enhancing teaching and learning in the classroom. It examines the evidence collected from a cohort of pre-service teachers at the end of a one-year postgraduate initial teacher education course. The pre-service teachers were asked about their experiences, both on school placements and in university. We examined their learning about using technology, the difficulties they faced and the type of experiences from which they think successive cohorts of pre-service teachers would benefit.
The indirect impact of using modern technology, especially the calculator and the Internet, in reducing mathematics anxiety

Ali Jafarabadi
Education Department, Iran

Session 2AP2P

The relatively recent introduction of new technology into the mainstream of education has been accompanied with hot debates. The terms “technological tools” or “ICT” encompass the range of hardware and software with not necessarily the same effects on the educational process and this makes the debates so burning and complicated. Hence, we cannot approve one rule for all the cases and educators are supposed to investigate these into groups which exhibit common codings and warrant further investigation. The project, initiated in the context of Engineering Maths at Loughborough, is being further developed jointly with the department of Mathematical Sciences at the University of Liverpool with a view to improving the flexibility and adaptability of the system. The current application is for a class of 250 students each submitting six assignments. Student and staff feedback is being used to improve the system and its implementation.

Automated assessment and feedback on MATLAB assignments in computational mathematics

Alan Irving
Department of Mathematical Sciences, University of Liverpool, UK

Session 7AS1P

We report progress on an automated system for the assessment and provision of feedback on computational mathematics assignments using MATLAB. Each assignment product is designed as a self-contained MATLAB function file, which accepts externally supplied test data and whose output contains the required assignment results. The latter can include intermediate as well as final results so that partial credit and more useful feedback can be given. The assessment code checks whether the submitted function runs and, if it does, tests the requested output against a correct reference code, using a variety of inputs. The results, anonymised total marks and individual feedback files, are made available via the VLE and the web. Useful marking details and summaries are provided for the tutor to assist with assembling generic feedback for the whole class. An additional facility allows the tutor to convert the marking script into a modified binary version that the students can use to get preliminary feedback on how well their code performs against the final marking criteria. This helps prevent the student performing blind submission of code that is doomed to failure because of some simple programming error. We have also developed code that compares the active portions of all submitted code to check for collusion. It assigns a numerical correlation coefficient to similar pairs of files and then, where necessary, collects these into groups which exhibit common codings and warrant further investigation.

Theatrical or efficient use of ICT in mathematics teaching?

Antonín Janěáøík and Jarmila Novotná
Faculty of Education, Charles University, Prague, Czech Republic

Session 2IN1P

The use of computers in mathematics education at primary and secondary school levels and in pre-service teacher training is topical. Computers have become a tool of motivation and foster comprehensible interdisciplinary links between mathematics and other subjects. However, the use of computers in teaching asks for new approaches to exposition and to mathematical content. This might be one of the reasons why recent studies in mathematics education show that, despite many national and international actions aiming at integration of ICT into mathematics classrooms, such integration in schools remains underdeveloped. The rate of this integration increases markedly slowly when compared to the speed of evolution of the technology.

One of the causes for this state is the huge diversity of ICT resources, which often leaves teachers unsure of which to use, and when and how to use them. Another important retarder of successful use of ICT in teaching is a lack of information on the potential advantages and dangers of inclusion of activities using ICT into teaching. Despite the fact that ICT has a huge potential in teaching, examples from practice show that in many cases theatrical examples contribute very little to development of mathematical knowledge and may even be counter-productive.

Integration of computers into teaching should always be governed by the principle of its efficiency. It is appropriate to use computers only in those situations in which it really brings benefit, opens new perspectives or significantly decreases the amount of time needed for technical calculations. The aim of this paper is to demonstrate the potential of both of these ways of use of ICT on concrete problems and herewith to show examples of improper use of ICT.

Implementing a dynamic geometry approach in classrooms

Zhonghong Jiang
Texas State University, US

Session 6CU2P

This paper describes the theoretical foundations and key elements of an approach to high school geometry that utilises dynamic geometry (DG) software and supporting instructional materials to help students construct mathematical ideas. The presentation will focus on how that approach will be operationalized in the classrooms and a research study that examines the efficacy of the DG approach.

Dynamic Geometry is active, exploratory geometry carried out with interactive computer software such as the Geometers’ Sketchpad and Cabri-Geometry. The theoretical foundations of the DG approach are the constructivist perspective and van Hiele’s learning model. As the key elements of the DG approach, the teacher should lead the students to construct geometric objects, perform actions (drag, measure, transform, and/or animate) on the constructed objects, observe what characteristics change and what remain the
same, investigate mathematical relationships, form and test conjectures, receive immediate feedback, think mathematically and prove (or disprove) conjectures.

A four-year study is funded by the US National Science Foundation to conduct repeated randomized control trials of the DG approach. The study compares effects of that intervention with standard instruction that does not make use of computer tools. The basic hypothesis of the study is that the DG approach results in better geometry learning for most students. The study tests that hypothesis by assessing student learning in 76 classrooms randomly assigned to treatment and control groups. Student learning is assessed by a standardized geometry test, a conjecture-proving test, and a measure of student beliefs about the nature of geometry and mathematics in general. Teachers in both treatment and control groups also receive relevant professional development. Fidelity of implementation for the experimental treatment is monitored carefully. Data for answering the several research questions of the study are analyzed by appropriate HLM methods. This presentation will report on the first two years of the study.

Working in the 21st century – moving teacher professional development online

Angela Jones
Ministry of Education, New Zealand

Session 7TD3P

2010 has been a time of change for secondary education in New Zealand as schools and teachers implement the New Zealand Curriculum. As part of a three-year implementation the Ministry of Education (MoE), in association with the New Zealand Qualifications Authority, has been reviewing all curriculum-related standards so that they are aligned to the New Zealand Curriculum, to resolve issues of duplication between standards and ensure credit parity.

As most teachers are only now becoming familiar with our new achievement standards, sample assessment resources (tasks) are vital. In recognition of this the MoE is providing two resources for each new Level 1 standard. The New Zealand Association of Mathematics teachers (NZAMT) has a history of providing secure resources (tasks) to support the old standards to teachers.

I recently instigated a series of professional development (PD) for teachers in New Zealand involving working with teachers and advisors writing additional assessment resources for use by the wider teaching community via NZAMT. In the absence of direct funding a face-to-face writing workshop was impractical. Writing was undertaken voluntarily by advisors and teachers in the virtual space – made possible via the use of an Elluminate virtual meeting room and a free educator wiki. These writing workshops have involved a high level of professional development for those involved particularly as understanding the standard has to be the first priority before valid assessment tasks can be written. We have finished two cycles of writing and completed the development of three resources to the final editing stage. These results, obtained with minimum budget, sector buy in and high PD are extremely positive.

The aim of the presentation will be to share the experiences from these writing workshops, discuss feedback from teachers and consider future opportunities for online professional development.

Using Grand Challenges within technology enhanced learning (TEL) to frame research and practice in mathematics teaching with technology

Marie Joubert
University of Bristol, UK

Session 2IN2P

There is now a wide research literature concerning the use of technology in the teaching and learning of mathematics. General text books, guidance for teachers, national curricula and other teacher materials almost always include advice and guidance related to the use of technology (ICT) and practitioner journals frequently include accounts of how technology has been used in a particular setting. Both research and practice have commonly framed their understanding of the landscape of ‘what is going on out there’ in terms of the software or hardware used (e.g. dynamic geometry or handheld technologies) or in terms of the mathematical area addressed (e.g. graphs and functions, geometrical transformations.)

This presentation/paper takes a different approach, borrowing the three Grand Challenge themes from the European Network of Excellence, STELLAR, to frame our understanding of the research and practice presented within this ICTMT10 conference. The three Grand Challenge themes are:

1) Connecting learners, which is concerned with the issues and questions that arise from the increased connectedness of learners through the use of, for example, the Internet.
2) Orchestrating learning, which aims to understand the opportunities and challenges for teachers when technology is introduced into their classrooms.
3) Contextualizing learning, which focuses on how the use of technology provides new and different learning contexts for teaching and learning.

I argue that the use of this Grand Challenge framing will provide a new and different understanding of the current landscape and future challenges for research and practice in the use of technology in mathematics teaching, and the presentation will conclude by considering what a mid-term research agenda might look like for our community.

Teachers’ scenarios with the use of digital tools in mathematics as a means of redefining the teacher–curriculum relationship

Elissavet Kalogeria and Chronis Kynigos
Educational Technology Lab., School of Philosophy, University of Athens, Greece

Giosgos Psycharis
Department of Mathematics, University of Athens, Greece

Session 1TD1P

The present study analyses 19 scenarios developed by mathematics teacher educators-in-training, during their training course at the University of Athens. The subject of the course was the pedagogical use of digital tools in the teaching of mathematics. Scenarios were used as one of the methods for increasing reflection.

A scenario with the use of technology in the teaching of mathematics should include a series of crucial aspects concerning the teaching and learning process, such as the mathematical concept on which it focuses; the students’ difficulties in relation to it; the mathematical concepts that are going to be embodied in the software microworlds; the added value given by technology; the kind of meanings the students are expected to develop; the social orchestration of the classroom; and time–space parameters and the teaching management.
The inclusion of all the above aspects goes beyond the classical teaching plans and gives a strategic character to the process of developing a scenario. It brings the teacher to the centre of attention and demands him to undertake an active role in the development of new, innovative curricula, enriched with the use of technology.

This study describes the analysis of scenarios with the use of the exploratory software “Turtleworld” and tries both to record the features of scenario design and investigate the role of this process in the teacher-curriculum relationship.

According to the findings of our analysis, teachers deconstructed and reconstructed the formal curriculum, depending on the needs of their scenarios and the mathematical concepts that were chosen to be embodied. By using the software tools they created many representations for those concepts, connected them accordingly and organized new, widened conceptual fields for them.

The visualisation of multivalued functions

Gabriel Katz
Massachusetts Institute of Technology, US

Vladimir Nodelman
Holon Institute of Technology, Israel

Session 2SS3P

Arithmetic operations with multivalued functions challenge the standard rules of algebra. Students first meet the notion of a multivalued function while studying the radicals (roots) of complex numbers. This subject becomes especially important in the complex analysis. Conceptual difficulties in operating with multivalued functions call for adequate visualisation tools. Our paper provides an analysis of instructional activities and of the software that helps to visualise graphs of complex multivalued algebraic functions. In our approach, we are guided by the classical theory of Riemannian surfaces. We exhibit templates of interactive visual models that probe the complex world of multivalued functions as well as samples of creative explorations of this mathematical world by the students. As a result, VisuMatica, a comprehensive software package developed by the second author, brings under the same roof the visual study of algebra, complex analysis, and elementary topology.

Learning about functions within a geometrical and symbolic software environment: a two-year study

Tran Kiem Minh
Laboratoire LDAR, Université Paris Diderot - Paris7, France

Session 7SE1P

Software learning environments, especially those offering extended multi-representational capabilities, are increasingly complex. That is why researchers are now sensitive to the process of instrumental genesis that transforms this kind of artefact into an instrument for students’ mathematical work. The necessity of considering students’ and teachers’ instrumental genesis when introducing new tools in mathematics teaching learning is now widely recognised (Artigue, 2002; Bueno-Ravel & Gueudet, 2009; Drijvers, Kieran & Mariotti, 2010). It is also recognised that when a tool offers a wealth of capabilities deeply connected to mathematical knowledge, the instrumental genesis is likely to be complex and cannot be achieved in the short term. It is especially the case of tools offering the means to work both on geometrical and algebraic situations, and articulate these (Weigand & Bichler, 2010). Few studies actually provide specific examples of a genesis of one especially important in the complex analysis. Conceptual difficulties in operating with multivalued functions call for adequate visualisation tools. Our paper provides an analysis of instructional activities and of the software that helps to visualise graphs of complex multivalued algebraic functions. In our approach, we are guided by the classical theory of Riemannian surfaces. We exhibit templates of interactive visual models that probe the complex world of multivalued functions as well as samples of creative explorations of this mathematical world by the students. As a result, VisuMatica, a comprehensive software package developed by the second author, brings under the same roof the visual study of algebra, complex analysis, and elementary topology.

The role of interactive assistance in discovering geometrical theorems at secondary school

Magdalena Kucio
Gimnazjum nr 9, Kraków, Poland

Session 7SS2P

There are many interesting geometric theorems essential for didactics. Many of them refer to the analysis of the properties of geometrical figures. Some of them can be analysed and expanded during extra-curricular activities for pupils who show mathematical skills or interests.

Teaching practice shows that solving geometrical problems causes many difficulties for pupils. The question is whether a well-chosen interactive tool can help to remove these barriers. The possibility of providing pupils with materials prepared and sent by the teacher over the Internet is the additional advantage of such a course in the future or already have years of expertise, this presentation will allow an occasion to discuss best practices. I will conclude with some feedback on the online experience as well as an overview of the tools and changes I hope to implement in future online courses.

Teaching mathematics online: creating a rich learning environment

Ilona Kletskin
University of Toronto, Canada

Session 3SE1P

In today’s rapidly changing educational landscape, online courses are becoming an increasingly prevalent component of undergraduate instruction. Online courses are extremely attractive in the flexibility that they offer to learners, but providing an engaging learning environment online can prove to be a challenge. In this talk, I will discuss my experiences developing and teaching an online first-year Calculus course.

Looking at issues of course design and management, assessment, and student engagement, I will discuss the challenges and opportunities that come with the online environment, and how tools such as WebCT blogs and Adobe Connect can be used to enrich the online classroom. Whether you might be teaching an online course in the future or already have years of expertise, this presentation will allow an occasion to discuss best practices. I will conclude with some feedback on the online experience as well as an overview of the tools and changes I hope to implement in future online courses.

The role of interactive assistance in discovering geometrical theorems at secondary school

Magdalena Kucio
Gimnazjum nr 9, Kraków, Poland

Session 7SS2P

There are many interesting geometric theorems essential for didactics. Many of them refer to the analysis of the properties of geometrical figures. Some of them can be analysed and expanded during extra-curricular activities for pupils who show mathematical skills or interests.

Teaching practice shows that solving geometrical problems causes many difficulties for pupils. The question is whether a well-chosen interactive tool can help to remove these barriers. The possibility of providing pupils with materials prepared and sent by the teacher over the Internet is the additional advantage of such a course in the future or already have years of expertise, this presentation will allow an occasion to discuss best practices. I will conclude with some feedback on the online experience as well as an overview of the tools and changes I hope to implement in future online courses.

In my lecture I will focus on research of the interactive teaching materials created with the help of the GeoGebra program. I will also present examples of such tools and ways of using them. The research shows that there are not only positive aspects of using such teaching aids and I would also like to share my observations of some possible dangers connected with this type of teaching.
Combining theoretical frameworks to investigate the potential of computer environments offering integrated geometrical and algebraic representations

Jean-Baptiste Lagrange
Université Paris Diderot and University of Reims, France

Session 8CU1P

Many authors now stress the advantage of considering sensual experience of dependencies as a basis for students’ understanding of the idea of function and report on teaching experiments aiming to connect this experience to the algebraic notion of function. Some computer environments offer integrated geometrical and algebraic representations and functionalities to support this approach to functions. As for us, our aim is to study how dedicated software and classroom-based modelling activities can help students to construct the chains of functional meanings connecting representations of functions at different levels. We used two software environments that have been developed under different theoretical frameworks in different research and national contexts. One of these (called Turtleworld) is a piece of geometrical construction software that combines symbolic notation, through a programming language (Logo), with dynamic manipulation of geometrical objects by dragging on sliders representing variable values. The second software (called Casiope) offers a dynamic geometry window connected to a symbolic environment specifically designed to help students to work on functions.

In order to make sense of the respective potential of these environments for functional meaning making we exploit a grid designed to classify various activities about functions, and show potential connections between these. We also consider two teaching experiments (design and implemented): one with Turtleworld in the Greek context inspired by constructionism, and one with Casiope in the French context inspired by the theory of didactical situations. The paper aims to broaden views about the conceptualisation of functions by students by establishing links between these teaching experiments and by coordinating the underlying frameworks, constructionism, theory of didactical situations and also instrumental approach. We adopt “cross analysis” as a methodology built within the project ReMath as a means to progress in connecting and integrating theoretical frameworks in technology enhanced mathematics.

References


The influence of DGS on the production of geometrical justifications

Víctor Larios-Osorio
Universidad Autónoma de Querétaro (Fac. de Ingeniería), Mexico

Session 6SS1P

In the last year, two research projects were carried out with secondary school students in Mexico to observe the influence of dynamic geometry software (DGS) on the observation of geometrical properties, the formulation of conjectures and the production of deductive arguments (Larios, 2005; González, 2010). Two teaching experiments were designed with Cabri mathematics software to consider the properties of triangles and quadrilaterals. These experiments involved 14–15 year-old Mexican students from one public school. The results were analysed according to the theory of figural concepts (Fischbein, 1993) and the cognitive unity of theorems notion (Boero, Garuti, Mariotti, 1996), while also considering the role of DGS as a semiotic mediator between the geometrical knowledge and the students.

The results show that students’ production of justifications is influenced not only by the ideas about geometric proof and deductive argument, but also by the use of the software as a tool and by cognitive phenomena related to figural aspects of the geometric objects. For instance, we have observed that geometrical rigidity (Larios, 2005) hinders the proper observation of geometric properties (even on the dynamic environments). We also note that discourse of students (and their justifications) refers to the software, its options and its dynamic features. Thus the need arises to design suitable tasks for the classroom and to identify the teacher’s role in dynamic environments, while considering a suitable vision about geometric justifications in the classroom environment which takes into account the mathematical meaning of the proving process (Larios & Acuña, 2009).

References


Assessing mathematical problem solving behavior in web-based environments using log file analysis

Moshe Leiba and Rafi Nachmias
School of Education, Tel Aviv University, Israel

Session 3AS3P

Problem solving can be described as being composed of three dimensions: the problem, the process, and the outcome. Over the years, mathematical problem solving research has focused on describing the process, as well as on understanding attributes affecting it, and assessing its outcomes. Most of the research in this field is qualitative, and this is understandable due to the fact that the cognitive and meta-cognitive investigation involved in problem solving are complicated to trace. Nowadays, when many problem solving environments are implemented using the web, innovative research methodologies may be applied for assessing problem solving behavior in large populations. These innovative research methodologies rely on log file records, which are automatically and continuously collected by Internet servers, that document (almost) every action taken using three basic parameters: what was the action taken, who took it and when. The main purpose of this research is to explore cognitive and meta-cognitive processes during problem solving activities in online environments being used in elementary schools in various areas of mathematics (geometry, fractions, series, etc.).

The core of this research entails the development of a correspondence scheme between the logged traces of the students and the observed problem solving behavior. A mixed method involving both qualitative and quantitative analysis has been chosen for this research. Problem solving behavior is assessed by means of qualitative research, using think-aloud protocols as well as actual learning behavior in the online learning environment using log files (N = 5). Data from both sources are then triangulated, aiming to reflect on students’ problem solving behavior documented in log files; patterns in problem solving processes and factors affecting them will be investigated using quantitative (data mining) methods (N > 1000).
E-assessment in mathematics and statistics

Jeremy Levesley
University of Leicester, UK

Sally Barton
University of Nottingham, UK

Chris Sangwin
Birmingham University, UK

Bill Foster
Newcastle University, UK

Session 7AS2P

This session introduces an exciting new project funded by HE STEM involving 20+ HE institutions and focusing on the use of e-assessment. Many HE institutions are using e-assessment in mathematics and statistics and have reported benefits in pedagogy, feedback and resource saving especially at the teaching-intensive early stages of degree courses. However, there is little sector-wide structured dissemination, which results in a duplication of effort not only in implementation strategies, but also in the writing of questions and the creation of local e-assessment systems. There is now a need for this experience to be consolidated, shared and jointly reflected upon by the mathematics and statistics community, so that the potential contribution to mathematics and statistics teaching and learning as a whole can be evaluated. A sector-wide approach has been adopted and this project brings together a large group of university practitioners (20+), with professional providers of e-assessment technology as well as the eAssessment Association, to coordinate the sharing of experience. The key aims are to:

- Demonstrate benefits to institutions, staff and students.
- Address barriers to introducing sustainable and effective e-assessment.
- Give supportive and evidence-based guidance.

Outcomes

- Information for all STEM disciplines on present benefits and developments in e-assessment for mathematics and statistics in HE. This includes open-source e-assessment systems.
- Sharing of best practice through wide-scale dissemination to all STEM disciplines.
- Understanding barriers to the sustainable use of e-assessment in STEM disciplines and to potential future developments in HE.
- Criteria and implementation strategies in terms of pedagogy and resource implications, tested by our case studies at Nottingham and Leicester, helping departments and schools introduce sustainable e-assessment into their curriculum.
- A web-based e-assessment advisory resource for mathematics and statistics.
- Models for staff development in using e-assessment.

Video tutorials in teaching mathematics

Matija Lokar
Faculty of Mathematics and Physics, University of Ljubljana, Slovenia

Session 4TD3P

At the Faculty of Mathematics and Physics, University of Ljubljana, students use many computer-based mathematical tools. In a special course entitled “Computer tools in mathematics” various tools and the possibilities of their application in practical problem solving are studied. A part of the resources available to students are e-resources in the form of interactive tutorials, which explain the basic features of the tools used and demonstrate how they are used in the solving of different mathematical problems. The talk presents an approach towards creating such tutorials where GeoGebra is used. The software used in developing the tutorials is a freeware program, DebugMode Wink. These tutorials are produced by capturing screen snapshots while using GeoGebra. On each screenshot explanation boxes, audio, titles, navigation buttons and more can be added. The usage of navigation buttons allows the user of the tutorial to follow the construction more easily and to adjust the speed of the presentation to match his/her level of understanding. The e-resources created for this course are also used in the NAUK project (www.nauk.si), where free e-resources from mathematics, physics, logic and computer science can be found, and also in the EU Comenius project European Development for the Use of Mathematics Technology in Classrooms (EduMatics).

Online support for a distance-learning mathematics course

Tim Lowe
Department of Mathematics and Statistics, The Open University, UK

Session 8AS2P

The Open University has recently replaced its introductory mathematics module. The new module was launched in February 2010 and is offered twice each year, with at least 1500 students expected per presentation. Whilst based around printed course materials, the module makes extensive use of the Open University’s Moodle-based VLE to support and encourage learning.

In addition to online student forums and short videos of tutors explaining worked examples, several topics are supported by online applications to allow students to investigate the mathematical concepts involved. Each of the 14 units has an associated “Practice Quiz” to enable students to check and consolidate their understanding of the content of the unit. Students can take these quizzes as many times as they wish and will (probably) get a different set of questions each time. Up to three attempts at each question are permitted, with feedback and graduated hints being given after each incorrect attempt to facilitate and encourage independent learning. Complete worked solutions to each problem are also provided.

Alongside these “Practice Quizzes” are five online summative assessments, most covering several units. The questions in these are also randomly selected, but only one attempt per student is permitted and feedback is delayed until after the assessment cut-off date.

This presentation will discuss these online elements of the module and, in particular, their usage by students on the first presentation of the module.
Investigating numerical quadrature rules with a computer algebra system

Alasdair McAndrew
School of Engineering and Science, Victoria University, Australia

Session 7SE2P

With their ease of numerical and symbolic handling, computer algebra systems excel in handling difficult integrals numerically. Problems that might have taken students a long time to do with a handheld calculator can be done swiftly and easily with a few simple commands. Most computer algebra systems will contain some quadrature methods built in: trapezoidal, Simpson’s and higher-order Newton-Cotes rules, as well as Gauss-Legendre and other methods. In a standard undergraduate calculus course, students may well be introduced to the trapezoidal, Simpson and mid-point rules, with other methods waiting until a formal course in numerical analysis. But, in fact, it’s quite easy for students to develop their own rules for numerical quadrature, and to rediscover rules now only found in old texts, such as Weddle’s and Boole’s rules. In this talk I will show how students can play with quadrature rules, how new rules can be created, and how they can be tested.

Extreme CAS, the Bloodhound SuperSonic Car and the world land speed record – taking computer algebra to the limit

Michael McCabe
University of Portsmouth, UK

Ian Galloway
Science Learning Centre South East, University of Southampton, UK

Chris Blow
Student, University of Portsmouth, UK

Session 1SL2P

The Bloodhound SuperSonic Car (SSC) is a British project with the key objective of breaking the world land speed record of 763 mph and raising it to 1000 mph. It is by no means certain that this feat can be achieved, but mathematical calculations suggest that it can be done with existing technology. A wide range of problems, including the aerodynamic drag, propulsion, stability and safety, need to be overcome for the project to succeed.

The overarching objective of the project is to stimulate UK growth and investment in STEM (Science, Technology, Engineering and Mathematics) subjects. Bloodhound SSC is already attracting the interest of a
Papers – Abstracts

younger generation and encouraging them to follow careers in these areas. If the project succeeds its impact is expected to be even greater, just as the Apollo 11 Moon landings inspired a generation.

Mathematical activities relating to Bloodhound range from the use of arithmetic, algebra and calculus to find the acceleration, speed and distance travelled right through to the advanced computational fluid dynamics needed to optimise the car design. To illustrate some of the intermediate level mathematics, a final year undergraduate project has used the Maple computer algebra system to explore the horizontal (acceleration and deceleration), vertical (suspension), circular (wheels) and lateral (steering) motion of the car. Maple calculus and animations use accurate parameters from the design specification of the car to simulate its motion. Many other extensions to this work are possible.

During the past five years, there has been a major UK commitment at government, university and school level to investment in STEM subjects. Although the Bloodhound SSC team is only funded by modest donations from corporate sponsors and members of the public, its educational legacy may be just as important for inspiring young minds.

ICTMT delegates will be able to view a full-scale Bloodhound show-car outside the Portland Atrium from Monday to Wednesday of the conference. The Bloodhound driver, Andy Green, will be giving an invited talk about the project on Wednesday evening at 18.00.

Bloodhound SSC  www.bloodhoundssc.com

Mathematics ... and the land speed record! Final year mathematics project by Chris Blow
http://userweb.port.ac.uk/~mccabeem/projects2011/chrisblow.pdf

Research informed teaching projects in pro-am astronomy with Maple, MATLAB and GeoGebra

Michael McCabe
University of Portsmouth, UK

Graham Bryant, David Harris, Dave Briggs, Steve Knight, Carol Bryan and Robin Gorman
Hampshire Astronomical Group

Session 1SL3P

Since 2006, the UK research informed teaching initiative has provided funds (£10.1 million in 2010/11) for linking teaching and research, including the engagement of undergraduate students in research activities. While research into mathematics education is well established, taking mathematics education into research at university undergraduate level is extremely difficult.

There is a longstanding tradition of collaboration between professional and amateur astronomers, which began more than a century ago with the first measurement of a galaxy redshift (Henden, 2006). This paper reports on a project funded by the University of Portsmouth since 2009 to enable final year mathematics undergraduates to engage in research informed activities within pro-am astronomy. Progress in these projects has been achieved through the use of mathematical software (Maple, MATLAB, GeoGebra and Excel) to model recent astronomical observations.

Student motivation has been increased by providing the additional personal support of a mentor at the local Clarendfield observatory. Students have been helped to collect their own observational data for analysis and mathematical modelling.

One specific project, to which students have actively contributed, is in trying to unravel the mystery of Epsilon Aurigae, a star which has been observed since the mid-19th century. Epsilon Aurigae is eclipsed by a proto-planetary nebula every 27 years for a period of two years. The latest eclipse ran conveniently from August 2009 to May 2011 and has attracted international attention (Hopkins & Stencel, 2009). Mathematical modelling of the transit uses several different numeric, algebraic and geometric methods to produce a light curve for comparison with both local and international observations. For example, Monte Carlo simulations using Matlab have generated a realistic model of the Epsilon Aurigae system.

A similar project has been the observation and modelling of exoplanet transits (Haswell, 2010), the passage of planets beyond our Solar System across the line of sight towards their parent stars. Around 25% of the 500+ exoplanets detected during the past 15 years have been discovered by this method. The circular geometry of the eclipsing planet simplifies model calculations, although the observations are harder to make. Projects to observe asteroid rotation, solar activity and lunar topography are closer to home, but equally challenging.

Traditionally university undergraduates work on “clean” virtual simulations, allowing results to be guaranteed, but these projects give experience of the difficulties and frustrations associated with unpredictable scientific activities. Students are able to visit the observatory regularly both to gain experience of the practical issues involved and to discuss their progress. By analysing data and testing out different possible mathematical models, students can make a genuine contribution to pro-am astronomy in partnership with others.

References

Henden, A.A. (2006) Pro-am collaboration and the AAVSO.
www.hposoft.com/Campaign09.html

Contemporary mathematics: it’s starting to click

Jean McGivney-Burelle
University of Hartford, West Hartford, CT, USA

Session 3SE2P

At the University of Hartford our liberal arts mathematics course, Contemporary Mathematics (M116), covers mathematics discovered within the relatively recent past including Monte Carlo simulation, recurrence relations, voting methods, and graph theory. M116 draws students from music, art, education and the liberal arts and sciences. While these students are inherently bright they lack the motivational and confidence levels necessary to succeed in mathematics. Consequently, they are reluctant to ask questions in class because of past failure. In turn, this makes it difficult for faculty members to set a proper pace for the class and gauge student understanding.

As a way to engage students in M116 we have integrated a student-response system (i.e. clickers) into the course. In the short time we have used clickers we have found them to have a positive impact on promoting student engagement in class, encouraging participation from all students, and creating a safe space for shy and uncertain students to participate in class. The use of clickers has also allowed us to instantly gauge the general understanding of the class and take appropriate mid-course corrective action when students do not understand a particular concept or problem. Most recently we have begun collecting data on students’ responses to the questions we pose during class. Using these data we are able to write better questions – that is, questions that encourage more deliberation and discussion and result in more horizontal and less vertical bar graphs of responses.

In this presentation I will discuss our work with clickers in M116 including a discussion of the logistics involved and effective pedagogical strategies.
Introducing basic mathematical modelling concepts using sporting applications in MATLAB

Chris Mills
University of Portsmouth, UK

Session 6SL3P

Customised MATLAB scripts were used as an interface to demonstrate basic mechanical and modelling principles using sporting applications. Students began by applying constant acceleration equations to the simple sporting activity of kicking a football and were asked to determine the range of a kick based on initial angle and velocity conditions. The simple MATLAB projectile model was used to verify their calculations. The subsequent task involved optimisation of parameters within the constraints / simulation bounds to determine optimal performance criteria. What was the maximum distance the football could be kicked? What combinations of angles and velocities could be used to make a 20 metre pass?

Following this a more complex model of the cushioning properties of landing mats was introduced, which was based upon ongoing research in the area. After introducing the fundamental mathematics of modelling springs and dampers, students were asked to optimise the landing mat parameters to minimise the risk of injury within given constraints. A combination of basic mathematics, knowledge of the sporting activity and hands-on experience with the computer models seemed to engage students and help them visualise key biomechanical and modelling concepts within the 2010-2011 cohort.

Secondary school mathematics learners constructing geometric flow-chart proofs with a web-based learning support system

Mikio Miyazaki
Faculty of Education, Shinshu University, Japan

Taro Fujita
Faculty of Education, University of Plymouth, UK

Youichi Murakami
Sun First, Japan

Naoki Baba
Toyono Junior High School, Nagano, Japan

Keith Jones
School of Education, University of Southampton, UK

Session 7SS1P

As international research confirms, many secondary school students can find it difficult to understand and construct mathematical proofs. In this research project, we are developing a web-based learning support platform (available in both Japanese and English) for learners who have just started learning formal proof in geometry: www.schoolmath.jp/flowchart_en/home.html

In designing this learning platform we are adopting flow-chart proofs that include both open and closed problems in geometry that involve the properties of parallel lines and congruent triangles. By using technology based on Adobe Flash, learners complete proofs by dragging sides, angles and triangles to cells and our system automatically transfers figural to symbolic elements so that learners can concentrate on logical and structural aspects of proofs. The system identifies errors by referring to a database of acceptable answers classified into four categories. Learners then receive relevant feedback in accordance with the four types of error.

Solving contextual problems with the spreadsheet as an environment for the development of algebraic thinking

Sandra Nobre
Escola Básica 2, Olhão, Portugal

Nélia Amado* and Susana Carreira* (‘*presenters)
University of Algarve, Portugal and University of Lisbon

João Pedro da Ponte
University of Lisbon, Portugal

Session 8CU2P

Several authors (e.g., Ainley et al., 2004; Dettori et al., 2001; Rojano, 2002) view the spreadsheet as a powerful tool in mathematical problem solving, particularly in the development of algebraic thinking embedded in problem solving activities. One of the gains of connecting algebraic thinking and the use of spreadsheets is the creation of a significant environment to induce students into algebraic language. The spreadsheet has proved to be a relevant pedagogical resource in the construction of algebraic concepts, especially in what concerns working with functional relations, sequences and recursive procedures that are extensively used in solving mathematical problems. Using the spreadsheet in the context of problem solving emphasises the need to identify the relevant variables involved and fosters the search for variables that depend on other variables, resulting in composed relations. The definition of intermediate relations, by means of spreadsheet formulas in intermediate columns, meaning the decomposition of more complex relations in chained simpler ones, is a
special feature inherent to the use of the spreadsheet that amounts to important results in solving algebraic contextual problems (Carreira, 1992; Haspekian, 2005). Moreover, the spreadsheet offers an algebraic organization of the structure of a problem through an apparently arithmetic approach (Haspekian, 2003).

In this paper we report and discuss a contextual problem solving task relating the number of seats to the number of people in a restaurant, which was proposed to a class of 8th grade (13–14 year-old) students. These students had been developing a reasonable experience in the use of the spreadsheet to model relations within contextual problems and chose to use this tool to solve the aforementioned problem, engaging in the process of translating relations between variables and combining them in chained models, while working with fractions, multiples, and expressions. We intend to highlight the role of the tool in students’ processes of variable identification and translation of the problem conditions, their numerical approaches to algebraic models and their experimental forms of finding solutions to equations.

References


Old proofs, new technologies
Margarida Oliveira
Escola E.B. 2,3 Piscinas Lisboa and Universidade do Minho, Portugal

Suzana Nápoles
Universidade de Lisboa, Portugal

Session SCU2P
This paper focuses on a study that is being developed, in a school in Lisbon, on the impact of technologies on the teaching and learning of mathematics.

The objective of the work presented is to understand how designing simple computer programs, or translating a mathematical algorithm into a programming language, can improve student learning of mathematics, when compared with conventional teaching. It provides multiple and complementary representations to teach a mathematical concept.

It also aims to illustrate how computer programming can be considered a credible tool to deepen understanding of mathematical concepts and their specific applications, and to help develop students’ capacity to solve problems in mathematics.

Papers – Abstracts
It is crucial to understand the importance of mathematical representations in the teaching and learning processes as tools for the comprehension of the history of mathematics both in its cultural and scientific facets. The methodology used involves three groups of students: one of the third cycle of basic education (7–9th grades), a high school class (10–12th grades) and a third group of college students. It will take place during three consecutive years. An important factor for its success is to develop a systematic and continuous work from the very beginning of the school year, so that the basic procedures involved and the programming needed to develop applications can be rapidly internalized by the students.

The teachers involved in this project are regular teachers; the one for the third cycle is an early career teacher, the secondary school teacher has considerable experience, and we have a college professor. The work takes place in teams who carry out regular meetings to make necessary adjustments and to evaluate progress.

Alongside the work with students, the two school teachers (third cycle and secondary education) will also receive training. These teachers will develop materials for their students, thus allowing assessment of how this kind of work can be extended to all teachers.

The paper presents two typical examples present in the national curriculum for mathematics education. One concerns the demonstration of the well-known Pythagorean theorem and the other the resolution of a certain type of second degree equations given by the Arab mathematician al-Khwarizmi.

Designing windows for researching students’ experiences of dimension
Nicole Panorkou and Dave Pratt
Institute of Education, University of London, UK

Session 3SS2P
This study explored the experiences of dimension among young school children. A phenomenographic research study was designed (Marton, 1981) gathering meanings of dimension from 24 students during four situations. Data were collected using clinical interviews (Hunting, 1997), accompanied with the design of tasks using Elica software, physical objects, the film Flatland, and Google SketchUp in each of the four situations respectively. Within this overall methodology, there was a need to structure that experience. Whereas in some phenomenographic studies the aim has been to consider the depth of knowledge by forming a hierarchy between surface and deep approaches of a phenomenon, here the connection between setting and meaning emerged as the key-structuring factor. It therefore became appropriate to analyse that setting from the perspective of it being a ‘window’ on children’s experience of dimension and to see that experience as articulated in terms of ‘situated abstractions’ (Noss & Hoyles, 1996).

This paper presents an analysis of each situation by taking into account the representation of dimension in the tasks, the types of vocabulary resources available to students, and the level of students’ involvement and illustrates how each setting differentiated the generation of meanings among the children. An exploration of the potential and the constraints of the tools showed that SketchUp, together with the use of its dimensional tools, offered particular affordances for the mathematical expression of dimension, even though the children were very young (10 years old). Building on the idea of ‘designing for abstraction’ (Pratt & Noss, 2010) and the ways that designing and modelling fosters the utility of mathematical concepts (Anley, Pratt, & Hansen, 2006; Simpson, Hoyles, & Noss, 2005), the examination of the four situations gave an insight into what makes a window expressive both to the student phenomenon and the researcher–student relationship.
**Teachers’ attitudes and beliefs about using ICT in teaching mathematics**

Sirje Pihlap  
University of Tartu, Estonia  

Session 1TD2P

Several research studies confirm that using ICT in teaching mathematics motivates students in their learning process and facilitates their understanding of the subject (Baki & Güveli, 2008; Luik, 2004; Pihlap, 2009, 2010). Even though it has been possible to use computers in teaching mathematics for a long time, in many states there is a problem as the use of computers in classrooms is still low (Watson, 2002; Prei, 2010). In Estonia computers have been used in teaching mathematics for about 15 years. During the last 10 years, however, they have been used more widely. According to the present Estonian curriculum, it is not obligatory for teachers to use computers in teaching mathematics. It depends on the teacher if, and how, the ICT possibilities are used in mathematics lessons. A qualitative study was conducted to find out mathematics teachers’ attitudes and beliefs towards using ICT. Based on the interviewing of a focus group it is explained how teachers assess the necessity of using ICT and its impact on learning results and learning motivation. Also, the factors that determine a teacher’s decision on whether to use computers in teaching mathematics is clarified. Finally, it is pointed out as to what kind of help is needed by teachers to integrate computers into mathematics instruction.

**Using interactive GeoGebra-based educational assistance for introducing concepts connected with averages – preliminary research results**

Marzena Płachciok  
Gimnazjum nr 32, Kraków, Poland  

Session 6SS2P

The geometrical interpretation of averages, Cauchy’s theorem and similar statements present a barrier to understanding that can sometimes be difficult to overcome even for stronger pupils. The fact that teachers do their best during classes is not enough to overcome the problem. Here the idea of didactic assistance, which is available “outside the classroom”, becomes relevant. Interactive material, accessible to pupils via the Internet, may be helpful because not only can it explain but it can also widen topics using additional materials. Students can then work with it in their own individual way.

In my lecture I shall demonstrate such a didactic conception by showing how the interactive GeoGebra software package, published on an e-learning platform, can be used to introduce concepts connected with averages. This assistance includes not only traditional material and classic tasks, but goes beyond the range of the current curriculum. In my research I concentrate on 16–17 year-old pupils. The results of my research show not only the positive aspects of using such help but also the risks of teaching in this way.

**Analysing T-algebra solution files to improve student support**

Rein Prank  
University of Tartu, Estonia  

Session 2SS1P

T-algebra (http://math.ut.ee/T-algebra) is an interactive learning environment covering four areas of school mathematics: calculation of the values of integer expressions; operations with fractions; solving linear equations, inequalities and linear equation systems; and operations with polynomials. The student solves tasks step-by-step. Each solution step in T-algebra consists of two substeps: 1) Selection of the operation from the menu and marking the operand(s) in expression. 2) Entering the result of the operation. The program verifies each substep and displays error messages. The student should correct any mistakes before going on to the next substep. Explicit input of the intentions of the student in substep 1 enables them to avoid entering the results of meaningless conversions. The program also contains an automatic solver and is able to give hints in any situation. T-algebra saves students’ solutions (both finished and unfinished) in solution files together with all error and help request situations. The main program and additional teacher tools for reviewing the work of the group on an assignment enable: the viewing of solutions and error/help situations as they looked on the student’s screen; the creation of student/task tables of solved/unsolved tasks, step counts, solution times, error counts, hint counts; the creation of message/task tables to indicate how many times different error messages have appeared (ordered by frequency); and the performing of data mining for appearance of concrete expressions, messages, error categories, and sticking points in the solution process. This paper describes how we used the reviewing facilities to identify the difficulties caused by T-algebra itself. As a result, we made some changes in the operation of the student program, reformulated several instructions for steps and error messages and developed additional recommendations for teachers on how to obviate certain difficulties. For associated documentation email: rein.prank@ut.ee

**Didactic computer games as a tool for discovering reductive reasoning**

Tadeusz Ratusiński  
Pedagogical University of Kraków, Poland  

Session 3SS3P

Reduction is a very effective type of reasoning, especially for solving mathematical problems. One of the primary aims of school teaching is to demonstrate such a way of thinking and argumentation to pupils. However, it is hard to teach reduction in a natural way in a school setting. Could some particular type of mathematics problem help with this? Well-chosen educational computer games could perhaps provide a solution. They can discreetly provoke situations in which pupils discover the reductive method in order to win the game. In my lecture I’ll show the results of research in the use of educational computer games for developing reductive reasoning in 10–13 year-old pupils. I have tested a few specially prepared PC games based on Flash technology “outside the classroom”. The results highlight the positive aspects of using such a tool, especially when students must change their way of thinking from visual perception to numerical inference.
Using sport to engage and motivate students to learn mathematics

Carol L. Robinson
Loughborough University, UK

Session 6SL2P

In recent years concerns have been expressed about the level of student engagement in the learning of mathematics at university. There can be a wide variation in the level of prior knowledge of students and many do not appreciate the importance of mathematics for their course. Often they are taught in large classes and poor attendance at lectures and tutorials is not uncommon. Universities are finding that they have to look at ways of addressing the issues of how to motivate and assist such students in their learning of mathematics. This paper describes how technology has been used to motivate students of Sports Technology in the learning of mathematics at Loughborough University. Applications from the world of sport are introduced whenever it is appropriate and MATLAB is taught to enable the students to solve realistic problems. The mathematical background of the students involved is varied and the required pre-requisite is a GCSE grade A in mathematics. Group projects include modelling the velocity of a downhill skier, the height a pole vaulter can clear, the effects of lift and drag on the length of drive of a golf ball, and the size of parachute required to ensure a smooth landing. All of these require the use of the MATLAB. In-class engagement is enhanced by the introduction of electronic voting systems. Questions involving sporting applications can be posed in-class and immediate feedback received. The effect of introducing such material, on attendance and progression rates, and student engagement is also reported. For associated documentation email: c.l.robinson@lboro.ac.uk

Mathematical modelling with technology: the dynamic role of representations

Ornella Robutti, Ferdinando Arzarello and Francesca Ferrara
Dipartimento di Matematica, Università di Torino, Italy

Session 2SS2P

Our research deals with the use of different technologies in problem-solving activities at secondary school level.

The activities are of two kinds: one deals with sequences of natural numbers, the other with geometry and motion. The overall aim of the activities is to find a model (respectively for a sequence and for a geometric configuration) to describe the situation, and to represent this model in various ways (using a table, a recursive function or a close formula for the sequence, and using a construction or a Cartesian graph for the geometric situation).

The tasks have been part of a teaching experiment where students used not only paper and pencil, but also technological tools: a spreadsheet in the case of sequences, and GeoGebra and TI-Nspire for geometry. Results of the teaching experiment were analysed, in order to prepare materials for teacher training in a Moodle platform for e-learning (EdUmatics – Comenius Project).

Our analysis focused on the passage from static to dynamic representations and back, to observe how technologies may foster dynamic cognitive processes of students in the solving of mathematical problems. Analysed data tell us that the dynamic features of technology support the genesis of conjectures, and their validation, along with the choice of independent and dependent variables.

Furthermore, the use of dynamic representations in modelling situations enhances the dialectic between the empirical side and the theoretical side of mathematical objects. For example, in TI-nspire, the Data Capture function (used to model a situation) allows data collections in a way similar to physical samples. On the other hand, DGS lets students choose various quantities as independent variables, allowing for different dynamic representations of one situation, and for the exploration of corresponding mathematical objects.

References


Mathematics lecturers’ views of the advantages and disadvantages of electronic and traditional assessment

Peter Rowlett
University of Birmingham, UK

Session 8AS1P

This presentation will report on a study into mathematics lecturers’ views of the advantages and disadvantages of assessment and feedback with and without the use of computers. The study has captured the views of users and non-users of e-assessment systems at universities with large cohorts of academically strong students and those with relatively small cohorts of relatively weak academic backgrounds. This research is particularly focused on identifying when lecturers feel traditional or electronic assessment is more effective and appropriate and why they think this is so. Questions were around the themes: the lecturer’s use of technology in assessment and appropriateness of traditional and electronic assessment; student experience and benefit; practicalities of setting and marking different assessment types; and, efficiency and effectiveness of traditional and electronic assessment methods.

This session will present the findings of this research and the issues that are raised relating to appropriate and effective use of e-assessment in HE mathematics programmes. Particularly, this research aims to identify when lecturers believe e-assessment and automated feedback can have a positive effect on learning and student experience, when traditional offline assessment is preferred, and why.

Teachers engage in peer tutoring and course design inspired by a professional training model for incorporating technologies for mathematics teaching in Mexican schools

Ana Isabel Sacristan
Center for Research and Advanced Studies (Cinvestav), Mexico

Ivonne Sandoval
National Pedagogical University, Mexico

Nadia Gil
Federal Administration of Educational Services – DF (SEPDF), Mexico

Session 6TD2P

Two years ago, at ICTMT 9, we presented results from a long-term professional development Master’s programme for in-service teachers that focussed on the incorporation of technologies for mathematics teaching and learning. In the past five years, we have had the opportunity to document the impact of the programme on the participants’ academic lives.
The problem of the digital divide for mathematics teachers in developing countries
Ana Isabel Sacristán, Sandra Evely Parada and Lourdes Miranda
Center for Research and Advanced Studies (Cinvestav), Mexico
Session 5IN3P
In this digital era, there is a need to incorporate technologies into educational practices. In our country (Mexico), there have been many policy and educational reforms with this aim. However, many factors create a gap between this political will and the reality of school teachers, particularly in non-developed countries, where resources, access to digital technologies and training are scarce. Our aim was to look at how mathematics teachers use technologies in their practice. In doing this, we became aware of some deep limitations that teachers have.

In 2010, we worked with a community of 71 middle-school mathematics teachers and asked them to sign up to online forums and web resources that we had set up for them. We were surprised that this was a big obstacle. Most teachers admitted not knowing how to use a web browser; over a third of them did not even have an email account; and we also observed that most teachers had difficulties using the hardware (the mouse, the keyboard, and so on). Although these teachers admitted their limitations, they also expressed their fear of using technologies, of exposing their lack of digital competencies and of asking for help; a vicious circle, as these fears prevent teachers from developing the competencies they need. Despite remedial actions on our part, many difficulties have continued.

In another part of the research, we surveyed 140 high-school mathematics teachers who do have basic ICT skills, and observed many of them. Less than two-thirds of them use technologies at all in their lessons, generally only once per school year, and then usually just for facilitating the construction of graphics.

These results point to the gravity of the digital divide in Mexico: digital competencies and use are scarce, and create an obstacle towards harnessing technologies for enriching the mathematical teaching and learning.

VITALmaths – a bank of video clips for autonomous learning of mathematics
Duncan Samson
Education Department, Rhodes University, South Africa
Session 3IN3P

VITALmaths is a collaborative research and development project between the University of Applied Sciences Northwestern Switzerland (PH FHNW) and Rhodes University. The project involves the development, dissemination and evaluation of short mathematical video clips designed specifically to encourage the autonomous learning of mathematics. The project has three main objectives: (1) to produce short video clips designed specifically for the autonomous learning of mathematics; (2) to establish and maintain a website to house and freely distribute these video clips; and (3) to establish a research agenda around their use and efficacy. The video clips are silent, purposefully very short (typically less than three minutes) and specifically incorporate natural materials using a stop–go animation technique to develop and explore a variety of mathematical ideas and themes.

These themes are developed in a progressive manner in a way that purposefully avoids specific pedagogical imperatives or predetermined outcomes. These video clips can be used in the preparation of lessons, for personal conceptualisation of mathematical concepts, and as motivational and explanatory tools, with the
emphasis lying on teachers and learners using them as autonomously and independently as they wish. A dedicated website has been established to house this growing databank of video clips (www.ru.ac.za/ VITALmaths) from which the video files can either be freely downloaded or streamed. This paper engages with a number of theoretical and pedagogical issues relating to the design, production and use of these video clips. In addition, synergies between the autonomous learning imperative of the project and the potential autonomous affordances offered by mobile technology are explored. A number of video clips will be shown in the presentation.

An assessment package for Maxima

Chris Sangwin
University of Birmingham, UK

Session 6AS1P

Many automatic assessment systems for mathematics use a computer algebra system (CAS) to automatically generate structured problems, establish the mathematical properties of students' answers and generate feedback. Since Fenishal's work in the late 1960s there have been many different implementations. Examples include MathWise, Aim, MapleTA, and STACK. CAS is usually designed to "do a calculation" rather than "establish a property of an object". These are subtly different problems, and existing desktop CAS are more or less suitable for establishing properties. In this paper we report research into which properties are most useful to be used independently. We also report some theoretical limits on the extent to which such algorithms can be guaranteed to terminate, and provide examples of their use.

A technologically enhanced mathematics curriculum for teacher education: an exploratory study

Fernando Luís Santos
School of Education Jean Piaget, Almada, Portugal

António Domingos
Faculty of Science and Technology, New University of Lisbon, Portugal

Session 6CU1P

Along with the challenges that the Bologna Process has brought to Higher Education in Portugal policy makers have expressed growing concern about science, technology and mathematics education and, with less satisfactory results in some international reports, there are big changes happening. The introduction of a new mathematics curriculum for basic education is reflected in teacher training, either by the particular definition of a new kind of student or the need for new methods of teaching and learning of mathematics.

It is argued that the curriculum should provide a sufficiently strong mathematical background and flexibility so that pre-service teachers can handle and create conditions for students to learn mathematics based on the three problems facing mathematical training: to identify content relevant to mathematical education; to understand how knowledge should be learned; and what we need in order to teach mathematical concepts to children.

Theories such as advanced mathematical thinking, self-regulated learning, as well as an increased use of technology in the classroom based on methodologies studied in the context of STEM (Science, Technology, Engineering and Mathematics) education, support this paper as a starting point for a broader investigation.

The redesign of a quantitative literacy class: student responses to a lab-based format

Nicole Scherger
Elgin Community College, IL, US

Session 1SE1P

The purpose of this study was to observe students' retention, success, and attitudes towards mathematics in a quantitative literacy course taught in a lab-based format, utilizing Microsoft Excel. Quantitative literacy develops skills in problem solving, logical analysis, use of mathematical models and functions, statistical and graphical representation of data, and decision making. Work on this course was driven by renewed attention given to the importance of quantitative literacy. The seminal work in this area, Mathematics and Democracy: The Case for Quantitative Literacy (National Council on Education and the Disciplines, 2001), calls on colleges to re-examine how they prepare their students to be citizens capable of dealing with the numerical and quantitative needs of the future.

Because of the growing need for today's students to not only be competent consumers of quantitative information, but to also be technologically literate, the redesigned course implemented the daily use of Excel in classroom demonstrations, group activities, and individual assignments, and utilized data from many fields of study. The teaching techniques used in the course, including collaborative groups, practical content, open communication and dialogue, and the use of writing, are reflective of feminist pedagogy, which was the philosophical framework of the study.

Retention data revealed that the retention rate in the redesigned course was 90.3%, compared to 84.7% in the traditional section; grades data revealed the success rate in the redesigned course was 72.1%, compared to 66.1% in the traditional sections. Results of mathematics attitude surveys showed marginally significant growth (p = .05) in students' attitudes towards the relevance and utility of mathematics in the redesigned course compared to the traditional course. Students taking the redesigned sections additionally showed significant growth compared to their traditional counterparts in their attitudes towards real world application problems (p < .01), the use of computers (p < .01), and their consideration of taking additional mathematics courses (p = .04).
Change of and transfer between representations – especially between digital and paper-and-pencil representations

Barbara Schmidt-Thieme
University of Hildesheim, Germany

Hans-Georg Weigand and Andreas Bauer
University of Wuerzburg, Germany

Session 2SE1P

The flexible use of representations is a major goal in mathematics and mathematics education. Mathematical knowledge is very much related to the use and change of, as well as the transfer between, representations. There is a wide range of research to this topic, e.g. constructing adequate representations, interpreting representations, working with representations.

Most of this research concentrates either on representations that are generated by computers or representations or notations on paper-and-pencil work. A main obstacle concerning the understanding of representations, however, is the discrepancy between these two types of representation. How do they fit together? Which ones can be seen as equivalent? How is this related to the mathematical content? How do they differ in restricting or opening mathematical actions?

This is particularly a problem if students work with handheld technology in the classroom. Usually they have to give notes of the solution on a piece of paper, especially when they take a test. In a long-term empirical investigation we experienced many problems concerning the relations and the transfer between notations on the computer screen and on paper. There are also some mathematical obstacles produced by digital representations.

To investigate these obstacles one needs a theoretical framework for representations of mathematical ideas and concepts that will be able to integrate both ‘digital’ and ‘paper-and-pencil’ representations. In this talk we shall present a framework based on cognitive psychology and linguistics, which will enable us to categorize different representations.

Subsequently, we shall discuss and analyze some examples of how students switch representations. This will lead us to some reflections on how to describe the competence of using representations and changing representational systems and how to support students in achieving this competence.

The effect of using Google SketchUp when teaching fifth graders about the surface area of composite solids

Pao-Chen Shih
Department of Information and Computer Education, National Taiwan Normal University, Taipei, Taiwan, ROC

Ju-Ling Chen
Department of Educational Psychology and Counseling, National Taiwan Normal University, Taipei, Taiwan, ROC

Kuo-En Chang
Department of Information and Computer Education, National Taiwan Normal University, Taipei, Taiwan, ROC

Yao-Ting Sung
Department of Educational Psychology and Counseling, National Taiwan Normal University, Taipei, Taiwan, ROC

Session 7IN2P

The main purpose of this study was to investigate the learning effect of Google SketchUp software when integrated into the teaching instructions for fifth graders finding the surface area of composite solids. This research was conducted under a quasi-experimental method, with a non-equivalent pre-test–post-test control group design. There were 111 fifth graders (the subjects) collected from four classes in Keelung city, and divided into the control group (n = 55) and the treatment group (n = 56). All the subjects accepted a mathematics proficiency test on the surface area of composite solids before the teaching experiment was conducted. The treatment group accepted the ‘SketchUp auxiliary instructional model’ and the control group accepted the ‘tradition instructional model’ for finding surface area of composite solids. Two-way ANCOVA was applied to investigate the learning achievement performed by the two groups on finding the surface area of composite solids. The results were as follows:

1) Students who accepted the ‘SketchUp auxiliary model’ had better learning results than students who accepted the ‘tradition instructional model’.

2) In each group, there was no significant difference in learning effect caused by gender, but a significant difference was shown in the boys’ learning results between the groups.

3) There was a significant difference between teaching methods and learning attitudes. The students who had accepted the ‘SketchUp auxiliary instructional model’ exhibited an improvement in their attitudes towards learning mathematics.
The use of technology in teaching secondary school mathematics

Duduzile Sibaya
University of Zululand, South Africa

David Clarke
International Centre for Classroom Research, Australia

Patrick Sibaya
University of Zululand, South Africa

Session 6SS3P

Technology is recognized worldwide as being valuable in the teaching of science and mathematics. Research conducted in this field has focused on the pedagogical use of technology in schools, access to technology and the impact of technology on the academic achievements of learners. The purpose of this study is to investigate the different types of technology that mathematics teachers use in teaching secondary school mathematics, and how this technology is integrated in the teaching of mathematics. To this end, a random sample was chosen consisting of 350 secondary school mathematics teachers in the Empangeni district, KwaZulu-Natal, South Africa.

Computerised assessment and student attitudes

Colin Steele
University of Manchester, UK

Session 7AS3P

Computerised assessment in mathematics has been used at the University of Manchester since about 1998 (and possibly before) using a variety of programs and platforms, gradually moving towards more sophisticated ones.

With each new development, new possibilities emerge in terms of the kinds of question that can be asked and the kind of processing that can be done to a student response. However, this is accompanied by a cohort of students needing to operate the system in a slightly different way to previous cohorts. There is also a process among the staff in finding the best mode in which the students can carry out assignments successfully.

When taking part in a computerised assessment, students have to enter answers in some way, e.g. select an option from multiple-choice, enter a number, put in a mathematical formula etc. Each situation entails some amount of discipline, and some students may show more than others.

A similar situation exists with the mode in which the assessment is done. Clearly, there are some situations where supervision is desired but if students are to try assessments several times and build up understanding, there must be a system where such repeated practice is rewarded.

This presentation looks at the various forms of computerised assessment in mathematics used at UMIST and the University of Manchester, concentrating on the reaction of students to the assessment.

Some aspects of using the GeoGebra software package in mathematics teaching

Alla Stolyarevska
The Eastern-Ukrainian Branch of the International Solomon University, Kharkov, Ukraine

Session 6SS3P

Analytic geometry is the branch of algebra used to model geometric objects – points, (straight) lines, and curves (circles, ellipses, hyperbolas, parabolas) being the most basic of these. While studying analytic geometry, students of Computer Science in our university have often encountered difficulties in solving a variety of problems.

In the 2010–2011 fall semester, the GeoGebra package was chosen to assist students in their learning of analytic geometry. One of the useful built-in capabilities of GeoGebra is the logging of the solution. This provides students with ample opportunity not only to see the result of their decision, but also to trace the steps of its construction. Therefore in addition to visualization it is also possible to use an algorithmic approach, which is equivalent to the problem solving abilities, applying a set of rules. Using GeoGebra's interactive Construction Protocol the students have constructed curves as the loci of points and have solved problems at different levels of complexity.

The main idea of this work is to point out a gradual increase in students’ level, from remembering and understanding to applying, analyzing, evaluating and creating. It considers some new possibilities in the process of studying analytic geometry for the students, who mostly use mathematics instrumentally.

Among the teaching materials, in addition to books written by Russian mathematicians D. Beklemishev, V. Ilyin and E. Pozniak, the books Theory and problems of precalculus by Fred Safier, and Geometry by Barnett Rich and Christopher Thomas (Schaum’s Outline series) were used.

3D modelling in teaching and learning geometry

Petra Surynková
Charles University, Prague, Czech Republic

Session 7AS3P

This article addresses an application of computer modelling in the teaching and learning of geometry. Our aim is to increase the interest of students in studying synthetic geometry at secondary schools and colleges. The main field of our interest is descriptive geometry – geometric constructions, projections, the geometry of curves and surfaces. One possible approach to improving the study of geometry is the integration of computer software in the teaching process. This seems to be interesting, attractive and motivational for students. The use of computers in education is modern. We use the Windows program Rhinoceros, a NURBS-based package for visualization, for proving geometric problems in the plane and in space or for demonstrating the application of geometry in practice. We deal especially with the geometry of curves and mainly surfaces. We now have a large collection of pictures that illustrate examples of surfaces in building practice and architecture. We also show the use of software on some concrete examples. Of course, we refer to the advantages and also the disadvantages of computer modelling. We mention how to use geometric modelling systems for image creation or illustrations of geometric problems. The outputs can be used in some publications and also for home schooling and e-learning. We have web pages with a database of 3D models and geometric tasks in the plane and in space, and we provide access to these resources to our undergraduate students.
An overview of approaches for producing mathematics question banks and the automatic creation of numerical calculation questions in Questionmark Perception using macros in Excel

Giles Tewkesbury, Simon Chester and David Sanders
University of Portsmouth, UK
Session 3AS2P

Computer-based testing (CBT) has been used at various levels at most universities in the UK. Computer-based assessments can be used for end-of-unit summative testing and also for formative testing during a unit to help students prepare for end-of-unit examinations.

Computer-based tests can consist of a number of questions selected from banks of questions. It is often desirable for examiners to randomise elements of some questions so that students are unlikely to be presented with a question that they have attempted previously. In this way, students are less likely to “learn the test” – reciting answers to questions without understanding the underlying subject matter. Furthermore, this approach discourages plagiarism.

Questionmark Perception (QMP) provides a friendly interface for creating questions. However QMP has very limited functions for producing numerical questions and cannot create questions containing random values.

This paper presents a ‘QML Generator’ spreadsheet that has been created to generate randomised questions based upon a question template. Questions generated from this spreadsheet can then be imported into QMP as a bank of questions. The use of this spreadsheet is described in this report.

The paper then evaluates the functionality of this new system along with five other CBT solutions with respect to numeric questions. A summary comparison of these evaluations is presented.

Order and chaos: interactive computational activities for the classroom

Maria Joana Torres and Ricardo Severino
Universidade do Minho, Portugal
Session BAP1P

It has long been believed that typical students learn better through contemporary approaches to questions originating in physics problems that allow experiments. This belief motivated us to develop interactive computational didactic materials about contemporary mathematics that can be used both in the classroom and in mathematics clubs in school. Most topics in mathematics curricula are presented in an abstract setting, with no physical meaning, which makes students feel no motivation and enthusiasm for what they see as a ‘dead’ discipline. However, since Galileo Galilei and Isaac Newton it has been possible to search for dynamical systems that allow one to understand natural phenomena. Indeed, it was this ability to simulate the reality, and to predict its temporal evolution, that proved to be the key to the success of science itself. Dynamics (or dynamical systems), the study of how physical systems evolve with time, is a contemporary research field that has the profit of being comprehensible by young students. Furthermore, it allows the introduction and exploration of many of the topics in the students’ mathematics curricula. Dynamical systems are present in many different branches of science, which allows interdisciplinarity, such as biology, economics, ecology, medicine, meteorology, astronomy and computer science. Moreover, most problems have a physical insight. These features of the field of dynamics lead us to elaborate a series of interactive computational activities based on dynamical systems topics such as evolutionary models, ordered pattern formation, generation of fractals and many interesting features of “chaos theory”. Another important goal to achieve with these activities was to give mathematics an experimental/laboratory component, which is rarely present. In fact, all the interactive computational didactic materials developed include simulations with applets designed for this purpose. Last, but not least, students can enjoy the beauty of mathematics since they can, for instance, generate wonderful pictures by iteration of a simple function with the help of a computer.

Mobile computer laboratory for teaching mathematics

Jana Vávloňová
University of South Bohemia, Czech Republic
Session SIN1P

In mathematics teaching, it is appropriate to use new technologies. However, teachers have to often solve technical problems such as inadequate school computer facilities or their unavailability. This usually happens when a teacher wants to use them. In our school, we have solved this issue by providing the school with the mobile computer classroom, which consists of 15 MacBooks. This paper summarises the advantages and disadvantages of its use in mathematics lessons. Moreover, it states which key competencies can be developed by working with the mobile computer classroom. In the last part of the paper, I present specific examples of mathematics lessons in which our mobile computer laboratory was used.

Interactive cognitive tools in mathematics

Daniela Velichová
Slovak University of Technology
Session 6CU3P

The paper will present a few ideas about how the use of new computer algebra and dynamic geometry systems can contribute to creating cognitive connections that reinforce the knowledge and understanding of basic concepts in mathematics. Recent research has shown that computer-based manipulatives are more effective than those involving physical objects, in part because they can dynamically link together multiple representations of the investigated concepts, and also because they enable, on a virtual reality platform, to put virtual hands on and manipulate abstract concepts having no “real 3D solid” interpretation. At the beginning of the third millennium we are facing a dramatic change in the basic nature of teaching and learning strategies caused by the massive usage of new dynamic ICT. We can benefit from this development in general, and in mathematics especially, as currently available dynamic and visual learning environments could affect our perspectives in terms of the content and comprehension of mathematics education. One of the powerful critical features of interactive electronic instructional materials and dynamic mathematical software solutions is their virtual nature and existence, in which abstract mathematical objects are the real objects and therefore the continuous interaction between these objects and users is possible, and it could be considered as a continuous dynamic interaction.

Several examples will be presented on how the dynamic multi-platform mathematical software package GeoGebra might be used for learning and teaching in mathematics, geometry and computer graphics. The focus is on the created added value of this useful utility in providing a solution for how to influence the formerly passive role of students in the process of education. This haptic device, which detects slider movements and presents views of adjustable mathematical objects, is one of the advanced cognitive tools for making students more active in learning mathematics.
New technologies in the next decade

Hans-Georg Weigand
University of Würzburg, Germany

Session 2IN3P

The advantages and disadvantages of the use in mathematics lessons of digital technologies (DT), especially of computer algebra systems, have been widely discussed. What will be the meaning of DT in the next few years? What is the basis for an answer to this question and how might it be possible to get a vision of possible developments?

A first aspect might be an evaluation of developments in the past. How was the situation in the middle of the last century when we introduced computers into mathematics lessons? Can we learn from past developments?

A second aspect is the evaluation of the present situation. The 17th ICMI Study Mathematics Education and Technology: Rethinking the Terrain was published recently by C. Hoyles & J.-B. Lagrange. It gives an evaluation of the present situation concerning the use of DT and attempts to present a basis or a vision for the development of DT in the forthcoming years. The word ‘vision’ is used quite often: a vision for the development of the software, the hardware, the pedagogical landscape, the mathematics in the classroom, the learning and the teaching. The last paragraph of this book is called ‘Future directions’.

I think the book is not a vision, but it may serve as a basis for visions (Weigand, 2010). The talk is a critical reflection of past and current developments, and it gives some hypotheses of possible gainful developments:

1. DT will support the process of thinking in relations, e.g. relations between different subjects, between 2D and 3D geometry, between the past the present, and this will be a central condition for improvements.

2. The gainful use of DT in the classroom requires a master plan for the integration of all kinds of DT into the learning and teaching process.

Benchmarking and mastery: integrating teaching, learning and assessment

Roy Williams
University of Portsmouth, UK

Session 4SS3P

E-Assessment in mathematics had been established in several universities, over the past decade or more. Much work has been done in developing materials for assessment, on a range of different platforms. This work has now matured, by and large, to the stage where e-assessment can include algorithmic question creation, good graphics display, and the ability to write answers in mathematical notation. More recently, some academic publishers have started to develop and provide more diverse, if not always fully integrated, packages of resources, including e-books, e-assessment, and a range of associated materials and resources, often in ‘cloud’ based platforms. We are now at a stage where we can explore the possibilities for a fully integrated system, which is based in teaching and learning, rather than in assessment. This paper addresses two related aspects of the issue: the technical and the conceptual shifts that are required to integrate teaching, learning and assessment, particularly in the initial years of university mathematics courses. It should be possible to do this if we move away from a paradigm of testing to one of benchmarking and mastery instead. We will describe current practice at the University of Portsmouth, and outline a framework for a flexible and fully integrated, multi-modal system, which includes teaching, tutoring, portfolios, EVS’s, e-books, interactive links between resources, interactive reports to service students, lecturers and tutors, and a flexible system to add to and customise previously authored materials. The paper will also explore the options of proprietary, open source, and commercial modes of provision, and some ideas on possible business models, across these sectors.

Linking IT-based semi-automatic marking of student mathematics responses to pedagogical objectives

Khoon Yoong Wong, Kwang-Shin Oh, Qiu Ting Yvonne Ng, Beng Chong Teo and Kalimuthu Kanchiyappan
National Institute of Education, Singapore

Session 8AS3P

The purposes of a system to auto-mark students’ responses to mathematics test items are to expedite the marking process; to enhance consistency in marking; and to alleviate teacher assessment workload. We propose that a semi-automatic marking system better serves pedagogical objectives than a fully automatic one. The two pedagogical objectives to be addressed are that teachers should know about the range of students’ solutions and that they should provide meaningful feedback to students through utilization of customizable feedback. Both objectives align with using assessment data for learning. Our proposed IT-based system consists of a marking component and a feedback component, and it will provide closer linkage between IT-based marking and these pedagogical objectives.

The mathematics items are classified into three types: closed, semi-open and open. The closed items are select-response types such as MCQ, or they require only a specific number or word as the answer. These questions will be automatically marked as right or wrong. For the semi-open or open items (construct-response), the system provides several possible answers based on a marking scheme, and the teachers select from these answers through a drop-down menu or add their own answers to the menu. This cuts down on marking time, but more importantly it alerts teachers to the alternative answers given by their students in a systematic way. To insert feedback for the students, the teachers can select from an initial feedback pool or add their own comments.

At the end of the marking, the system can output detailed results by student or by question. Further item analysis can be conducted based on the output. On the basis of these results, the research team and the teachers will plan follow-up activities to help students master the contents, for example, by using student errors as a springboard for further learning.

Using technology to improve the conceptual understanding of three-dimensional geometry in primary school learners

Tyger Yegambaram
Lotusville Primary School and Durban University of Technology, South Africa

Session 1SE2P

The purpose of this research is to determine whether the use of computer enhanced instruction and classroom intervention will significantly improve the primary school learners’ geometric understanding of three-dimensional concepts. The research focuses on the learners’ ability to engage in computer generated instruction for Learning Outcome 3: Space and shape. The research involves Grade 7 learners with pre- and post-tests being administered to ascertain whether learners can benefit from the use of computer generated instruction. The results exhibit a significant improvement of the learner’s scores when computers are used as a teaching and learning tool.
Interactive self-paced learning using Mathematica

Yakov Zinder and Tim Langtry
University of Technology, Sydney, Australia
Session BAP2P

Mathematica is a computer algebra system with powerful graphical and computational capabilities and an impressive ability for performing symbolic calculations. This computer algebra system has proven to be a useful instrument in teaching practically all fields of mathematics. An extensive body of literature reflects the breadth of experience in teaching with Mathematica that has been accumulated in universities all over the globe. In saying this, it is important to stress that, in the majority of cases, Mathematica is used only as a tool for visualisation or as important software for any career in mathematics, science or engineering. In the latter case, Mathematica becomes not a medium for, but rather the object of, teaching. Although the richness of Mathematica’s computational environment is widely acknowledged, very little has been done to utilise its potential as a platform for a new teaching modality. This new generation of Mathematica-based learning support software will open new horizons for teaching mathematics and related subjects, but also imposes significant challenges for the instructor, both technical and pedagogical in nature. This talk will address challenges of both types. The pedagogical challenge for the instructor is to develop new procedures for teaching, wherein the strategies appropriate to face-to-face teaching are replaced or augmented with novel strategies for designing an interactive computer-based learning experience for the student. The technical challenges are closely linked with the pedagogical ones. In particular, the instructor’s efforts must be shifted from the development of software to the development of the learning environment. This requires software that combines both an end-user focused approach with flexibility that allows the implementation of a variety of teaching strategies. We demonstrate how these challenges were addressed in our university and discuss directions for future research.

Developing mathematical understanding with ICT in the classroom

Nicola Bilsby
Eltham College, UK
Session B8IN1W

In this workshop I will share my research findings and encourage colleagues to reflect on the use of TI-Nspire and Navigator, the wireless connectivity system in the classroom, and consider strategies for assessing how effectively ICT has been used to support the development of mathematical understanding.

How can ICT motivate pupils to want to learn a difficult subject?

Douglas Butler
ICT Training Centre, Oundle, UK
Session 5SE1W

There are many software titles around now, and the purpose of this workshop will be to let delegates find out what makes Autograph different. Firstly, it was created in the classroom and its essential quality, which teachers like so much, is that it helps students to learn and consequently to enjoy a difficult subject. At the same time it can help the teachers to enjoy teaching the subject!

Images and data can be seamlessly incorporated to allow topics of immediate interest to be blended into a classroom lesson with a distinct STEM focus.

The workshop will look at how the judicious use of “slow plot” and Autograph’s “scribble tool” can foster real understanding. These tools are particularly well suited for use with interactive boards, and also suite the “walk-about” states. The key is pedagogy, and the aim must always be to make sure that students are made to feel involved at every stage, so that a lesson never becomes a “show and tell” environment.

The approach works just as well for the younger students as for the more advanced mathematicians. Pupils who are settling into concepts such as gradient (slope), functions, inequalities, transformations, and right up to differential equations and 3D linear algebra can all benefit from visualisation, but only if it is handled in an interactive and collaborative way.

The workshop will also show how easy it is to create web resources from Autograph in statistics, 2D and 3D, so that teachers and students can share ideas on the Internet.
On your bike: practical application of mathematics

Sarah Chapman
Advanced Skills Teacher, Hayesbrook School, Kent, UK
Session 3AP1W
Explore how to increase students' awareness of the mathematical world and facilitate a deeper understanding inside the classroom through a practical application of riding a bike.

This workshop will provide an opportunity for delegates to analyse the mechanics of a bike so that they can confidently deliver a practical, functional lesson involving a number of grade C topics. In this session a bicycle will provide the starting point for work on ratios, compound measures and circles. The workshop is particularly relevant for STEM-based subject teachers at secondary level and will incorporate ICT and multimedia.

Lights, camera, mathematics: how the use of digital cameras can support secondary school mathematics learners

Dave Eacott
Park Community School, Hampshire, UK
Lucia Threadgill
The Petersfield School, Hampshire, UK
Session 4TD2W
The Hampshire Leading Mathematics Teachers Information Technology Development Group has been established for a number of years. The group is made up of teachers from secondary schools in Hampshire, UK working with the Hampshire Mathematics Advisory Team. The group has specifically set out to establish new sets of resources which support the use of Technology to improve the teaching of mathematics in schools; the focus is on learners using the technology but all resources could be adapted for use as a teacher demonstration tool.

There is an increasing awareness that accessibility of software has become a barrier to the use of technology in mathematics. This workshop provides the opportunity to try out some of the resources we have developed to make use of the Google Earth software. The software has the advantage of being free to users and therefore accessible, without licensing restrictions, to learners in their homes.

During the workshop you will find out how to access the Google Earth software and learn how the basic functions work. You will have an opportunity to trial some of our resources which support the teaching of bearings and measurement, using local maps. You will also be shown ways in which the software can help demonstrate the use of bearings in 'the real world', particularly looking at airports, and finally you will be able to follow and create a treasure hunt that goes all around the world, supporting learners to appreciate the importance of accuracy when measuring bearings over long distances.

Around the world in 60 minutes using Google Earth: helping secondary school mathematics learners to develop their understanding of bearings

Helen Humble
Amery Hill School, Hampshire, UK
Dave Eacott
Park Community School, Hampshire, UK
Session 3TD1W
The Hampshire Leading Mathematics Teachers Information Technology Development Group has been established for a number of years. The group is made up of teachers from secondary schools in Hampshire, UK working with the Hampshire Mathematics Advisory Team. The group has specifically set out to establish new sets of resources which support the use of Technology to improve the teaching of mathematics in schools; the focus is on learners using the technology but all resources could be adapted for use as a teacher demonstration tool.

There is an increasing awareness that both cost and accessibility of software have become a barrier to the use of technology in mathematics. This workshop provides the opportunity to try out some of the resources we have developed to make use of the Google Earth software. The software has the advantage of being free to users and therefore accessible, without licensing restrictions, to learners in their homes.

During the workshop you will find out how to access the Google Earth software and learn how the basic functions work. You will have an opportunity to trial some of our resources which support the teaching of bearings and measurement, using local maps. You will also be shown ways in which the software can help demonstrate the use of bearings in 'the real world', particularly looking at airports, and finally you will be able to follow and create a treasure hunt that goes all around the world, supporting learners to appreciate the importance of accuracy when measuring bearings over long distances.

Wirelessly connecting TI-Nspire CX handhelds in the classroom to share mathematical ideas

Cindy Hunt
Davison CE High School, UK
Session 2IN1W
The arrival of TI-Nspire Navigator CX will require teachers to evolve their practices with the previous system, reworking previously developed lesson activities to take advantage of new functionality. In this session, you’ll find out about some early lessons, and hopefully get a peek inside a secondary mathematics classroom!
A classroom activity – just how fast does ‘Bloodhound’ go?

Pip Huyton
Independent Mathematics Consultant, UK
Session 4AP1W

This workshop presents an opportunity for delegates to explore the use of ICT with digital images, video and mathematical modelling, to discover the speeds at which the ‘Bloodhound Supersonic Car’ travels.

The workshop is particularly aimed at teachers of secondary/FE/UG mathematics/science subjects. The software that will be used during the session includes Vernier LoggerPro 3 for data logging and video analysis and Promethean’s ActivInspire specialist education software.

A 30-day free trial version of the software Vernier LoggerPro3 Demo can be downloaded from www.inds.co.uk/education/software.htm, in addition ActivInspire Personal Edition can be accessed for free through www.PrometheanPlanet.com/ActivInspire.

Cars – Maths in Motion

Angela Jones
Ministry of Education, New Zealand

Val Brooks
Deputy Director, Stockton CLC (retired)
Session 4SL1W

As a result of meeting Val Brooks in the UK, Angela instigated a project in New Zealand involving the use of an interactive mathematics program (Cars – Maths in Motion) with a class of 13–14-year-old boys to promote engagement in mathematics. This is a piece of software designed to help encourage students to grasp basic mathematical skills and to use them on a practical level, by involving them in a competitive simulation of a series of Grand Prix races at school, national and international level.

Students identify a variety of mathematical concepts implicit in the learning experience, and describe ways in which the software presents opportunities to encounter, apply or develop these ideas. Working in small groups, they are given details of a race track and other information that includes variables such as the number of laps and the weather forecast. They then have to measure and calculate the length of each straight and the angle of each bend. Add to this driver temperament, mathematics modelling, estimation, decimals, percentages, scale, ratio, long multiplication and division, strategy and teamwork and you have a mathematics project that keeps students engaged and highly motivated, and appeals to ability levels across KS2, 3 and 4 (UK) and curriculum levels 3, 4, 5 and 6 (NZ).

The aim of the workshop will give a hands-on experience for teachers to begin to understand how the project is motivating and engaging to anyone involved and will also give opportunities to discuss how the use of the software can be integrated into the curriculum with benefits both in the UK and internationally. The teacher’s heightened awareness capitalises on the novel context to promote increased opportunities for learning and participation in mathematics.

Information on the Jaguar Cars – Maths in Motion challenge for schools can be found at www.mathschallenge.co.uk and at http://home.bconnect.com/cambs-software/MIM.html

Three-dimensional geometry in a virtual 3D world: using Google SketchUp to support secondary school mathematics learners to appreciate three-dimensional shapes, plans and elevations

Randall Jull
Brune Park Community College, Hampshire, UK

Chris Martin
Hampshire Mathematics Advisory Team, UK
Session 4TD1W

The Hampshire Leading Mathematics Teachers Information Technology Development Group has been established for a number of years. The group is made up of teachers from secondary schools in Hampshire, UK working with the Hampshire Mathematics Advisory Team. The group has specifically set out to establish new sets of resources which support the use of Technology to improve the teaching of mathematics in schools; the focus is on learners using the technology but all resources could be adapted for use as a teacher demonstration tool.

There is an increasing awareness that both cost and accessibility of software have become a barrier to the use of technology in mathematics. This workshop provides the opportunity to try out some of the resources that we have developed to make use of the Google SketchUp software. The software has the advantage of being free to users and therefore accessible, without licensing restrictions, to learners in their homes.

During the workshop you will find out how to access the Google SketchUp software and learn about how the basic functions work. You will have an opportunity to try some of our resources which support the teaching of geometry and space without the limitations of young people’s spatial awareness. We will look at calculating surface area where you can look around every surface, consider opportunities for teaching three-dimensional Pythagoras, create nets of complex shapes without needing to manually construct them first and make scale models to construct an icosahedron through using the golden section.
A geometry tool for everyone: using GeoGebra software to support secondary school learners with understanding geometry and algebra

Chris Martin
Hampshire Mathematics Advisory Team, UK

Greg Wilson
Cowplain Community School, Hampshire, UK

Session 5TD2W

The Hampshire Leading Mathematics Teachers Information Technology Development Group has been established for a number of years. The group is made up of teachers from secondary schools in Hampshire, UK working with the Hampshire Mathematics Advisory Team. The group has specifically set out to establish new sets of resources which support the use of Technology to improve the teaching of mathematics in schools; the focus is on learners using the technology but all resources could be adapted for use as a teacher demonstration tool.

There is an increasing awareness that both cost and accessibility of software have become a barrier to the use of technology in mathematics. This workshop provides the opportunity to try out the GeoGebra software. The software has the advantage of being free to users and therefore accessible, without licensing restrictions, to learners in their homes.

The GeoGebra software has been developed by others and in this workshop we act as advocates of how this software can be used to enhance mathematics teaching. During the workshop you will find out how to access the GeoGebra software and learn about how the basic functions work. You will have an opportunity to see demonstrations on how it can be used and trial some resources to get you thinking. You will be able to work through a series of activities exploring three key areas of the software: understanding geometric construction, developing algebraic understanding, and transformations. These activities are aimed at providing you with a basic understanding of how the software can be used and encourage you to explore further yourself. Links and direction to other resources available will also be provided on the day.

Seizing the opportunity of using online learning for UK mathematics support

Sue Milne
ELandWeb Limited, UK

Leslie Fletcher
School of Computing and Mathematical Sciences, Liverpool John Moores University, UK

Session 2AS1W

The recently published (January 2011) report to HEFCE by the Online Learning Task Force sets out:

• Ways to encourage:
  • Flexibility in UK provision
  • Online pedagogy

• How to:
  • Support institutions to take full advantage of rapidly developing technology and rich sources of content
  • Ensure quality provision to meet rapidly changing student demands

• Seeks:
  • A stronger understanding of the potential of web-enabled learning and the use of social media
  • Greater prioritisation of teaching partnerships between technologists, learning support specialists and academics
  • An end to the ‘not invented here’ syndrome

• And concludes that:
  • Good practice must also be shared
  • There is no point duplicating effort to create content that is already available and proven to work
  • Institutions can build on the existing open educational resources initiative to achieve economies of scale and efficiencies

This workshop will consider how these aims can be realised within the mathematics support community and ways in which technology can help. Specific examples of good practice will be sought, from prospective participants and elsewhere, and ways in which they can be represented, disseminated, discussed and tested will be explored. The usefulness of technological support such as LAMS for capturing and coding good practice and the OU's Learning Space for curation and dissemination will be discussed and analysed using real examples.

The proposers of this workshop were heavily involved in the FETLAR project so are aware of the scope of existing open source resources in mathematics support. They have been involved in online learning and support in mathematics for many years, so are well placed to take forward the agenda set out in the Task Force report.
Workshops – Abstracts

A web-based learning support system to help secondary school mathematics learners construct geometric flow-chart proofs

Mikio Miyazaki
Faculty of Education, Shinshu University, Japan

Taro Fujita
Faculty of Education, University of Plymouth, UK

Youichi Murakami
Sun First, Japan

Naoki Baba
Toyono Junior High School, Nagano, Japan

Keith Jones
School of Education, University of Southampton, UK

Session 6SS1W

This workshop provides the opportunity to try some of the geometrical proof problems that we have designed to support secondary school mathematics students as they build their knowledge of mathematical proof. Our web-based learning platform uses flow-chart proofs and includes both open and closed problems involving the properties of parallel lines and congruent triangles. By using Adobe Flash-based technology, learners complete proofs by dragging sides, angles and triangles to cells and our system automatically transfers figural to symbolic elements so that learners can concentrate on logical and structural aspects of proofs. The system identifies errors by referring to a database of acceptable answers classified into four categories. Learners receive relevant feedback in accordance with the four types of error.

In the workshop, participants have the opportunity to experience our system by working on various geometric proof problems. For example, an introductory problem by which the user can construct four different proofs, another open problem but this time with two steps to the solution, and a proof problem involving the base angles of an isosceles triangle.

The workshop provides the chance to discuss interface design, the use of open and closed problems in the teaching and learning of proof, the effectiveness of feedback given by web-based systems, how to internationalise such a system, and so on. Video clips of learners using our system are also available.

Workshops – Abstracts

The impact of technology on the way mathematics and statistics have been taught in the last decade

Ghada Nakhla
The Sixth Form College, Solihull

Session 5TD3W

Workshop participants will explore:

- The uses of graphics calculators in teaching A-level Mathematics and Statistics (using the idiot's guide).
- Does the calculator/technology enhance students' conceptual understanding of mathematics and statistics?
- Does the calculator/technology make higher grades accessible to lower ability students doing A-level mathematics?
- Are exam boards integrating this technology into their mark schemes?
- Will the way we use technology in the mathematics classroom affect the way we will assess students in future?

The workshop will involve sharing good practice of the use of technology in the mathematics classroom. This will involve hands-on experience and discussion on what lecturers/teachers think of the impact of technology in enhancing students' conceptual understanding.

Animated questions

Jim Noble
International School of Toulouse, France

Session 7CU1W

Dynamic geometry and similar dynamic software have been a major influence on my own understanding of mathematics and consequently my own teaching. Start with the notion that all squares actually meet the minimum requirements to qualify as all other quadrilaterals. (National variations in the definition of a trapezium or trapezoid do provide an interesting challenge to this notion.) How often does this notion upset students who somehow want rectangles and squares to be discretely different from each other? I suggest that a mathematical object or phenomenon is best described by its properties and that these properties can best be explored in a dynamic environment. The ability to bend, stretch, and explore a dynamic situation demands that we consider generalities and their limits where static representations provide us only a particular case.

Why, then, are so many questions in mathematics classrooms asked through a static, fixed and often printed medium? Developments in technology have prompted me to explore the setting of 'animated questions' where students are shown short animations of particular mathematical phenomena and asked to explore and define them by attempting to recreate them. In this workshop I propose to engage the audience with a number of examples of these animated questions exploring geometry, functions, sequences and more. In exploring the problems I hope the group is prompted to recognise the benefits of asking questions in this way in terms of exploring generality, engagement and problem solving.

I work in a school in which students carry their own laptops with them at all times, which aids such experimentation, but this is not a prerequisite for being able to ask these questions. What it does do is make me increasingly curious about how long it will be before external assessment tools for mathematics will be set using technology as a medium and thus allowing a broader, more versatile style of questioning of which these animated questions are just an example.
Integrating STEM and inspiring STEM activities with TI-Nspire technology

Adrian Oldknow
University of Chichester, UK

Linda Tetlow
Independent Mathematics Consultant, UK

Session 6AP1W

STEM is a matter of current concern worldwide. TI has produced a series of STEM booklets for TI-Nspire technology in the UK. This session will look at some of the examples around which strategies will be discussed for using TI technology as a catalyst for STEM subjects working together. The session will also explore using data from a variety of sources about topics such as the weather, nutrition and census information to engage students’ interest in analysing real world problems.

Brunel’s bridges, boats, books and box

Peter Ransom
Independent Mathematics Consultant, UK

Session 6AP1W

This workshop will focus on STEM activities based on the work of Isambard Kingdom Brunel, exploring various practical activities with TI-Nspire CX handhelds.

Matching, speed dating, human sculptures and curve stitching: developing secondary school learners’ understanding of line graphs using graphical calculators and digital cameras

Lucia Threadgill
The Petersfield School, Hampshire, UK

Session 6AP1W

There is an increasing awareness that accessibility of software has become a barrier to the use of technology in mathematics. This workshop provides the opportunity to try out some of the resources we have developed to make use of iPods and other mobile technology, a handheld solution to technology that negates the need to have access to a dedicated technology room.

This workshop is an opportunity for a hands-on experience of how iPod Touches can be used in your classroom to enhance your mathematics lessons and develop your pupils’ learning. You will have the opportunity to experience the use of different applications specifically designed for mathematics learning and provided with ideas of how you can use them in a classroom environment. You will also discover how to set up your own interactive quiz using a Gmail account and have pupils send in live data recorded directly onto your screen, providing opportunities for instant feedback, discussion and assessment.

Engaging all learners in your classroom is every teacher’s problem; see how one school is approaching the problem using an audience response voting system. The use of handheld technology has helped assist with Assessment for Learning and Assessing Pupils’ Progress and is a fun way for pupils to be tested on what they have learnt. You will see some of the engaging activities that can be created and learn how the inbuilt report function can quickly and effectively provide feedback on individual pupils and whole class progress.

Mathematics in the palm of their hands: developing the use of iPods and other mobile technology to support secondary school mathematics learners

Greg Wilson
Cowplain Community School, Hampshire, UK

Randall Jull
Brune Park Community College, Hampshire, UK

Session 3TD2W

The Hampshire Leading Mathematics Teachers Information Technology Development Group has been established for a number of years. The group is made up of teachers from secondary schools in Hampshire, UK working with the Hampshire Mathematics Advisory Team. The group has specifically set out to establish new sets of resources which support the use of Technology to improve the teaching of mathematics in schools; the focus is on learners using the technology but all resources could be adapted for use as a teacher demonstration tool.

There is an increasing awareness that accessibility of software has become a barrier to the use of technology in mathematics. This workshop provides the opportunity to try out some of the resources we have developed to make use of iPods and other mobile technology, a handheld solution to technology that negates the need to have access to a dedicated technology room.

This workshop is an opportunity for a hands-on experience of how iPod Touches can be used in your classroom to enhance your mathematics lessons and develop your pupils’ learning. You will have the opportunity to experience the use of different applications specifically designed for mathematics learning and provided with ideas of how you can use them in a classroom environment. You will also discover how to set up your own interactive quiz using a Gmail account and have pupils send in live data recorded directly onto your screen, providing opportunities for instant feedback, discussion and assessment.

Bring interaction and flexibility to your classroom!

Jane Woods
The Dame Judith Professional Centre, Portsmouth, UK

Session 4TD3W

In this presentation you will see how one department has developed the use of handheld technology to engage all pupils in their classes.

Engaging all learners in your classroom is every teacher’s problem; see how one school is approaching the problem using an audience response voting system. The use of handheld technology has helped assist with Assessment for Learning and Assessing Pupils’ Progress and is a fun way for pupils to be tested on what they have learnt. You will see some of the engaging activities that can be created and learn how the inbuilt report function can quickly and effectively provide feedback on individual pupils and whole class progress.
Special ICTMT themed edition of **Teaching Mathematics and its Applications**

The Editors of *Teaching Mathematics and Its Applications: an International Journal of the IMA* have again agreed to produce a special themed edition of the journal containing papers presented at the conference. Papers will be subject to the same rigorous review procedure as those submitted to the journal in the normal manner.

The scope of the journal is specified on its website:

> The journal provides a forum for the exchange of ideas and experiences which contribute to the improvement of mathematics teaching and learning for students from upper secondary/high school level through to university first degree level. A distinctive feature of the journal is its emphasis on the applications of mathematics and mathematical modelling within the context of mathematics education world-wide. The journal's readership consists of mathematics teachers, students, researchers and those concerned with curriculum development and assessment, indeed anyone concerned about the education of users of mathematics.

Papers from ICTMT must fit within the scope of the journal to be considered for publication.

If you wish your paper to be considered for publication in the journal please send your manuscript to marie.joubert@bristol.ac.uk by 1 September 2011. Your manuscript should be a version of the paper you submit for the conference and should be of an appropriate scholarly standard. There is a limit to the number of papers that can be printed in this special themed edition. Consequently the International Scientific Committee will select the papers in accordance with this limit. If you submit a paper and it is not selected for the themed edition, you can still submit the paper to TMA via the normal procedure (see http://teamat.oxfordjournals.org).

---

**About our sponsors**

**Texas Instruments: www.ti.com**

Texas Instruments Education Technology is proud to sponsor ICTMT.

At Texas Instruments we want to encourage more students to enjoy and understand mathematics, and therefore become inspired to take their mathematics to a higher level.

With over 20 years of Education Technology experience, our teams have had the opportunity to work side-by-side with thousands of teachers across the world to support them in addressing the apparently continuously changing demands of the classroom. But are all the needs really continuously changing? Some things – improved access to quality teaching for all pupils, exploratory and visual ways to engage those who say ‘I can’t do maths’ – are always high on the agenda and will be for some time!

We remain dedicated to improving learner opportunities by supporting the appropriate use of ICT in the classroom throughout curriculum revisions. We strongly believe that Professional Development is paramount to the successful introduction and appropriate use of any new technology, and we are delighted to support T3 in this endeavour. Our partnership over the years with the T3 organisation, Teachers Teaching with Technology, has enabled Texas Instruments to evaluate the technology through the eyes of classroom teachers and to develop appropriate classroom materials and CPD. Research underpins the development of our solutions.

In particular, almost a decade of research went into the development of **TI-Nspire™** – a revolutionary ICT learning platform for the mathematics classroom, the science lab and beyond. TI-Nspire was developed in partnership with many mathematics teachers and education specialists and consists of a handheld device running software that is also available for classroom presentation and for the computer suite. Regular free, downloadable updates ensure that TI-Nspire meets the ICT demands of today’s curriculum emphasis: documents, graphs, geometry, statistics, spreadsheets, financial functions, data logging and a calculator application (all dynamically linked) encourage exploration of multiple representations of a problem and its solutions. The 2009 Ofsted report entitled **Mathematics: understanding the score** highlighted the need to enable learners to make connections across different areas of mathematics.

At this year’s ICTMT conference, we hope you will have the time to enjoy the wide and stimulating variety of sessions on offer, and find useful things to share with colleagues and learners.

The team from Texas Instruments would be delighted to meet you, so do visit our stand in the exhibit area when you have a moment in between all the great sessions on offer!

Have a stimulating and sociable ICTMT conference!

Andrea Forbes
Education Technology Group, Texas Instruments

**Bloodhound SSC: www.bloodhoundssc.com**

The mission of the UK Bloodhound project is to “confront and overcome the impossible using science, technology, engineering and mathematics and to motivate the next generation to deal with global 21st century challenges”. The Bloodhound SuperSonic Car (SSC), designed to raise the world land speed record above 1000 mph, is currently being constructed in the UK. A full-scale mock up of the Bloodhound SuperSonic Car will be on display outside the Portland Atrium until Wednesday evening when it has to leave for display at the British Grand Prix.
Wiley: www.wiley.com
WileyPLUS: www.wileyplus.com

Wiley have sponsored the Bloodhound SSC show car at the conference. Wiley’s Scientific, Technical, Medical, and Scholarly (STMS) business, also known as Wiley-Blackwell, serves the world’s research and scholarly communities, and is the largest publisher for professional and scholarly societies. Wiley-Blackwell's programs encompass journals, books, major reference works, databases, and laboratory manuals, offered in print and electronically. Wiley Higher Education serves undergraduate, graduate, and advanced placement students, lifelong learners, and, in Australia, secondary school students. They publish educational materials in all media, notably through WileyPLUS, their integrated online suite of teaching and learning resources. Their programs target subjects including mathematics, the sciences, engineering, computer science, business and accounting, statistics, education, psychology and modern languages.

Adept Scientific: www.adeptscience.co.uk
Maplesoft: www.maplesoft.com

Adept Scientific and Maplesoft are proud to co-sponsor this conference. Maplesoft (Waterloo, Ontario) is the leading provider of high-performance software tools for engineering, science and mathematics. These include the renowned symbolic mathematics application Maple; the powerful multi-domain physical modelling and simulation software MapleSim; and the online testing and assessment tool Maple T.A. Its product suite reflects the philosophy that, given great tools, people can do great things. Adept Scientific (Letchworth, Herts) supplies and supports all Maplesoft products in the UK and Ireland, Germany and the Nordic countries. Adept offers a portfolio of software and hardware tools for research, teaching and industry, in such areas as mathematics, data acquisition and analysis, laboratory applications, quality assurance and bibliographic data handling. The company’s position as one of the world’s largest multi-source suppliers of technical computing products is based on its reputation for technical expertise and award-winning customer service.

IMA: www ima.org.uk

The Institute of Mathematics and its Applications (IMA) is the UK’s learned and professional society for mathematics and its applications. Founded in 1964, it was incorporated by Royal Charter in 1990 and subsequently granted the right to award Chartered Mathematician designation. It also awards the Chartered Scientist designation and the Chartered Mathematics Teacher designation.

Promethean: www.prometheanworld.com

Promethean’s aim is to unlock the potential of human achievement in education and training at all ages around the world. It does so by creating, developing, supplying and supporting leading edge, interactive learning technology and by encouraging the growth of the world’s largest online teacher community in this field. In these ways, Promethean is helping bring to life the promise of 21st century learning, improving engagement and results for learners and teachers alike.

As the official interactive education technology partner of the Bloodhound SSC (SuperSonic Car) Project, the iconic engineering adventure to design and build the first SSC capable of achieving 1000 mph and smashing the world land speed record, Promethean is working with the team to support its international education programme. Through the partnership, they strive to capture the imaginations of young people and engage them in the science that underpins this challenge, and inspire students to pursue Science, Technology, Engineering, Mathematics education and careers.

Autograph: www.autograph-math.com

Autograph is proud to be sponsoring teachers to attend ICTMT10. Autograph is a dynamic PC and Mac program operating in three modes:

1D - Statistics & Probability
2D - Graphing, coordinates, transformations and bivariate data
3D - Graphing, coordinate transformations, geometry, vectors and differential equations

It is designed to help teachers and pupils visualise mathematics at secondary/college level, using dynamically linked ‘objects’.

Oxford University Press: www.oup.com

Oxford University Press (OUP) is the biggest university press in the world and is a department of Oxford University. OUP publishes well over 230 academic and research journals covering a broad range of subject areas, two-thirds of which are published in collaboration with learned societies and other international organizations. Teaching Mathematics and its Applications is published by OUP on behalf of the Institute of Mathematics and its Applications and includes a selection of papers from ICTMT conferences. For further details see the section entitled “Special ICTMT themed edition of journal” on page 106 of this booklet.

The OUP mission, as part of the University, is to bring the highest quality research to the widest possible audience. They have been publishing journals for more than a century, and as part of the world’s oldest university press, have more than 500 years of publishing expertise behind them.

Wightlink: www.wightlink.co.uk

Wightlink are the main link between the Isle of Wight and the mainland. Every year, they carry over 5 million passengers, making them one of the UK’s largest domestic ferry operators. Delegates can get a 50% reduction on the day return fare for foot passengers by showing their conference badge. From Portsmouth their ferries travel to Fishbourne and catamarans to Ryde.
Social programme

Most of the social events are included in the delegate rate; the social excursions on Thursday afternoon need to be booked separately. Payments can be made in advance or can be paid at general registration on Tuesday 5th July.

Reception – Tuesday 5th July

Please join us for a drinks reception in the Portland Atrium at 18.30.

The Vice-Chancellors from the University of Portsmouth (Professor John Craven) and the University of Chichester (Professor Clive Behagg) as well as the Lord Mayor of Portsmouth (Cllr Cheryl Buggy) will be extending a warm welcome to delegates.

After the reception, the Spinnaker Tower will be open until 23.00 for all delegates to enjoy the spectacular views of the dockyard and across the Solent to the Isle of Wight at their leisure. Simply show your delegate badge to gain entrance. The Spinnaker Tower is conveniently located in Gunwharf Quays, where you will find a wide selection of bars, cafes and restaurants. Why not visit the tower both before and after your meal to see the views in daylight as well as lit up at night?

Invited lecture and drinks reception – Wednesday 6th July

18.00 to 20.00

Bloodhound SSC is the name of a project aiming to break the world land speed record with a car powered by a jet engine and a rocket designed to reach approximately 1609 km/h. Andy Green, the driver, will be giving a lecture about the car, which will be on display at ICTMT on Tuesday and Wednesday.

Excursions – Thursday 7th July

- Fishbourne Roman Palace
  £12 per person (Coach and entrance fee)

Originally constructed in the first century AD, the Palace consisted of over one hundred rooms each with a mosaic floor. Today, about a quarter of the mosaic floors remain, some only fragments and some almost in their entirety – with many of them incorporating traditional geometric designs! In addition to the mosaics, the remains of a number of walls, columns and other infrastructure, such as an impressive hypocaust, can also still be seen. The garden is also home to some typical plants of the Roman era.

Coach leaves Burnaby Road at 12.30 and departs Fishbourne at 16.30.

- Chichester
  £5 per person (Coach only)

The beautiful and historic cathedral city of Chichester is just 30 km from Portsmouth. Visit the Norman cathedral, wander through the pedestrianised streets at leisure, walk the City Walls, browse in the local boutiques or visit the art gallery.

Coach leaves Burnaby Road at 12.30 and departs Chichester at 16.30.

- West Dean
  £12 per person (Coach and entrance fee)

The gardens at West Dean cover over 90 acres and are split into four distinct areas. A 2½ mile circular walk through St Roche’s Arboretum gives spectacular views of the Sussex Downs as well as two national collections of trees. The walled Kitchen Garden area is abundant with common and rarer fruits and vegetables. Sixteen original Victorian glass houses are home to a range of exotic fruits and plants such as peaches, grapes and orchids, while the restaurant offers the opportunity to relax over a traditional English Cream Tea.

Coach leaves Burnaby Road at 12.30 and departs West Dean at 16.30.

- Weald and Downland Open Air Museum
  £12 per person (Coach and entrance fee)

This fascinating museum has a wide range of rescued and restored buildings ranging from the 13th to the 19th century. Traditional crafts and rural trades are demonstrated, giving an insight into the daily lives of the farmers and people of the area.

Coach leaves Burnaby Road at 12.30 and departs Weald and Downland Open Air Museum at 16.15.

- Walking tour of Portsmouth
  £4 per person

This leisurely, guided walk through Old Portsmouth highlights points of interest relating to Vice Admiral Lord Nelson and Portsmouth around the time of the Battle of Trafalgar.

Meet at the Anglican Cathedral (St Thomas’) at 13.30 for a 1–1½ hour walk. Student ambassadors (in their purple University of Portsmouth T-shirts) will accompany delegates from the University to the meeting point.

Whilst here you might also like to visit:

- Portsmouth Historic Dockyard

The Historic Dockyard at Portsmouth is home to Nelson’s flagship HMS Victory, the Mary Rose museum, the National Museum of the Royal Navy and HMS Warrior. An inclusive ‘site ticket’ allows at least one visit to each of these attractions plus a harbour tour. Sadly, the hull of the Mary Rose is not currently on view, but the rest of the museum is still open. The ticket, which costs £20, enables you to visit at your leisure throughout your stay and would be ideal for non-conference going partners.

- Isle of Wight

Why not take advantage of the proximity of the Isle of Wight to explore this tranquil island? The hourly crossing from Portsmouth to Ryde as a foot passenger on the catamaran takes only 22 minutes, and Wightlink have kindly agreed to a 50% reduction for all delegates on production of their delegate badge for the duration of the conference. In Ryde itself you can explore the town, the golden beach, Puckpool Park and Appleby Park. Further afield, but easily accessible by public transport, is East Cowes where you will find Queen Victoria’s island retreat, Osborne House. The Needles Old Battery gives a fascinating insight into how the island was defended as well as giving a bird’s eye view of the three distinctive chalk stacks that comprise The Needles.
Social programme

- **Winchester**
  
  The ancient capital of England is steeped in history. Winchester has a cathedral saved from sinking into the ground by a lone diver, the first 13th century Great Hall in Medieval England, housing the legendary Round Table of King Arthur, medieval gateways and monuments in addition to more modern shops and attractions.

- **The New Forest National Park**
  
  The ancient forest was used in the 11th century by William the Conqueror for hunting. Since then, little has changed. Ponies, deer and other wildlife still roam freely amongst the trees and heathland and birds of prey frequently soar in the sky above. Local Verderers and Agisters maintain the natural beauty and ecological balance of the forest.

Conference dinner – Thursday 7th July

The conference dinner will be held in Portsmouth Historic Dockyard, aboard the unique HMS Warrior. Launched in 1860, the Warrior was Britain’s first iron-hulled, armoured warship and was the largest, fastest and most powerful ship of her day. Now restored and back in the Portsmouth Dockyard, she serves as a visitor attraction and venue.

Timetable:

19.00  Pimms reception on the half deck with sea shanties by Shep Woolley
19.45  Call to dinner
20.00  Dinner served, accompanied by wine and mineral water

Table entertainment during dinner

Rousing anthems until 23.00

Please note: a vegetarian option for dinner is available – any requests for this should have been made in advance by indicating your dietary requirements on the online registration form.

Please also note that, due to the wooden decks on the Warrior, no stiletto heels may be worn on board. Minimum heel area is 1.5cm x 1.5cm although ‘Heel Stoppers’ are permitted.

You may also wish to dress slightly more warmly than you would for usual indoor venues!

General information

Computing facilities

Internet access is available for all delegates to use in Portland and Rees Hall. In Portland and Richmond buildings there is WiFi throughout. In Rees Hall the Internet is obtainable via Ethernet cables in the bedrooms (there is no WiFi available in Rees itself).

To access the Internet all delegates will be required to have a Temporary Internet Access card, which will be available from the Conference & Lettings desk in Portland Atrium on the first day of the conference (Tuesday 5th July from 08.30). These cards are valid for both the Conference buildings and Rees Hall and will last for the duration of the conference.

For technical support: during the conference (09.00–17.00) please see the Conference & Lettings desk in the first instance. At all other times please contact the IT Helpdesk on 023 9284 7777.

If you have an Eduroam account you will not need a Temporary Internet Card. For technical support of Eduroam accounts please contact your own IT department in your University/Education establishment.

Photocopying facilities

Please ask at the conference information/registration desk in Portland Atrium if you need to make any copies of documents relating to your presentation.

Health and Safety

- **Fire alarms**
  
  All fire alarms in the University buildings are tested weekly. Fire alarms are located on each floor of each building.

- **Fire exits**
  
  Fire exits are clearly labelled throughout each building.

- **Fire assembly points** (see map below)
  
  Portland Building – Portland Car Park
  Lion Gate Building – Portland Car Park
  Richmond Building – open area outside of building

![Fire assembly points](image.png)
General information

• Toilets
  Portland Building:  Ladies – Ground Floor and 2nd Floor
                  Gents – Ground Floor and 1st Floor
                  Disabled – Ground Floor and 1st Floor
  Richmond Building: Ladies – Ground Floor and 1st Floor
                    Gents – Ground Floor and 1st Floor
                    Disabled – Ground Floor and 1st Floor

Smoking
Smoking is prohibited in all University buildings, but there are designated smoking areas outside.

Dietary, Mobility and Other Requirements
Please let the registration desk know if you have any additional special requirements.

Badges
Please wear your badge throughout the conference.

ICTMT10 Feedback and ICTMT11
We welcome your feedback!

Your feedback on the academic programme, social programme and the general organisation of the conference is encouraged in order to assist in the preparations for ICTMT11 in 2013. Please complete the feedback form in your conference bag and return it to the conference information desk in Portland Atrium at the end of the conference or complete the online version via the conference website http://ictmt10.org afterwards. During the closing session of the conference there will be an announcement about the plans for ICTMT11.

About the City of Portsmouth

Portsmouth is an island city, measuring approximately 5 miles wide and 3 miles long. It is the home of the modern UK Royal Navy and is proud of its maritime heritage; the Historic Dockyard is home to HMS Victory, HMS Warrior, the Mary Rose and the Royal Naval Museum. In the local area there are many examples of Britain’s sea defences such as Southsea Castle and the sea forts, which are clearly visible from the Spinnaker Tower. Apart from its naval heritage, Portsmouth has many fine buildings including two cathedrals – one Catholic and one Anglican.

Portsmouth has been home to a diverse range of key historical figures including Charles Dickens, Isambard Kingdom Brunel, H.G. Wells, Rudyard Kipling, Peter Sellers and Arthur Conan Doyle.

Portsmouth is a vibrant city packed with shops and hostelries. Close to the University is a relatively new development, Gunwharf Quays, where you will find a wide range of designer outlet stores, restaurants, cafés and bars, cinema and other entertainment – all on the waterfront.

ICTMT10 history and background

The biennial ICTMT conference is a legacy of Professor Bert Waits’ (Ohio State University) commitment to promote technology in mathematics education. The inaugural conference was held in Birmingham, UK in 1993. The ICTMT conferences aim to bring together lecturers, teachers, educators, curriculum designers, mathematics education researchers, learning technologists and educational software designers, who share an interest in improving the quality of teaching and learning by effective use of technology. It provides a forum for researchers and practitioners in this field to discuss and share better practices, theoretical know-how, innovation and perspectives on educative technologies and their impact on the teaching and learning of mathematics. Previous ICTMT conferences have been held every two years in the following countries:

<table>
<thead>
<tr>
<th>ICTMT</th>
<th>Year</th>
<th>City</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICTMT1</td>
<td>1993</td>
<td>Birmingham</td>
<td>England</td>
</tr>
<tr>
<td>ICTMT2</td>
<td>1995</td>
<td>Edinburgh</td>
<td>Scotland</td>
</tr>
<tr>
<td>ICTMT3</td>
<td>1997</td>
<td>Koblenz</td>
<td>Germany</td>
</tr>
<tr>
<td>ICTMT4</td>
<td>1999</td>
<td>Plymouth</td>
<td>England</td>
</tr>
<tr>
<td>ICTMT5</td>
<td>2001</td>
<td>Klagenfurt</td>
<td>Austria</td>
</tr>
<tr>
<td>ICTMT6</td>
<td>2003</td>
<td>Volos</td>
<td>Greece</td>
</tr>
<tr>
<td>ICTMT7</td>
<td>2005</td>
<td>Bristol</td>
<td>England</td>
</tr>
<tr>
<td>ICTMT8</td>
<td>2007</td>
<td>Hradec Králové</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>ICTMT9</td>
<td>2009</td>
<td>Metz</td>
<td>France</td>
</tr>
</tbody>
</table>
International scientific committee

Steve Arnold, Compass Learning Technologies, Australia
Michèle Artigue, Université Paris Diderot, Paris, France
Bärbel Barzel, University of Education, Freiburg, Germany
Rosa Bottino, Italian National Research Council (CNR) Institute for Educational Technology (ITD), Italy
Alison Clark-Wilson, University of Chichester, UK
Paul Drijvers, Utrecht University, Holland
ian Galloway, University of Southampton, UK
Keith Jones, University of Southampton, UK
Marie Joubert, University of Bristol, Chair, UK
Jan Kaspar, Charles University, Prague, Czech Republic
Moshe Lieba, Tel-Aviv University, Israel
Matija Lokar, University of Ljubljana, Slovenia
Michael McCabe, University of Portsmouth, UK
Jarmila Novotná, Charles University, Prague, Czech Republic
Adrian Oldknow, University of Chichester, UK
Federica Olivero, University of Bristol, UK
Robyn Pierce, University of Melbourne, Australia
Dave Pratt, Institute of Education, University of London, UK
Ornella Robutti, University of Turin, Italy
Nathalie Sinclair, Simon Fraser University, Burnaby, Canada
Luc Trouche, Institut National de Recherche Pédagogique, Lyon, France
Hans-Georg Weigand, University of Würzburg, Germany

Acknowledgements

The Local Organising Committee would especially like to thank the following for their valuable contributions towards the planning and delivery of the conference:

David Goodwin and Nicki Bown (general conference organisation)
Andy Redmond, Tony Whitelock and Jemma Best (finance)
Kate Daniell, Maricar Jagger and Tracy Hunt (marketing)
Rosemary Shearer and Stephen Ganfield (this conference handbook)
Jean Antcliffe (sponsors)
Barrie Miles and Craig Browning (computing support)
Spencer Williams and Andrea Forbes (TI)
Stella Diamond and Chris Burke-Hynes (Bloodhound support)
Caroline Segrave Kovacs and all her team of conference ambassadors
Andrew Osbaldestin, Head of Mathematics, University of Portsmouth
Adrian Oldknow, Emeritus Professor, University of Chichester

We thank all delegates for their contributions and the many others who have supported ICTMT10 along the way.

Local organising committee

Alison Clark-Wilson, University of Chichester, Co-chair
ian Galloway, University of Southampton
Carol Knights, University of Chichester, Social Events
Chris Martin, Hampshire Local Authority
Michael McCabe, University of Portsmouth, Co-chair
Lynn Peyt, University of Portsmouth
Stephen Webb, University of Portsmouth
Alison White, University of Portsmouth, Conference Manager
Jane Woods, Portsmouth City Local Authority
**Personal conference timetable**

*Please fill in your choice of parallel session, meetings and excursions in the blank boxes.*

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td>Registration (Portland Atrium)</td>
<td>Plenary Keynote 2 (PO 1.53)</td>
<td>Parallel Session 7:</td>
</tr>
<tr>
<td>10.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.00</td>
<td>Welcome (PO 1.53)</td>
<td>Coffee</td>
<td>Coffee</td>
</tr>
<tr>
<td>11.30</td>
<td>Plenary Keynote 1 (PO 1.53)</td>
<td>Coffee</td>
<td>Plenary Session 8:</td>
</tr>
<tr>
<td>12.00</td>
<td>Parallel Session 4:</td>
<td>Lunch (picnic)</td>
<td>Plenary Keynote 4 (PO 1.53)</td>
</tr>
<tr>
<td>12.30</td>
<td>Lunch (hot)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.30</td>
<td>Parallel Session 1:</td>
<td>Lunch (hot)</td>
<td>Closing ceremony</td>
</tr>
<tr>
<td>14.00</td>
<td></td>
<td>Lunch (hot)</td>
<td></td>
</tr>
<tr>
<td>14.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.00</td>
<td>Tea</td>
<td></td>
<td>Lunch and departure</td>
</tr>
<tr>
<td>15.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.00</td>
<td>Parallel Session 2:</td>
<td>Tea</td>
<td></td>
</tr>
<tr>
<td>16.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.00</td>
<td>Meetings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.00</td>
<td>Welcome reception (Portland Atrium)</td>
<td>Public Lecture (RB LT1)</td>
<td></td>
</tr>
<tr>
<td>18.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.00</td>
<td>Drinks reception (Portland Atrium)</td>
<td>Pre-dinner drinks on HMS Warrior</td>
<td></td>
</tr>
<tr>
<td>19.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.00</td>
<td>Public Lecture (RB LT1)</td>
<td>Conference dinner on HMS Warrior</td>
<td></td>
</tr>
<tr>
<td>20.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.00</td>
<td>Spinmaker Tower open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>